FOOD SAFETY STANDARDS IN TOMATOES AND THEIR EFFECTS ON RISK MITIGATION FOR GROWERS

By

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To my mom, dad, grandparents and sister, Dominique. Without their support I would not have accomplished all that I have already accomplished in life. I would also like to dedicate this to Brian, who for the last two years has stuck beside me through thick and thin. His unwavering support has helped me to accomplish this and so much more.

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There is limited research done on the impacts of risk mitigation practices that are being implemented with food safety standards in specific produce industries. Extensive research has been done on cattle and some leafy green produce, but very few topics touch on the issues with tomato production. There has been a significant decrease in the probability of contracting a food borne illness from Florida tomatoes, mainly due to the enforcement of food safety standards. Yet it remains unknown what the cost of a food safety incident in the market is. This research addresses both of these concerns utilizing regression analysis to quantify the impact of an incidence on Florida tomatoes and a value-of-information analysis to determine the impact of food safety measures to mitigate these impacts. There is evidence that an incidence of salmonella results in a significant price decrease. In addition, the findings of the present research indicate that there has been a significant decrease in the probability of contracting a food borne illness from Florida tomatoes. There are numerous opportunities for further research on this topic that could be done with larger data sets.

CHAPTER 1
INTRODUCTION

Beginning in the early 1900s food safety became an issue that the government attempted to tackle. With the advent of modern transportation and the means to send goods quickly across borders there is an even stronger need for regulations. In 2007 the state of Florida implemented their own set of food safety guidelines in response to the multi-state salmonella outbreak in July of that year. Many of the growers in Florida utilize various audit companies to ensure that their product will be accepted by the packing houses and suppliers. This is in response to a push by the supplier to maintain strict tracking and credibility standards in the produce market to limit their risk of food safety incidents. Maintaining standards that Florida wants for growers and the additional costs of private audits increases the cost to produce tomatoes. This cost is ultimately passed on to the consumer, and assuming that the consumer can get cheaper produce from another source, there is no incentive to maintain these standards.

Starting in 1998 food safety became a large concern for the tomato industry because 14 out of the 78 outbreaks were linked to fresh tomatoes from 1998 through 2008. It was during 1998 the federal government issued the GAPs guide, which provides general guidelines to producers of fresh produce. In 2004 the Food and Drug Administration (FDA) issued a Produce Safety Action Plan (Action Plan) that had four general goals associated with it. They intended to (1) prevent contamination in fresh produce, (2) limit the impact of contamination to the public, (3) facilitate better communication and (4) improve relevant research on food contamination. Another facet of this Action Plan was to create a multi-year tomato safety initiative which began in

2007. This program was in coordination between the states of Virginia and Florida, the FDA and several educational institutes. It is through this research and funding that the commodity specific guidelines for tomatoes have originated (Guidance 2009).

Growers are concerned that there is no risk mitigation with these food safety standards, and that there is not any improvement before and after implementation of the standards. In 2007 mandatory food safety audits were enforced in the Florida tomato industry. It remains to be seen if these standards have caused an improvement in food safety. The standards ultimately provide an indication that the product is safe, the guidelines are followed and the food safety outbreak is not originating at their farm. Yet recent studies done by Arnade (2009) and Lloyd (2001), suggest that even if a grower is not responsible it will affect them regardless. In the case of the spinach E.Coli outbreak, one year after the incidence there was still evidence of a decrease in demand that can be attributed to the food safety outbreak

This research looks at how food safety standards have impacted producers in Florida. By utilizing Value of Information (VOI) analysis it can be determined if there is a difference between growers that utilize private audit firms and growers that only utilize Florida Department of Agriculture and Consumer Services (FDACS) audits. This data was not available during this study and therefore the VOI provides an analysis of what will occur when a food safety incident occurs. Additional research was done to determine what the price impact on tomatoes due to food borne illnesses was. Regression analysis was employed to examine the impact that salmonella and hepatitis A have on the price of tomatoes. A survey was created and distributed to determine the impact that food safety regulations and guidelines have had on individual growers in terms of profit, price and their beliefs. These methods have not previously been employed to study Florida tomatoes and food safety.

This research is intended to help producers understand the impact of food safety regulations are on their bottom line. Furthermore it will allow some understanding of what regulations provide to consumers and producers alike.

CHAPTER 2
LITERATURE REVIEW

The first studies on United States food safety date back to the early 1900s. In 1902 according to the Food and Drug Administration (FDA), funds were first allocated to a study to determine the safety of food preservation. It was at this point in time, after studies were done that it was determined the onus of food safety should be on the producer of food, and that it should be food labels that provide consumers with all the information that they need. The only thing that was conquered during this time was the actual ingredients that went into the product would be included in labeling and not the manner in which the product was handled. It was in 1906 that the first law was signed by Theodore Roosevelt and “prohibited the introduction of misbranded and adulterated foods, drinks, and drugs in interstate commerce; prohibited the addition of color additives to conceal inferiority; and prohibited the use of "poisonous" colors in confectionary”. This was called the Pure Food and Drugs Act and was enforced by the Department of Agriculture and the Bureau of Chemistry (Janssen 2009).

It was also at this time that an important piece of literature was published, *The Jungle* by Upton Sinclair (1906). This highlighted the conditions in which meat was produced and catapulted the Meat Inspection Act at the same time the Pure Act was passed. Then in 1913 another law was passed which was referred to as the Gould Amendment which required listing ingredients on the packaging. It was in 1930 that the Agency controlling these standards, the Bureau of Chemistry, became the Food and Drug Administration that we know today. The first law to pass under this new organization was the result of individuals dying due to a chemical in the food product. Finally in 1939 the first act passed relating to tomato products and it dealt specifically with canned tomatoes, paste and puree, and aided in determining actual ingredients. Different laws and regulations were enacted in the following years, some focusing on specific products others on problems with production or labeling (Janssen 2009).

It was in 1997 that President Clinton presented a proposal for a food safety initiative, titled ‘Food Safety from Farm to Table’. This proposal was intended to further reduce the incidence of food borne illness using strategies outlined by the six agencies in charge of regulating food safety. It was the intention of the government at this point in time (1994) that private and public organizations work together to combat food safety issues. The report stated that the health system was not able to adequately monitor and control food pathogens to an extent necessary to prevent deaths and illness. There were six fundamental agencies that dealt with food safety- two under the Department of Human and Health Services, three under the Department of Agriculture and one under the Environmental Protection Agency. It was these agencies who pushed for implementation of the Hazard Analysis and Critical Control Point (HACCP) system in order to identify points of contamination and clearly outline who is responsible for each part of the regulatory system for food safety. This type of program existed on a Federal level for meat, poultry and seafood, at the time of this report. The 1967 Federal Meat Inspection Act requires that poultry and meat be inspected at the state level. The requirements ensure that the level of inspection at the state level is either equal to or beyond the requirements at the Federal level (Federal Food Safety Laws 2010). Unfortunately there is no federal regulation at a state level for these procedures. It has become the responsibility of the states to create their own standards and enforce them (United States 1997).

