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Perception of Risk and Risk Management in Fruit and Vegetable Marketing in Tennessee: The Case of Product Liability Risk

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To the Graduate Council:

I am submitting herewith a thesis written by Zongyu Li entitled "Perception of Risk and Risk Management in Fruit and Vegetable Marketing in Tennessee: The Case of Product Liability Risk." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Margarita Velandia, Major Professor

We have read this thesis and recommend its acceptance:

Chris Clark, Kim Jensen, Dayton Lambert

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Perception of Risk and Risk Management in Fruit and Vegetable Marketing in Tennessee: The Case of Product Liability Risk

A Thesis Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Zongyu Li
May 2014

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Abstract

The product liability risk related to fruit and vegetable marketing is that of customer liability associated with injuries caused by harmful products such as contaminated fresh produce. An event associated with product liability risk may have a very low probability of occurrence but may result in a large economic loss. Producers may be unaware of the product liability risk they face, the potential cost of this risk and, therefore their need to adopt measures against this risk. The purpose of this thesis is to examine perceptions of Tennessee fruit and vegetable producers about product liability risk when selling fruits and vegetables, and measures they take to protect themselves against this risk. The data for this thesis was gathered from a survey of Tennessee fruit and vegetable producers.

This study examines both fruit and vegetable producer perceptions of product liability risk as a risk face when selling fruits and vegetables and producer adoption of insurance providing product liability coverage. The first essay of the thesis focuses on the evaluation of factors associated with fruit and vegetable producer perceptions of product liability risk. The second essay of this thesis evaluates the factors influencing producer adoption of insurance providing product liability coverage.

Factors influencing fruit and vegetable producer perceptions of product liability risk are evaluated using a probit regression. Results suggest that perceptions of product liability risk are associated with producer primary occupation, total household income, whether a farmer produces lettuce or cantaloupes for sale, percentage of farm's gross annual sales from fresh fruits and vegetables, and the number of farms harvesting vegetables for fresh market in the county where the farming operation is located.

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Using a probit regression with instrumental variables this study also assesses the factors influencing Tennessee fruit and vegetable producer decision to adopt insurance providing product liability coverage. Results suggest that farmer decision to purchase product liability insurance is associated with the percentage of sales made through retail outlets (e.g., institution, grocery and restaurant).

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TABLE OF CONTENTS

www.manaraa.com

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LIST OF TABLES

Part 1: Perceptions of Risk in Fruit and Vegetable Marketing in Tennessee: The Case of Product Liability Risk

Part 2: Factors Affecting Producer Adoption of Product Liability Insurance: The Case of Fruit and Vegetable Growers in Tennessee

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LIST OF FIGURES

Part 1: Perceptions of Risk in Fruit and Vegetable Marketing in Tennessee: The Case of Product Liability Risk

Part 2: Factors Affecting Producer Adoption of Product Liability Insurance: The Case of Fruit and Vegetable Growers in Tennessee

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Introduction

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Introduction

The high level of production, market, and financial risk that producers have to face is a typically characteristic of agriculture (Velandia et al. 2009; Uematsu and Mishra 2011). Risk is the uncertainty that could lead to changes in an individual's welfare such as losing money, potential harm to human health, and events that affect availability of resources, among others (Harwood et al. 1999). In general agriculture risk typically is correlated with the chance of a negative outcome (e.g., financial loss or yield decrease) and the uncertainty in the decision making process due to incomplete information such as market prices (Parker et al. 2012). Risk varied within different agricultural sectors and supply chains. In the production and marketing of fruits and vegetables risk include bad weather, pest infestations, quality inconsistencies, liability risk, and market fluctuations (Martinez et al. 2010).

One of the risks that has been associated with fruit and vegetable marketing is that of customer liability associated with injuries caused by harmful products such as contaminated fresh produce (Lynch, Tauxe, and Hedberg 2009). The increase in foodborne illness outbreaks associated with fresh produce in the U.S has triggered increased concerns among consumers about food product liability risk (Ribera et al. 2012; Dewaal and Glassman 2013; Painter et al. 2013). Fruits and vegetables accounted for about 46% of foodborne illness outbreaks in the U.S. between 1998 and 2008 (Painter et al. 2013).Governmental authorities and industry have responded to these public concerns with new food safety standards, certifications, and regulations (Boys 2013).

Regardless the increase in food borne illness outbreaks, the likelihood a producer will face legal actions may be low because of the legal system structure, and high transaction and information costs that reduces the likelihood of an affected consumer to be compensated (Buzby,

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Frenzen, and Rasco 2001). Therefore, despite the existence of product liability risk in marketing produce farmers awareness of product liability risk face when marketing fruits and vegetables, the potential cost associated with this risk, and measures to mitigate or protect their farm operation against this risk may be low. In recent years governmental agencies in collaboration with the medical community have increased the knowledge about forborne illnesses and their sources (Buzby, Frenzen, and Rasco 2001; Pflumm 2011; Porter, Baker, and Agrawal 2011). As a result, producer likelihood of facing legal consequences due to food product liability risk and therefore the risk of economic loss due to this type of risk may increase in the future.

As a response to public concerns about foodborne illness outbreaks, new food safety regulations and standards have been proposed by government and industry. The 2011 Food Safety Modernization Act (FSMA) is the most comprehensive reform to U.S food safety laws since the 1950s aiming to build a system that can decrease foodborne illness outbreaks and improve safety of the U.S. food supply (U.S. Food Drug Administration 2014), The 2011 FSMA gives authority to the Food Drug Administration (FDA) to implement of food safety policy that follows a science-base and risk-based approach. A science-based and risk-based approach allows FDA to prioritize food safety issues base on the level risk found by scientific information. Additionally, the 2011 FSMA requires the implementation of Hazard Analysis Critical Control Point[1] (HACCP) procedures by food handling facilities; in this act farms are treated as food handling facilities and therefore they also are required to follow an HACCP plan. Finally, a number of exemptions where added to the FSMA because of the potential negative economic impact of this act on small business, including small farms (Ribera and Knutson 2011). For example, those farms or businesses with less than $25,000 in annual sales, who market products

[1] The U.S. Food and Drug Administration defines HACCP as "a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement and handling, to manufacturing, distribution and consumption of the finished product." (U.S. Food Drug Administration 2013b)

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mostly directly to consumers, restaurants and stores, or who sell products within 275 miles from where the product was produce are exempt from regulations impose by the FSMA (Holcomb, Palma, and Velandia 2013).

The Global Food Safety Initiative (GFSI) was introduced in 2000 by a group of international retailers (e.g., Tesco and Walmart). The GFSI is a set of food safety protocols impose to food manufactures selling products through certain retail chains all over the world. Some of the requirements impose by the GFSI include ingredients use and storage and handling of products (Holcomb, Palma, and Velandia 2013). Under the GFSI protocols there seem to be no exemptions for small businesses including small farms. With new governmental regulations such as the FSMA and industry interventions such as the GFSI, further barriers are likely to arise for small and medium sized farms wanting to access certain market outlets (Boys 2013; Ribera and Knutson 2011). For example, if small and medium sized farms are required to carry a food product liability insurance to market their products, the additional fix cost associated with this risk management tool may prevent for these producers to access any market (Boys 2013).