Prior to the salmonella outbreak of 2007 that was at first attributed to tomatoes, "the Florida tomato industry developed BMPs and GAPs that everyone is mandated by law to follow" (Ashby 2009). BMPs refer to the best management practices while GAPs refer to good agricultural practices, both are frequently used in agricultural audits. The most recent outbreak occurred because of salmonella Saintpaul and was attributed to tomato production in June of 2007. According to the Center for Disease Control and Prevention (CDC) as of 1990 there have been 12 multi-state produce outbreaks in addition to various smaller outbreaks that can be attributed to the production of tomatoes (CDC Salmonella 2010). In July, 2002 an outbreak occurred in Orlando Florida resulting from the strain salmonella Javiana that was traced back to roma tomatoes (Toth 2002). Furthermore in August, 2002 another outbreak occurred resulting from the strain salmonella Newport while there has been no report by the CDC linking this outbreak back to tomatoes; the media has implicated a packing house in the Northeast region of the United States (Shin 2008).

In 2004 CDC reported an 18 state outbreak of salmonella resulting from infected roma tomatoes, in 3 separate outbreaks. All of the CDC studies were based on a case-control study using an equal number of well and sick individuals to determine the source of the outbreak. Once they obtained these data a multivariate analysis was performed to determine that the illness resulted from the consumption of fresh sliced roma tomatoes, at least in the 2004 case (Corby 2005). Then from 2005 to 2006 there were 519 confirmed cases of salmonella resulting from tomatoes grown in Ohio, Virginia and Florida fields. Again a case control study was conducted and three separate outbreaks of salmonella were traced back to tomato production. The most recent outbreak in April

2007 was ultimately traced back to Jalapeno peppers, but not before irreparable damage was done to the tomato industry. The tomato industry is still experiencing the aftershock of being linked to the salmonella scare in the form of a decrease in revenue of ten percent (Ashby 2009). There appears to be greater implications than just a loss of revenue though as the California growers for leafy greens have shown food safety costs to have more than doubled since their link to E. Coli. Like the state of Florida, California has adopted standards for growers that enable buyers to trace back and ensure that the produce is properly grown. California leafy greens are subject to the California Leafy Green Products Handler Marketing Agreement (LGMA), which is similar to the standards enforced by the Florida Tomato Committee in the form of audits (Growers 2009).

Fortunately for the growers of Florida Tomatoes, long before standards were in place, independent audits existed. Companies like Primus performed audits on the growers in order to ensure packing houses were getting clean produce. This was not standardized across the industry, and as a result the state stepped in with government audits. The problem now is that some growers still have to perform the independent audits in addition to the government mandated audits which is resulting in increased costs for the growers. These audits are in some cases mandatory before the shipping house will package and ship the tomatoes to the supplier. No data yet exists on what the risk is for not performing these audits on the tomato growers themselves, but there is some information on the impact that these food scares have had on other markets.

Lloyd et al. (2001) focus on food safety scares and the impact they have on beef and other markets, specifically in relation to Bovine Spongiform Encephalopathy (BSE).

In addition they are focusing on what has occurred because of the link between BSE and Creutzfeld-Jakob disease (CJD). They find that a link between a particular product and a disease or problem results in a market collapse for the product. Furthermore they focus on the supply chain and the effect that the food scare has on each of three stages in the marketing chain: retail, wholesale and producer. Their findings indicate that the producer is the hardest hit, financially, with more than double the fall out than what can be expected for the retailer. This is not a constant effect but rather a generalization of what has occurred to the beef sector as a result of the linkage between beef and CJD as a result of BSE. An increase of poultry consumption is also reported as beef consumption falls because of the link to CJD. This can be expected as poultry is a substitute for beef in the event of a price change or in this case a food scare. This has direct implications to the tomato industry because there are substitutes for tomatoes. Furthermore the link between a food safety incident and tomatoes will cause a decrease in the production of tomatoes according to price and demand (Lloyd 2001).

Calvin states that in 1998 the FDA submitted voluntary guidelines to limit microbial contamination using GAPs. It is important to note that there are no mandatory federal guidelines that growers and shippers must use, and regulations vary state to state with Florida being the first to influence tomato standards in the form of an audit. Calvin makes a point to note that Federal guidelines leave it to the discretion of each grower to determine if the risk outweighs the cost to implement certain procedures which would help to eliminate microbial diseases in fresh produce. Furthermore growers can opt to have a private audit done, which some packing houses and purchasers require, the cost for this in some areas is substantial. Outbreaks are actually increasing as measured through the 1990's which would indicate that not enough is being done to curtail the risk associated with growing fresh produce (Sivapalasingam 2004). This does not distinguish between domestic and international produce that is sold in the United States, the study we will be conducting looks at the impact that any food borne outbreak on tomatoes has on the overall Florida tomato industry. It remains to be explained why the actual number of outbreaks has increased and whether this is a result of better oversight by the FDA and other regulatory bodies or whether there actually are more cases (Calvin 2003).

Carter and Smith (2006) estimated the market effect of a food scare using genetically modified StarLink corn. This study ended up being a natural study because StarLink corn was leaked by accident into the non-modified corn and was consumed by humans. A natural study means that this study was not controlled but occurred in the public arena. The public found out about the introduction of the genetically modified corn into their food and the effects are studied in this paper. The authors highlight three methods previously used to determine the impact that StarLink had on the corn market, yet ended up using a new model that created a relative price for a substitute (RPS). This model was adequate because it takes into account other products that can affect demand and uses time series data to adjust for the food shock. In essence they isolated the shock from any and all other changes such as income and technology, allowing them to estimate the effect that StarLink had on the market for corn. The point is made that "the exact time that StarLink hit the market is often unknown" which suggests that using a model estimated with time series data may be the best way to optimize results. This study ultimately found that there was a significant decrease of 7 percent in the price of corn which lasted for approximately one year. Overall individuals were willing to accept the risk of eating genetically modified products at a price reduction (Carter 2006).

The question of whether food safety information impacts U.S. meat demand is answered at least partially by Piggott and Marsh (2004). They introduced the point that food safety concerns are easier to detect and remain a shock to the system longer than concerns over health. Such concerns are usually in the form of outbreaks where information to the public is readily available and tend to shock demand due to the influx of information. Their theoretical model infers that such shocks are a result of belief about quality due to the safety scare and thus they relate quality and food safety as inversely related. This research concludes by finding that the economic impact of food safety issues is small but statistically important for the product and its substitutes (Piggott 2004).

There is an argument that the overall benefit of tracking far outweighs the costs associated with the process. Cox et al. (2005) focused on this in determining a probability model that allows costs to be estimated for each decision made. Dealing with BSE they determine that discovery of BSE in the United States regardless of where it came from can severely damage export trade. In order to mitigate this risk they determined probabilities using a probability tree with not tracking and tracking and not testing and testing. They were able to develop costs associated with each of these models and determined that the cost associated with not tracking was the equivalence of $90 million per year, while tracking costs were only $10 million. This study showed that tracking resulted in lower risks and overall less cost to the market. It was determined that the ideal outcome was for tracking and testing cattle from Canada in order to mitigate risk associated with BSE (Cox 2005).