Fruit and vegetable farms in Tennessee are on average smaller in acreage and sales volume compared to the farms nationwide and in surrounding states (USDA-NASS 2007). According to the 2007 U.S. Census of Agriculture, the average acreage per vegetable farm in Tennessee is 22, 68 for the U.S., and 28 for seven surrounding states (i.e., Alabama, Georgia, Kentucky, Mississippi, North Carolina, Virginia and Arkansas). As for the average vegetable sales value, Tennessee vegetable farms sell on average approximately $48,000 per year, which is lower than the average sales value per vegetable farm in the U.S ($212,490) and surrounding states ($85,900) (USDA NASS 2007). Small farms mostly selling their produce directly to consumers may be more likely to be uncertain about the impact of new food safety regulations

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on their operation (Martinez et al., 2010). Large produce farms usually sell through intermediate channels such as brokers, retail, and wholesale outlets which traditionally have imposed specific standards and protocols in order to guarantee product food safety to final consumers. In contrast small farms are less likely to sell through these outlets and therefore have been less familiar with management procedures to guaranteed food safety of their products to the final consumer. A better understanding of Tennessee fruit and vegetable producer perceptions of product liability risk and the factor influencing the adoption of measures to manage this type of risk (i.e., purchasing product liability insurance[1]will help Extension personnel and governmental agencies to better assist Tennessee producers in the adoption of food safety standards, certifications, and regulations while helping them to stay competitive in the marketing of fruits and vegetables.

Risk face by grain crops, livestock, and dairy producers, specifically those associated with price and yield variability as well as their use of risk management tools have been extensively evaluated by previous studies (Shapiro and Brorsen 1988; Knight et al. 1989; Makus et al. 1990; Goodwin and Schroeder 1994; Harwood et al. 1999; Mishra and El-Osta 2002; Sherrick et al. 2004; Davis et al. 2005; Pennings et al. 2008; Velandia et al. 2009). There are very few studies that have evaluated risk face by fruit and vegetable producers as well as their adoption of risk management tools (Hanson et al. 2004; Asfaw, Mithöfer, and Waibel 2010; Ali and Kapoor 2008; Sriboonchitta et al. 2008; Kersting and Wollni 2011; Boys 2013). These studies are discussed in more detail in the following section.

Literature Review

Perception of Risk

Perceptions of sources of risk are the starting point for producers when making risk management decisions. The differences in perceptions of sources of risk may be determined by

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farmer and farm business characteristics such as age, experience, farm size, farm diversification, marketing channels used to sell products, as well as personality, beliefs, and culture (Ahsan and Roth 2010; Le and Cheong 2010; Uematsu and Mishra 2011; Van Winsen et al. 2011; Kisaka-Lwayo and Obi 2012; Parker et al. 2012). Only limited attention has been paid to the evaluation of perceptions of sources of risk and the use of risk management strategies for cash-crop farming specifically fruits and vegetables (Hanson et al. 2004; Asfaw, Mithöfer, and Waibel 2010; Ali and Kapoor 2008; Sriboonchitta et al. 2008; Kersting and Wollni 2011; Boys, 2013).

Using a survey of beef producers in Texas and Nebraska, Hall et al. (2003) examined beef producers perception of risk sources, perceptions of the effectiveness of various risk management tools in managing those risks, along with their interest in risk management education. Using a 5-point Likert scale farmers were asked to rate sources of risk based on their perceptions about impact of a specific risk on farm income. They were also asked to rank risk management tools based on their efficacy in reducing risk. Respondents indicated that drought and price variability were the most likely risks to affect farm income. In terms of risk management strategies efficacy in handling risk, producers identified maintaining animal health, low cost of production, financial reserves, and off-farm income as the most effective strategies in managing risk. Although beef farmers perceive price variability as one of the most important sources of risk, on average they rank considerably low forward contracting and future and option markets as effective risk management strategies. This result may be explained by the fact that producers expressed very low knowledge of these risk management tools. Finally, Hall et al. used probit regressions to evaluate factors affecting producer interest in additional education training in four areas: 1) forward contracts; 2) futures and options; 3) financial management; and 4) herd health. They found that age, prior use of risk management tools, previous risk

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management education, and risk aversion significantly influence producer interest in risk management education.

Using a survey of fruit and vegetable farmers conducted in six districts in the state of Uttar Pradesh India, Ali and Kapoor (2008) evaluated perceptions of farmers about risk face when producing fruits and vegetables. Farmers were asked to indicate perceptions of risks using a five point Likert scale where 1 meant strong disagreement and 5 meant strong agreement with a specific source of risk. Sources of risk were classified into five categories: 1) investment risks; 2) socio-economic risks; 3) environmental risks; 4) production risks; and 5) market risks. Ali and Kapoor presented means and standard deviation for all risk sources evaluated. Within the investment risk categories they found fuel cost as one of the most important risks perceive by farmers; for the socio-economic risk category, poor linkages between research and extension was perceived to be the most important perceive risk; among the environmental risks weather was perceived by farmers as the most important risk; pest and diseases, as well as high input prices were found to be the most important risks perceived by producers in the product risk category; finally, low price for products and high perishability of fruits and vegetables were perceived as the highest risks within the market risk category. Regardless of perceptions of risk sources among fruit and vegetable producers in this study more than 50% of them indicated not using any risk management strategy.

Morales et al. (2008) used a survey completed by 1047 farmers in five countries members of the European Union (EU) to evaluate farmer perceptions of risk, demand for risk management tools, and the use of these tools among farmers in Hungary, Spain, the Netherlands, Germany, and Poland. Among surveyed farmers the highest perceive risks were associated with climate and natural disasters, as well as price volatility and animal diseases. Among the strategies to handle

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risk farmers indicated using savings, cash balances, and crop diversification as their main ways to manage risk and a small percentage of respondents use crop insurance as a risk management strategy. Using logit regressions Morales et al. evaluated factors influencing the use of crop, livestock insurance, and futures and options as risk management strategies. They found that differences between countries as well as crop diversification influence the adoption of crop/livestock insurance and futures and options.

Ahsan and Roth (2010) examined how mussel farmers in Denmark perceived and managed risks. They conducted personal structured and semi-structured interviews with 14 of the total 18 existent mussel farmers in Denmark to gather information about perceive impact of sources of risk on economic performance and relative importance of various risk management strategies in handling risk. Farmers were asked to rate relevance in terms of potential economic impact of 32 predetermined sources of risk and importance on managing risk of 21 risk management strategies using a Likert scale from 1(not relevant/not important) to 5(very relevant/very important). The most important risks perceived by the Danish mussel farmers were bad weather, uncertainty of future mussel demand and prices, and potential changes in regulations. On the other hand, Danish mussel farmers considered minimizing cost of production, cooperating with other farmers in production and marketing activities, and maintaining liquidity and solvency to be the most important risk management strategies. Similarly to Hall et al. (2003), Ahsan and Roth found a mismatch in some perceptions of sources of risk and the risk management strategies considered to be relevant to mitigating risk. For example, although uncertainty about future mussel demand and prices were perceived as relevant risks by the Danish mussel farmers, common strategies to handle these risks such as production

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contracts and diversification of products were not perceived as important strategies to handle risk by these farmers.

Using a survey of Vietnamese catfish farmers Le and Cheong (2010) evaluated factors affecting catfish farmers' perceptions of sources of risk and efficacy of risk management strategies. First, they use a factor analysis to reduce the number of risk sources evaluated (40) and the number of risk management strategies analyzed (50) to six. The standard factor scores obtained from a factor analysis of the sources of risk and risk management strategies were used as dependent variables in the multiple regression analyses to identify the farmer/farm business characteristics influencing perceptions of risk sources and efficacy of risk management strategies. Estimates from the risk perceptions multiple regressions were used as independent variables in the risk management multiple regression analysis. Results from this study suggest that age and gender of the farmer, farming experience, farm size, access to external technical consultation were likely factors to influence catfish farmers' perceptions of risk sources in their operation, although the goodness of fit of these regressions was rather low. On the other hand, results from the multiple regressions used to evaluate factors influencing risk management strategies efficacy perceptions suggests that perceptions of risk sources have a significant influence on the perceive effectiveness of risk management strategies on handling risk.