Arnade, Calvin and Kuchler (2009) studied the impact of a food safety shock on the market in relation to the 2006 outbreak of E. coli in bagged spinach products. This is one instance where the FDA made an announcement at the time of the outbreak and not after the incident had already occurred. This study focused on determining the overall impact of substitutes in the market and the market for spinach itself. Using the Almost Ideal Demand System (AIDS) in a two-staged analysis, the upper and lower stage, they obtained two equations to estimate impacts. They concluded that following the FDA announcement in 2006 of the problem with bagged spinach, the demand for this product dropped significantly, and remained low even at the end of 2007. This drop in demand also affected the purchase of other bagged leafy greens, but did not appear to have as large of an effect on bulk leafy greens including spinach. Overall there was a decrease in the total expenditures on leafy greens by 1%. This demonstrates that there is a measurable impact of a food safety scare that affects both substitutes and the products and extends far beyond the actual outbreak (Arnade 2009).

The early 1900s forced the creation of several different agencies and programs to regulate problems resulting from food production. This was really the advent of food safety hazards and the research that followed. Just in the last ten years (2000-2010) various administrative leaders have made it a point to propose legislation related to food safety, from Clinton with the Food Safety from Farm to Table report and just this past year with Obama developing the Food Safety Administration (United States 1997). While there have been numerous outbreaks of salmonella and other food borne illnesses related to tomatoes, the research does not exist that demonstrates the risk associated with food safety that farmer is taking to produce tomatoes and furthermore what has been done to mitigate that risk. In 2008 another outbreak of salmonella Saintpaul occurred and while it was not traced back to tomatoes, tomatoes were implicated early on (Ashby 2009). This had a direct impact on the sale of tomatoes across the nation and affected the farmers in Florida specifically (Ashby 2009).

The Florida Department of Agriculture and Consumer Services (FDACS) had begun enforcement of Tomato Good Agricultural Practices (T-GAP) and Tomato Best Management Practices (T-BMP) using audits enforced by the state of Florida. These standards were widely recognized by the industry, but Florida was the first state to enforce them on a state-wide basis. This enabled the state to say that tomatoes from Florida were not the culprit in the 2008 outbreak. The impacts of food safety shocks and scares have been investigated by numerous authors but primarily with respect to beef and its substitutes. A natural study by Carter and Smith (2006) provides some basis in which we can look at the market effects of a food safety shock using corn. Furthermore Piggott and Marsh dissect what happens with demand when a food safety shock occurs. We will primarily be focusing on what type of risk exists for producing fresh tomatoes, and whether the risk has in some part been mitigated by audits required by the State of Florida.

At this time (2010) there is draft guidance for Federal legislation related to tomato production and food safety issues. This legislation is the nearly the same combination of measures and control that the State of Florida uses to prevent food borne illness. This legislation does not call for mandatory federal inspections. The need for private inspections may still exist with this legislation as buyers may still require growers to use these services, thus increasing costs. This legislation is pending and utilizes the same checklists and ideologies as the mandatory Florida inspections; the data presented in this paper is likely to reflect that risk associated with passage of this legislation.

CHAPTER 3
METHODOLOGY

Purpose

The purpose of this study is to determine the impacts of food safety incidences on tomato growers and whether audits decrease the risks that they assume. It is hypothesized that salmonella will have a large negative effect on the price of tomatoes when there is an incident. Furthermore it is believed that, in addition to public audits, private audits have the best ability to reduce risks for tomato growers.

Regression Analysis

Surveys were sent out to tomato farmers in Florida with several reminders sent to encourage a response. Unfortunately only two surveys were returned with useable data. This altered the manner of data collection but not the purpose of the study as a whole. As a result this study used data already reported in the scientific community. Every year the CDC releases a report on the number of food borne disease outbreaks by etiology. These data are used in a regression analysis. This information is readily available on the CDC website (Outbreak Surveillance Data). Based on these data, only incidents where tomatoes were listed as the vehicle of transmission were included in the study.

Starting in 2006 these data included the number of hospitalizations as well as the deaths due to each individual outbreak. These data provided the location of outbreak, the month of outbreak, the number of ill and the confirmed etiology. Not all cases were confirmed with some cases only stating the suspected etiology or vehicle of transportation. These data are included in the overall data even though they are not confirmed and only suspected. In many instances there is more than one vehicle of transportation; in these instances the data are included.

Regression analysis was performed to determine the overall impact on the price of tomatoes as a result of food safety incidences in the tomato market. Using a simple regression analysis with six independent variables and one dependent variable, the overall impact of a food scare on price was estimated. The price of tomatoes was specified as a function of the number of cartons produced (quantity) in Florida and Mexico, the price of a substitute, consumer income and finally whether or not the month had a food safety scare. This model uses the price of Florida tomatoes as the dependent variable. This price is used in order to analyze the effect that food safety scares associated with tomatoes as a whole have on the price of Florida tomatoes. The quantity of Florida and Mexican tomatoes is measured in cartons (25 pounds) of tomatoes. The price of Florida cucumbers was included in the model to account for substitution effects. The price of Florida green peppers was tried as an alternative to Florida cucumbers as a substitute but proved to be an insignificant factor. Consumer income is measured by the national consumer income reported by the Bureau of Economic Analysis. It is a report of earnings as received by employee per month. In addition an interaction term between consumer income and the price of Florida cucumbers was added to the model,. Finally there are two dummy variables, each measuring a different food etiology that has occurred; salmonella and hepatitis A. Two other dummy variables were tried in the model, norovirus and unknown, but both were found to be insignificant and removed.

SAS computer analysis program software[‡] was used to estimate the model discussed above. Formally, this model can be written as

$$P = \beta_0 + \beta_1 CI + \beta_2 QQS + B_3 SALMONELLA + \beta_4 HA + \beta_5 CUC + \beta_6 CIC \quad (3\text{-}1)$$

The variables in equation (3-1) are defined as follows : p: the price of Florida tomatoes, as reported by the Florida Agriculture Statistical Directory. qqs: the quantity of Florida tomatoes and Mexican tomatoes as reported by the Florida Tomato Committee Report. ci: consumer income as reported by the Bureau of Economic Analysis, measured as compensation received by employees (not deflated, seasonally adjusted at an annual rate). *cuc*: price of Florida cucumbers as reported by the Florida Agriculture Statistical Directory. $salmonella$: a dummy variable with respect to whether there was an outbreak of salmonella during the month in question, as reported by the CDC. ha: a dummy variable with respect to whether there was an outbreak of hepatitis A during the month in question, as reported by the CDC. *cic*: an interaction term between consumer income and cucumber price.

Equation (3-1) in level-level form was estimated using the OLS method. A log-log model was attempted but the results did not fit well. The model was corrected for autocorrelation after determining the model was subject to a first-order autocorrelation.

Equation (3-1) is a price dependent demand equation, and the impacts of the explanatory variables on price in terms of percentage changes, which are referred to as flexibilities, are often considered. The flexibilities of the variables can be derived from

[‡] The data analysis for this paper was generated using SAS software, Version 9.2 of the SAS System for University of Florida. Copyright © 2002-2008 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

the results as follows:

$$Flexibility = \frac{\partial \mathrm{p}}{\partial \mathrm{x}} * \frac{\mathrm{x}}{\mathrm{p}} \tag{3-2}$$

In equation (3-2) x stands for CI, QQS and CUC. The partial derivative $\partial p/\partial x$ is $\beta_1 + \beta_6$ CU when x = CI; β_2 when x = QQS, and $\beta_5 + \beta_6$ CI when X=CU.