Kisaka-Lwayo and Obi (2012) evaluated smallholder farmers' perceptions of risks, risk management strategies, and factors affecting these risk perceptions in KwaZulu-Natal Province, South Africa. This analysis used survey data of 200 smallholder farmers in KwaZulu-Natal Province, South Africa. Farmers were asked to rate their perceptions of the main sources of risk affecting their farming operation using a likert scale from 1 to 3 (1=no problem to 3=severe problem). Seven composite principle factors were obtained out of all sources of risks identified

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(20) using a principle component analysis. The seven sources of risk categories obtained from the principal component analysis include: 1) financial and incentives, 2) input-output, 3) crop production, 4) labor availability, 5) lack of production information 6) lack of market opportunity, and 7) input availability. The standard factor scores of these seven principal factors were used as dependent variables in a multivariate regression analyses to identify farmer socioeconomic characteristics, location, and risk preferences characteristics influencing perceptions of risk sources. Results from this study suggest that age, gender, education, location, information access, and risk attitude have a significant influence on the different perceptions of sources of risk.

Adoption of Risk Management Tool

When looking at previous studies examining adoption of risk management tools, we found a large number of studies evaluating adoption of tools associated with the management of price and yield risk as well as the factors influencing adoption of these tools (e.g., crop insurance, forward contracting, future and option markets) (Shapiro and Brorsen 1988; Knight et al. 1989; Makus et al. 1990; Goodwin and Schroeder 1994; Harwood et al. 1999; Mishra and El-Osta 2002; Sherrick et al. 2004; Davis et al. 2005; Pennings et al. 2008; Velandia et al. 2009). However, there are only few studies (Sriboonchitta et al. 2008; Asfaw, Mithöfer, and Waibel 2010; Kersting and Wollni 2011; Boys 2013) that have looked at the adoption of tools or strategies to reduce product liability risk such as Product Liability Insurance and Good Agricultural Practices (GAP)[2], among fruit and vegetable producers.

Using a survey of Thai pineapple farmers, Sriboonchitta et al. (2008) investigate the factors influencing farmer adoption of GAP. Results from a logit regression suggest that average farm price, having a contract with buying companies, farmer age, being a progressive or more

[2] "Good Agricultural Practices (GAP) are best practices for growing, harvesting, packing and transporting produce that will help minimize the risk of foodborne illness associated with these products" (Critzer and Wszelaki 2012)

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innovative farmer, average yield, requirements imposed on farmers by importing countries, and farmer environmental concerns all have a significant influence on pineapple farmers' decision to adopt GAP.

Asfaw, Mithöfer, and Waibel (2010) examined the factors influencing the adoption of the European Union (EU) private quality standards (EurepGAP) by small scale vegetable farmers in Kenya and the impact of EurepGAP adoption on household income. Using data from a survey of small-scale vegetable farmers in Kenya and a probit regression they identified the factors influencing adoption of EurrepGAP among small-scale vegetable farmers. They found that access to information, capital, services, and availability of labor had a significant influence in farmers' ability to adopt EU private food safety standards and therefore their ability to access developed country markets.

Kersting and Wollni (2011) evaluated the factors influencing the adoption of GlobalGAP by fruit and vegetable farmers in Thailand. GlobalGAP is a worldwide standard that assures the use of Good Agricultural Practices (GAP) by producers all over the world. Using data from a survey of Thai fruit and vegetable farmers conducted in 2010 and a bivariate probit regression that accounted for potential sample selection bias, Kersting and Wollni identified farmer age and education, household wealth, farm size, farm labor availability, intensity of irrigation use, number of agricultural trainings attended, and support by exporters on the GlobalGAP adoption as factors influencing the adoption of GlobalGAP certification by Thai vegetable farmers.

Boys (2013) presents results from a study evaluating small and medium scale (SMS) producer motivations and barriers to purchase food product liability insurance. This study involved an electronic survey of 256 SMS specialty crop farmers in the U.S. Southeast region including states from Virginia to Texas. About 38% of the survey respondents indicated they had

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food product liability insurance. Concerns with liability, buyer requirements, and interest in improving marketing strategy (e.g., adding value, firm reputation, differentiation of product) were identified as motivations behind the decision to purchase food product liability insurance. Benefits associated with the adoption of food product liability insurance identified by respondents include: increased access to markets, decreased litigation concerns, improvement of firm reputation, and increased ability to participate in today's business environment.