Sample mean values are used for p and the other variables present in the regression to estimate the flexibilities. In this manner the impact that changes to the food safety environment have on price of Florida tomatoes can be estimated.

VOI Analysis

Additional data from the Florida Tomato Committee annual reports will be used to calculate the incidence rate for food borne illness. A simple computation was used to estimate the incidence rate for each food borne illness by dividing the number of ill by the number of tomatoes produced. Originally data from various private audit firms were to be used to determine the probability of a food borne illness from audited farms as compared to non-audited farms. Various private audit firms were approached in order to obtain this information. Unfortunately this information was not made available and therefore the only analysis that could be completed to determine the probability of suffering from food borne illness for all tomatoes produced regardless of whether they were for privately audited farms or not. The incidence rate is estimated as follows:

$$\frac{Number\ of\ Ill\ from\ Salmonella, Norovirus, Hepatitis\ A\ or\ Unknown\ per\ year}{Quantity\ of\ Tomatoes\ Sold\ Nationally\ per\ Year} = Incidence\ Rate\ per\ Unit\ of\ a\ Food\ Borne\ Illness\ from\ Tomatoes \tag{3-3}$$

This equation will be used to determine the probabilities necessary to estimate the impacts of implementing food safety standards in Florida in June 2007 and how they impacted the incidence of food safety outbreaks. This will help to determine whether the cost associated with food safety programs actually mitigates any food safety risk for the producers of Florida tomatoes. By determining average prices, when there is no salmonella and price per month with incidences of 2007, using Equation (3-1) a revenue stream can be determined. The difference in the two revenue streams represents the overall impact of incidences of salmonella. In addition it can be found what percentage decrease in revenues will occur due to food safety incidences.

Figure (3-1) demonstrates the decisions that a grower has to make prior to shipping his product to suppliers. The first decision is inherent within the decision to produce tomatoes; the State of Florida requires that all producers undergo an FDACS audit. The second decision is one that is either pushed upon the producer or the producer makes the decision to participate in. Some suppliers require that producers have private audits done to ensure the quality of the product. The funds for these audits come out of the growers budget and are not in any way subsidized or funded by a third party. The audits are meant to be comparable to the FDACS audit but in some cases are more thorough. Had the data been obtainable from private audit firms, the probability of a farm passing on a food borne illness with and without private audits could have been determined. Without this data the value of the private audits cannot be determined.

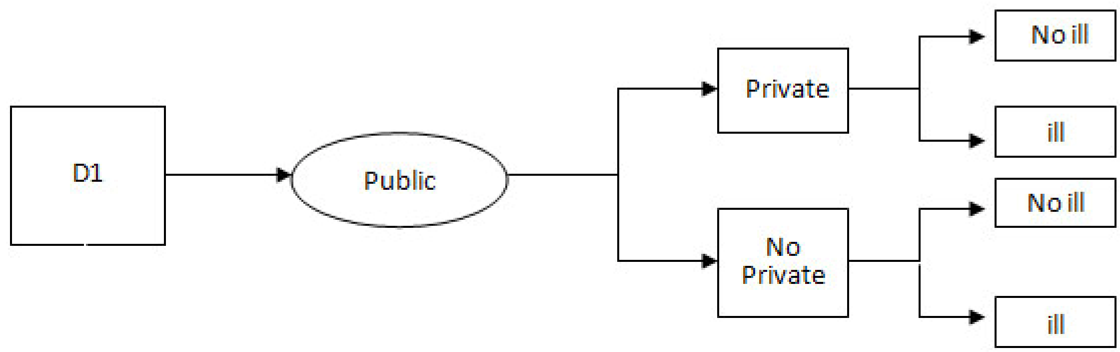

Figure 3-1. VOI Chart. D1: The original decision point. Ill: represents an incidence of food borne illness that is reported. No ill: represents no incidence of a food borne illness.

These two data sets will be combined to determine the overall effect of food safety scares in the tomato market. Utilizing both probability data and the regression the actual impact that these events have on the tomato market can be determined.

CHAPTER 4
RESULTS

The OLS method was initially used to estimate model (3-1). The Durbin Watson statistic, however, indicated an autocorrelation problem, and the model was re-estimated under a first-order autocorrelation structure for the error term. The OLS estimates are shown in table (4-1), while model estimates corrected for autocorrelation are shown in table (4-2). The results in table (4-1) and table (4-2) both indicate that an incidence of salmonella as related to tomato products results in a lower price for tomatoes. The results suggest that lower prices result from a decline in demand for the product as a result of food safety concerns. The coefficient on the salmonella dummy variable is significant at the 10% level of significance, with a negative sign, implying a decreased price with incidence. Thus, this variable demonstrates that food safety incidents can significantly affect the price of tomatoes. In addition, the estimated coefficient for the hepatitis A dummy variable was negative, indicating that this variable also negatively impacts the price. However, the p-value for the hepatitis A coefficient, , is rather large (0.2365) in comparison to those for the rest of the variables in the model, so there is no solid evidence that an incidence of hepatitis A will result in a decrease in price. Despite, the mixed level of statistical significance on these two dummy variables, the hypothesis that both of these variables, measuring incidences of a food safety outbreaks, affect the price of a tomato tomatoes would seem to be an interesting area for future research.

The data used in this analysis only spanned four years, from 2004 to 2007, and variation in the data was limited, possibly resulting in reduced significance of the model estimates. Nevertheless, some of the variables utilized in this regression had impacts which were expected by the researcher. The coefficient on the quantity of Florida and Mexican tomatoes that were produced each month was significantly different than zero at the 10% level and had the correct sign, negative; that is when quantity falls price tends to rise and vice versa. Consumer income and the price of cumbers, however, had neutral effects (not significantly different than zero), taking into account both the direct and interaction coefficients (the income effect was measured as the direct coefficient for income plus the interaction coefficient times the mean value of the cumber price, while the cumber price effect was measured as the direct coefficient for this variable plus the interaction coefficient times the mean value of income).

Another important note to make about the estimated model is that its R-squared value at 0.2664 is relatively low. Again, the length of data and limited variation of the variables may be underlying this result. Had there been more data available such as a ten year data set, a larger R-squared may have been found as well as higher t statistics for the estimated coefficients. This speculation suggests future research might consider repeating this analysis based on a larger data set.

As discussed earlier in the literature review there is a concern about the lasting effect of an incidence of a food borne illness. Although it is possible to pinpoint the instance that the food borne illness begins to occur, it is impossible to determine when exactly it hit the market. The regression model takes into account the month in which the incidence is registered with the CDC, and when there is an actual illness associated with it. A time decaying variable was added to the model but it was found to be insignificant. This does not necessarily imply that the effect only lasts the month that the outbreak occurs but rather that it is hard to quantify the impact that the outbreak may have on the market for a longer length of time. A longer time series data set would be ideal in this situation; it would need to include more than the four years of data that were available at the time of this study. Further analysis of this topic may find, for example, an impact like that estimated for the leafy green market; in this case, a severe outbreak resulted in an overall decrease in consumption and revenue for a much longer period than the incidence lasted. Seasonality is another factor that was not considered in this study due to the limited data. With an expanded data set this factor might also be explored.

As indicated above, a test was run on the OLS regression results to determine if there was an issue with autocorrelation. For the original OLS regression the Durbin-Watson was 0.952. This value falls below the lower limit with six variables and an intercept with 44 observations. The autocorrelation correction was run using a lag of 1 and a new Durbin-Watson was found of 1.5479. This is in the indeterminate range and is considered here to be acceptable.

Flexibility Analysis

Price flexibilities are utilized in this model with the dependent variable being price. The flexibilities simply indicate percentage changes in price for one percent changes in the dependent variables; i.e., they are elasticities in context of a price dependent demand specification. Generally, price flexibilities represent the response of price to changes in costs and demands when both are changing in a competitive market (Moore 1955). This concept allows the research to create comparisons between price and the various variables in the model through percentage changes.

Referring back to Equation (3-2) we can find the flexibilities for each variable. The flexibilities in this study are calculated at the sample mean values of the variables involved. The price flexibility for consumer income is -1.8344 which implies that a 1% increase in consumer income will result in a price decrease of 1.8344%. It is important to recognize that the flexibility for consumer income on the tomato price is a linear combination of two coefficients (the coefficient on consumer income and the coefficient on the interaction term). Based on the F-test, this flexibility is not statistically different from zero at the 10% level of significance. Therefore it does not suggest that tomatoes are an inferior good, but rather that tomatoes are neutral with respect to income. It should be noted that, income roughly follows a time trend variable and may be picking up other factors beyond the effect of income on the price of tomatoes.

The price flexibility of quantity is -0.595, indicating that a 1% increase in quantity produced results in a 0.595% decrease in price. For cucumbers, the price flexibility is 0.0604 which suggests that a 1% increase in the price of cucumbers results in a 0.0604% increase in the price of tomatoes. As is the case with consumer income, the impact of the cucumber price on the tomato price is a result of a linear combination of the cucumber price coefficient and the coefficient on the interaction term. This flexibility is also not statistically significant based on the F-test at the 10% significance level.

The last two variables for salmonella and hepatitis A are binary; and elasticities for these variables were not calculated. The regression coefficient for salmonella is -2.61, meaning an incidence of salmonella will decrease price by $2.61. To examine what percentage of price this is, consider the sample mean price of $11.39. If price were to decrease by $2.61 from $11.39 the percentage change would be 22.9%. This value provides a measure of the percentage decrease in price when there is an incidence of salmonella in the tomato market. Using the same method, the impact of hepatitis A on price can be examined. It should be noted that hepatitis A was found to be statistically insignificant. However, the sign of its coefficient was consistent with expectations; hence, the following does not have a strong statistical underpinning. The coefficient associated with hepatitis A is -4.10, which implies a decrease in price of $4.10 with an incidence of hepatitis A. This is a change in price of 36.0% from the base price of $11.39. Both of these percentage change values show the large extent that an incidence of a food safety outbreak may have on the price for tomatoes.

VOI Analysis

Using Equation (3-3) it is possible to find the probability of food borne illness for tomatoes produced for the United States market. It was not possible to find out the locations of all the outbreaks that were reported to the CDC, so the percentages are based on national output. From 2005 to 2006 the percentage opportunity of contracting a food borne illness from a tomato was $6.86 \cdot 10^{-6}$%. This implies that the chance not becoming ill is 99.9999314%. In 2007 these percentages changed slightly and the opportunity of becoming ill was $5.45 \cdot 10^{-6}$% or 99.999995% of not becoming ill.

The CDC does not report data to the public as to where they believe the outbreak originated unless there is conclusive evidence. While it can be argued that the chance of getting a consumer ill has decreased substantially from 2005 to 2007, the question is if it was a result of increased food safety standards or something else entirely. Farmers on average pay about fifteen hundred dollars to have a private audit done on their property, in addition to the cost to have the government perform their audit. This cost comes with no conclusive evidence that enforcing these standards results in fewer outbreaks of food borne illnesses. These percentages do not take into account where the tomatoes were produced. If the same data were to be run using only Florida tomatoes, the difference would be substantial. Most of the tomato production comes from California and Florida and the ability to pinpoint the source of the outbreak would do a lot to further the understanding of percentage risk of contracting a food borne illness.

It is important to note that in Figure (3-1) the first decision made is not actually a decision but more of a requirement. All tomato producers in the State of Florida are required to participate in an FDACS audit if they deliver their product to the general public. The second choice is one that the farmer can make on their own, or as required by their supplier. Private audits are supplied by many different firms and essentially do the same audits that FDACS does with some more in-depth analysis. Further research could be done in this area to determine if private audits provide enough additional benefit over public audits. Private audits are in most cases required by the packing house or the buyer of the tomato products and are paid by the grower. If these audits are essentially doing the same job that the FDACS audits are providing, then it really questions the need for both and the costs for growers to pay for private audits.

It is hypothesized that the optimal decision rule is to participate in both the public and private audits. There are a number of costs associated with this decision rule; the public audit cost, the private audit cost and the cost of an incident of a food safety outbreak. To determine the overall cost to the Florida tomato industry data from the Economic Research Service USDA division was utilized (U.S. Tomato Statistics 2010). U.S. fresh market field grown tomato production for the state of Florida in pounds was used to calculate revenue (Lucier 2008). From the regression equation(3-1) an price is calculated for every month and used to determine price received. Using the regression data and calculating an average price when there is no incident of food safety an average price of $11.15 was found. The cost for an audit is $75.00 an hour and the average audit takes about three and a half hours. This places the cost of a public audit at $262.50. A private audit on average costs between $1500.00 and $2000.00.[§]

A simulation of the tomato markets from the regression model when there is no incidence of salmonella in the tomato market estimates the state of Florida tomato industry earns on average $452,571,587 in revenue. When the model is simulated with the salmonella incidents that occurred the revenue is found to be $434,559,368. From these revenue estimates an expected value can be calculated which will help to determine at what cost audits are valued. The difference between these two revenues is $18,012,218. This is the value that can be placed on food safety audits to eliminate food borne illness risks to growers. This is the cost that growers as an industry can expect to pay to have audits still be worthwhile in terms of revenue streams. This amount is 3.98% of the actual expected revenue assuming there are no outbreaks of food borne illness. This value calculation is made with the assumption that the audits that are performed result in no incidences of food borne illness associated with salmonella or hepatitis A. It is important to note that while the expected value does not differ greatly from the value without salmonella the difference between revenue with salmonella and revenue without salmonella is substantial. Regardless of whether the incident occurs on Florida farms or outside the state of Florida the impact remains the

[§] This information was furnished by Charles Beasley who is the Bureau Chief of the Division of Fruits and Vegetables for the Florida Department of Agriculture and Consumer Services. He provided this information on a personal phone call on 3/29/2010 at 1 pm. He informed me that these were average estimates of prices for audits.

same, which is large in terms of the revenue lost. Furthermore, in relation to the revenue for three months in which the outbreaks occur (June July and October), the impact represents 28.32% of the revenue stream. By decreasing the incidence of salmonella in the market it is feasible that a large revenue increase can occur.

The implications are such that even though the probabilities appear low at first look, the substantial income that is lost due to an outbreak appears to justify the added cost of $262.50 for a public audit. It remains to be seen whether or not the additional expense for the private audit decreases the probability of selling infected produce.

The probabilities imply that there needs to be better monitoring in accordance with the audits. There is a question of the audits and whether they cover enough of the issues with tomatoes or the institution that is responsible for doing the audits. While there has been a significant decrease in the percentage chance of contacting a food borne illness from tomatoes, it remains to be seen where the critical point is, i.e., at what point is there less pressure placed on the grower to submit to public and private audits at regular periods in time.

Evidence exists that infers food safety standards are working and affecting the price of Florida tomatoes. As reported by the National Agricultural Statistical Service (NASS) there was a large decline in the price of Florida tomatoes in 2007 when the food incidents were at their highest, in terms of consumer awareness. Prices fell to $31.90 per 100 lb in 2007. This was with quantity produced more or less the same as in 2006 when price was at $40.90 per 100 lb. With the implementation of food safety standards and a decrease in quantity due to the low returns to growers, price rose in 2008 to $59.50 per 100 lb. While some of the price increase can be attributed to the quantity decrease, this provides anecdotal evidence to support the idea that food safety standards in Florida did cause some of this price increase (U.S. Tomato Statistics 2010).

Further research on this topic could impart knowledge on how the media affects the demand for tomatoes during and after a food safety incident. A study was done on apples that determined the impact the Alar crisis had on the public (Herrmann 1997). In addition to the research that has been done so far on tomato risk mitigation, looking at the media impact would certainly add to and enhance what is already known about the price impact on tomatoes in relation to an outbreak.

In conclusion there is evidence that food safety standards work to reduce the risk that a consumer has of getting ill from consuming a Florida tomato. Furthermore there is also evidence that the producer is mitigating their risk of producing a product that has a food borne illness by participating in the audits. It would be interesting to determine if the risk is further mitigated by participating in private audits as well as the mandatory public audits. This data was not available but hopefully in the future it can be determined if there is an additional benefit for a producer to pay for a private audit. This study is conclusive that an incidence of salmonella significantly decreases the price of Florida tomatoes; but the data do not show a decaying factor. With a larger data set it is hypothesized that there could be a significant decaying factor present. Further research on this topic will aid in public policy creation and food safety standards.

Table 4-1. OLS Regression Estimates of the Model (3-1)

VARIABLE	PARAMETER	Pr > |t|
INTERCEPT	-97.24650	0.1871
CI	0.03814	0.1184
QQS	-0.00048862	0.0232
SALMONELLA	-3.55695	0.0966
HA	-5.59330	0.2263
CUC	9.78701	0.0721
CIC	-0.00322	0.0735

Table 4-2. Estimates of Model (3-1) Corrected for First Order Autocorrelated

VARIABLE	PARAMETER	Pr > |t|
INTERCEPT	-91.8992	0.1987
CI	0.0363	0.1233
QQS	-0.000576	0.0142
SALMONELLA	-2.6138	0.1068
HA	-4.1024	0.2365
CUC	9.0225	0.0784
CIC	-0.002946	0.0802

CHAPTER 5
SUMMARY AND CONCLUSIONS

Three methods of data analysis were applied to fresh market tomato markets to reach a conclusion regarding policies changes for food safety standards. The regression analysis provides an important prospective into the cost associated with a food safety outbreak, in this case salmonella and hepatitis A. Both can have significant impacts on growers not associated with the food borne illness incident. The flexibility analysis provides insight into the percentage effects of each of the variables on price. Finally, the Value of Information Analysis provides an estimate associated with the cost of a food safety outbreak and the value of an audit that mitigates the risk.

The probability of contracting a food borne illness from tomatoes as calculated in this study is extremely low, but the impact on the grower of a food safety outbreak is high. Overall, it is estimated that the Florida tomato industry suffered an $18 million dollar loss on revenue from the food safety incidences of 2007. This is the impact of a food safety outbreak that did not necessarily occur on Florida farms but just the presence of an outbreak in the market that impacted all farmers. This $18 million dollar loss is what the industry can justify in spending on food safety audits, to ensure that there are no outbreaks of food borne illnesses.

The policy of enforcing food safety audits has appeared to work in terms of decreasing the opportunity of selling an infected tomato. While the food safety audits are currently being enforced in Florida but not in other states, this enforcement appears to have affected the opportunity of contracting a food safety illness from tomatoes. The added cost of the audits is offset by the lowered probability of a food safety incident and the savings associated with those lower probabilities. It remains to be seen whether private audits lower the probability of a food safety incident enough to affect the expected net revenues of the tomato grower to warrant the additional audits. Further research could help to provide this knowledge.

Further research on this topic would further determine the need for audits, whether they are private or public. Public audits are required by the state of Florida and the private audits at this time do not substitute for these public audits. It may be shown that private audits provide an added benefit to Florida growers there is reason to believe that food safety outbreaks can further limited by better enforcement of food safety standards. U.S. government policy could be implemented to force all tomato growers to have public audits done in order to reduce outbreaks of food safety illnesses. In the meantime Florida tomato growers can account for their improved food safety practices with the use of audits, in many cases both private and public. This might become a marketing tool that could mitigate some of the costs associated with food borne illnesses that result from tomatoes grown outside the state of Florida.

APPENDIX A
INFORMED CONSENT

Protocol Title: The Potential Impacts Throughout from Food Safety Practices Implemented by Florida Tomato Growers and the Impact of Recent Food Safety Scares

Please read this consent document before you decide to participate in this survey.

Purpose of the research study:

The purpose of this study is to determine the impact of implemented food safety standards in the state of Florida on the Florida tomato industry.

What you will be asked to do in the study:

Answer survey questions related to your production, harvesting and packing of tomatoes in the state of Florida as well as 4 demographic questions.

Time required:

10 minutes

Risks and Benefits:

There are no Potential Risks and the Benefits extend to the research community.

Compensation:

There is no compensation for this study it is entirely voluntary.

Confidentiality:

Your identity will be kept confidential to the extent provided by law. Your name will not be used in any report.

Right to withdraw from the study:

You have the right to withdraw from the study at anytime without consequence.

Whom to contact if you have questions about the study:

Gabrielle Ferro, Food and Resources Economics, UF/IFAS

561-373-4822

John Vansickle, International Agricultural Trade & Policy Center, UF/IFAS

352-392-1881 ext 221

Whom to contact about your rights as a research participant in the study:

IRB02 Office, Box 112250, University of Florida, Gainesville, FL 32611-2250; phone 392-0433.

Agreement: I have read the information above. I voluntarily agree to participate in the survey. Furthermore by returning the survey, I indicate that I agree to participate in the study.

APPENDIX B
SURVEY

Food Safety is becoming an ever important issue in today's society with recent outbreaks of food borne illness. There is limited data about the cost that farmers and growers will incur as a result of increased food safety standards. This survey will help us determine the overall impact on you as a grower due to increasing demands for food safety standards in tomato production.
We hope you enjoy taking this survey and we thank you in advance for your help and time.
For each of the questions please write in the space provided.

1. The following three questions relate to T-GAP and T-BMP as enforced by FDACS in 2007

a. How much do these programs add to your growing costs per acre?

____

b. How much do these programs add to your harvesting and hauling costs per carton?

____

c. How much do these programs add to your packing costs per carton?

____

2. Do your buyers require private audits?
YES _______ NO________

3. What year did your operation begin private audits?
____

4. On average how many private audits does your operation perform per year?
____

5. What is the average cost of a private audit for your operation?
____

6. Did your operation have a food safety incident prior to beginning use of private audits?
YES _______ NO________

a. If so, What was the fiscal cost of this incident?

____

7. Did your operation have a food safety incident after beginning use of private audits?

YES ________ NO_________

a. What was the fiscal cost of this incident?

____

8. What was the fiscal cost to your operation due to the 2008 Saint Paul Salmonella tomato food scare?

____

a. Was this in part due to produce that you were unable to sell?

YES ________ NO_________

9. The year following implementation of mandatory T-GAP and T-BMP what was the percentage increase in cost for production of your crop?

____

10. Do you believe private audit implementation added value to your products?

YES ________ NO_________

a. If Yes, How much value did it add ($/carton)?

____

The following question is based on your thoughts about food safety standards implementation in the State of Florida

11. Do you feel that the T-GAP and T-BMP have increased consumer confidence in Florida Tomatoes?

- ❑ Yes
- ❑ No

a. Why do you feel this way?

____

____

____

b. What other steps that have not currently been implemented, do you feel could be taken to increase confidence and demand for Florida Tomatoes?

____

____

The following section focuses on information about yourself.

1. Age ________

2. What is your gender?

   - ☐ Male
   - ☐ Female

3. What do you consider yourself?

   - ☐ Full time Farmer
   - ☐ Part time Farmer
   - ☐ Hobby Farmer

4. How many years have you farmed tomatoes?______________________

Survey

The purpose of this study is to determine the reduction in risk by implementing food safety standards, and how this affects the bottom line of the Florida tomato producer. A paper survey was administered to allow producers to provide accurate input into developing these estimates. The survey is described below.

The survey began by asking responders to identify the costs associated with T-GAP and T-BMP, as a means of measuring overall mandatory costs for implementation. The following question was asked to determine whether audit from private companies were require by buyers given that mandatory inspections by the State of Florida were already required. The following three questions related to the overall cost associated with these private audits including the year they were started and the overall cost of the audits over that period of time. The succeeding two questions attempted to determine the incidence of outbreaks prior to and after implementing audits, specifically private audits. Furthermore, the questions looked to uncover the fiscal cost of such an incident to the specific producer. By asking for information on specific incidents such as the 2008 salmonella food safety scare, the survey attempted to collect data that could provide a specific cost estimate associated with a food safety scare. The 2008 scare was later determined not to be caused by tomatoes but there was a lasting mark on the industry and there is an attempt to uncover this cost in this question.

There is a belief that implementing food safety standards has increased cost of production because there are additional steps that producers have to take in order to be compliant. Yet there is also a belief that because most producers were already using private audits, there has been little to no increase in cost of production. The survey attempted to determine if producers feel that audits increase the actual value of their product. This does not directly relate to the price that they are getting for the product but more about what they feel they receive for the product in relation to the additional cost of audits. The final question attempts to collect the producers' opinion of T-GAP and T-BMP. By determining if producers feel that consumer confidence is affected by the Florida audits that have been implemented there is a foundation that increased cost of production may be supported by adding value to the product. The end of the survey asks basic demographic questions to be utilized in determining the overall impact of producer demographics on their beliefs.

The survey as a whole is an attempt to determine the overall risk that is being mitigated by standardizing audits. There is inherently a cost related to an audit. In order to have someone perform the audit, they must be paid. It is yet to be determined if that actual increase in production cost as a result of these audits is actually mitigating the food safety risk that the producer assumes in growing the product and returns to the producer.

APPENDIX C
SAS OUTPUT

The SAS System 12:11 Tuesday, April 13, 2010

The MEANS Procedure

Variable	N	Mean	Std Dev	Minimum	Maximum
Year	44	2005.50	1.1309597	2004.00	2007.00
time	44	22.5000000	12.8452326	1.0000000	44.0000000
P	44	11.3931818	6.2203865	3.9000000	33.8000000
ci	44	3046.66	184.6064349	2749.25	3335.15
Salmonella	44	0.2727273	0.4505106	0	1.0000000
Norovirus	44	0.1136364	0.3210382	0	1.0000000
ha	44	0.0454545	0.2107071	0	1.0000000
Unknown	44	0.0909091	0.2908034	0	1.0000000
cuc	44	14.6500000	4.0465978	8.3000000	29.2100000
qqs	44	11775.72	4622.91	2966.00	19153.80
dt	44	0.2954545	0.4615215	0	1.0000000
dt2	44	0.2954545	0.4615215	0	1.0000000
var	44	0.3181818	0.4711553	0	1.0000000
varu	44	0.3863636	0.4925448	0	1.0000000
CIC	44	44742.60	12824.47	23271.86	88313.89

The SAS System 12:11 Tuesday, April 13, 2010

The REG Procedure
Model: MODEL1
Dependent Variable: P

Number of Observations Read	44
Number of Observations Used	44

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	415.15008	69.19168	2.05	0.0832
Error	37	1248.65787	33.74751		
Corrected Total	43	1663.80795			

Root MSE	5.80926	R-Square	0.2495
Dependent Mean	11.39318	Adj R-Sq	0.1278
Coeff Var	50.98892		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-97.24650	72.35223	-1.34	0.1871
ci	1	0.03814	0.02386	1.60	0.1184
qqs	1	-0.00048862	0.00020625	-2.37	0.0232
Salmonella	1	-3.55695	2.08657	-1.70	0.0966
ha	1	-5.59330	4.54542	-1.23	0.2263
cuc	1	9.78701	5.28610	1.85	0.0721
CIC	1	-0.00322	0.00175	-1.84	0.0735

The REG Procedure
Model: MODEL1
Dependent Variable: P

Durbin-Watson D	0.952
Number of Observations	44
1st Order Autocorrelation	0.484

The AUTOREG Procedure

Dependent Variable P

Ordinary Least Squares Estimates

SSE	1248.65787	DFE	37
MSE	33.74751	Root MSE	5.80926
SBC	298.563855	AIC	286.074527
MAE	3.96116614	AICC	289.185638
MAPE	39.266798	Regress R-Square	0.2495
Durbin-Watson	0.9520	Total R-Square	0.2495

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	-97.2465	72.3522	-1.34	0.1871
ci	1	0.0381	0.0239	1.60	0.1184
qqs	1	-0.000489	0.000206	-2.37	0.0232
Salmonella	1	-3.5569	2.0866	-1.70	0.0966
ha	1	-5.5933	4.5454	-1.23	0.2263
cuc	1	9.7870	5.2861	1.85	0.0721
CIC	1	-0.003217	0.001747	-1.84	0.0735

Test 1

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	0.144625	0.00	0.9482
Denominator	37	33.747510		

Test 2

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	91.290862	2.71	0.1085
Denominator	37	33.747510		

The AUTOREG Procedure

Estimates of Autocorrelations

Lag	Covariance	Correlation	-1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1
0	28.3786	1.000000	| |******************** |
1	13.7453	0.484356	| |********** |

Preliminary MSE 21.7209

Estimates of Autoregressive Parameters

Lag	Coefficient	Standard Error	t Value
1	-0.484356	0.145812	-3.32

Yule-Walker Estimates

SSE	909.35616	DFE	36
MSE	25.25989	Root MSE	5.02592
SBC	288.663543	AIC	274.390026
MAE	3.40228658	AICC	278.504311
MAPE	33.2186036	Regress R-Square	0.2664
Durbin-Watson	1.5479	Total R-Square	0.4534

Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	-91.8992	70.1857	-1.31	0.1987
ci	1	0.0363	0.0230	1.58	0.1233
qqs	1	-0.000576	0.000224	-2.58	0.0142
Salmonella	1	-2.6138	1.5800	-1.65	0.1068
ha	1	-4.1024	3.4081	-1.20	0.2365
cuc	1	9.0225	4.9798	1.81	0.0784
CIC	1	-0.002946	0.001637	-1.80	0.0802

Test 1

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	1.062245	0.04	0.8387
Denominator	36	25.259893		

The AUTOREG Procedure

Test 2

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	18.918553	0.75	0.3925
Denominator	36	25.259893		

APPENDIX D
SAS INPUT

Year	Month	P	ci	Salmonella	ha	cuc	qqs
2004	Jan	6.2	2749.247	0	0	15.46	16718
2004	Feb	8.1	2756.493	0	0	12.21	14257
2004	Mar	10.3	2768.391	0	0	16.67	16908
2004	Apr	11.1	2782.776	1	0	12.82	15682
2004	May	8.1	2803.839	0	0	8.3	15196
2004	Jun	5.7	2812.066	1	0	8.31	9782
2004	Jul	5.7	2823.202	1	0	8.31	9782
2004	Sep	23.4	2844.497	0	0	12.43	5946
2004	Oct	23.4	2859.314	0	0	12.43	5946
2004	Nov	33.8	2861.815	0	0	11.49	7469
2004	Dec	13	2954.816	0	0	10.61	15737
2005	Jan	3.9	2883.5	0	0	11.11	15376
2005	Feb	10.2	2890.707	0	0	9.46	12935
2005	Mar	10.2	2896.727	0	1	17.93	15775
2005	Apr	16.3	2912.355	0	0	16.11	13520
2005	May	12.4	2925.118	0	0	15.95	13963
2005	Jun	11.1	2940.244	1	0	16.11	9157
2005	Jul	11.1	2958.921	1	0	16.11	9157
2005	Sep	10.5	2985.148	0	1	19.58	4465.8
2005	Oct	10.5	2998.035	0	0	19.58	4465.8
2005	Nov	8.8	3010.039	1	0	19.58	10715.4
2005	Dec	22.9	3023.413	0	0	29.21	12387.2
2006	Jan	20.7	3067.898	1	0	13.15	15261.6
2006	Feb	11.6	3085.372	0	0	15.24	16417.4
2006	Mar	6.2	3098.54	0	0	22.39	19153.8
2006	Apr	8.6	3117.1	0	0	16.17	14826.5
2006	May	5.8	3123.026	0	0	11.99	15067
2006	Jun	7.3	3139.524	1	0	11.99	9554
2006	Jul	7.3	3144.257	0	0	11.99	9554
2006	Sep	8.4	3166.052	1	0	17.38	2966
2006	Oct	8.4	3176.815	0	0	17.38	2966
2006	Nov	7.4	3188.999	0	0	14.08	9766.2
2006	Dec	5.3	3214.631	0	0	14.85	13360.2
2007	Jan	8.9	3222.748	0	0	16.94	15655.8
2007	Feb	7.8	3242.753	0	0	19.42	17355.4
2007	Mar	6.6	3260.604	0	0	18.48	18812.2
2007	Apr	13.2	3260.123	0	0	11.77	14873.4
2007	May	8.9	3266.155	0	0	14.77	18028
2007	Jun	6	3273.722	1	0	14.77	10461
2007	Jul	6	3279.798	1	0	14.77	10461
2007	Sep	16	3306.165	0	0	11.55	3903
2007	Oct	16	3315.728	1	0	11.55	3903
2007	Nov	17.9	3327.385	0	0	13.75	8201.2
2007	Dec	20.3	3335.152	0	0	10.45	12244.8

Florida Tomato Committee and Florida Statistical Directory

APPENDIX E
FLEXIBILITY

VARIABLE	FLEXIBILITY
CI	-1.834438088
CUC	0.060486
QQS	-0.595339776

APPENDIX F
PROBABILITY DATA

Year	Confirmed Etiology	State	Month	Ill	Hospitalizations	Deaths
2007	Salmonella Newport	ML	6	65	11	0
2007	Salmonella Newport	NY	7	10	4	1
2007	Salmonella Newport	DC	6	46	not given	not given
2007	Salmonella Javiana	MD	6	5	3	0
2007	Unknown	NY	12	20	1	0
2007	Salmonella Typhimurium	MN	10	23	1	0
2007	Norovirus	CO	7	33	0	0
2006	Salmonella Berta	ML	1	16	4	0
2006	Norovirus	PA	9	17	0	0
2006	Salmonella Berta	PA	1	16	4	0
2006	Salmonella Newport	ML	6	115	6	0
2006	Salmonella Typhimurium	MD	6	18	4	0
2006	Salmonella Typhimurium	MD	9	8	1	0
2005	Norovirus	VA	4	38	N/A	N/A
2005	Unknown	NY	7	31	N/A	N/A
2005	Salmonella Braenderup	ML	11	84	N/A	N/A
2005	Salmonella Enteritidis	WY	6	20	N/A	N/A
2005	Salmonella Newport	ML	7	52	N/A	N/A
2005	Salmonella Newport	NY	7	27	N/A	N/A
2005	Hepatitis A	TN	3	23	N/A	N/A
2005	Hepatitis A	CO	9	17	N/A	N/A
2005	Norovirus	VA	4	14	N/A	N/A
2005	Unknown	FL	10	2	N/A	N/A
2005	Unknown	PA	10	19	N/A	N/A

2004	Campylobacter, Unknown	OH	5	13	N/A	N/A
2004	Salmonella Braenderup	ML	6	137	N/A	N/A
2004	Norovirus	CT	11	92	N/A	N/A
2004	Norovirus	OR	4	19	N/A	N/A
2004	Salmonella Anatum; Salmonella Group D; Salmonella Javiana; Salmonella Muenchen; Salmonella Thompson; Salmonella Typhimurium	ML	7	429	N/A	N/A

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BIOGRAPHICAL SKETCH

Gabrielle Alexandra Ferro was born in Bethesda, Maryland. She was raised in Lake Worth, Florida and attended Suncoast Community High School, graduating in 2004 from the International Baccalaureate Program. She completed the Master of Science in food and resource economics from the University of Florida College of Agricultural and Life Sciences in May 2010.

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