This study is intended to add to the limited literature concerning fruit and vegetable producer perceptions of product liability risk and the adoption of insurance providing product liability coverage. A first step in evaluating the role of product liability risk in the marketing of fruits and vegetables is to better understand fruit and vegetable producer perceptions of product liability risk. A second step in identifying the role of this risk in the marketing of produce is identifying factors influencing fruit and vegetable producer adoption of an insurance providing product liability coverage. Information about factors affecting producer perceptions of product liability risk and adoption of product liability insurance may be of assistance to policy makers as well as University/Extension personnel in assessing farmer information needs and identifying measures they may need to take to help them stay competitive in a new regulatory environment. Additionally, this information may be useful for insurance companies as they become aware of those producers more likely to adopt insurance that provides product liability coverage and therefore they may be able to better target potential clientele for these insurance products.

Objectives

The general objective of the proposed research is to evaluate perceptions of Tennessee fruit and vegetable producers about product liability risk and measures they can take to protect themselves against this risk. The specific objectives are: a) to identify factors influencing

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Tennessee fruit and vegetable farmer perceptions of product liability risk as a risk faced when marketing produce; and b) to assess factors influencing the decision to purchase an insurance that provides product liability coverage among Tennessee fruit and vegetable farmers.

Thesis Outline

The remainder of this thesis will be comprised of two essays. In the first essay, the perception of product liability risk as a risk face when marketing produce among Tennessee's fruit and vegetable producers will be evaluated. The factors affecting perceptions of product liability risk will be examined using a probit regression. Producer adoption of insurance providing product liability coverage and factors affecting the adoption of this insurance product will be evaluated in the second essay using a probit regression with instrumental variables.

The thesis will be organized as follows: part one presents description of data, empirical model, estimation methods, results and discussion, and conclusions for the first essay. Part two presents data, conceptual framework, methodology, results and discussion, and conclusions for the second essay. Finally, part three provides a summary and series of concluding comments.

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Part 1: Perceptions of Risk in Fruit and Vegetable Marketing in Tennessee: The Case of Product Liability Risk

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Abstract

This study focuses on the evaluation of factors affecting producer perceptions of product liability risk in fruit and vegetable marketing in Tennessee. Factors influencing fruit and vegetable producer perceptions of product liability risk are evaluated using a probit regression. The results suggested that perceptions of product liability risk were associated with producer primary occupation, total household income, whether a farmer produces lettuce or cantaloupes for sale, percentage of farm's gross annual sales from fresh fruits and vegetables, and number of farms harvesting vegetables for fresh market in the county where the farming operation is located. These findings should help Extension educators as well as policy makers to better understand the information needs of fruit and vegetable producers regarding product liability risk.

Introduction

In agriculture, risk typically is associated with two concepts: 1) the probability of a negative outcome (e.g., profit loss) and 2) the uncertainty in the decision making process due to incomplete information (Parker et al. 2012). The production and marketing of fruits and vegetables involve several types of risks such as exposure to bad weather, pest infestations, quality inconsistencies, liability risk, and market fluctuations (e.g. low sales volume, low prices) (Martinez et al. 2010). The product liability risk that has been related to fruit and vegetable marketing is that of customer liability associated with injuries caused by harmful products such as contaminated fresh produce (Lynch, Tauxe, and Hedberg 2009).

In the past few years, the number food borne illnesses associated with fresh produce reported to the Centers for Disease Control and Prevention in the U.S. have increased (Sivapalasingam et al. 2004; Ribera et al. 2012; Boys 2013). In response to these events, food

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safety policies and retail food safety standards have been proposed to protect consumers and help producers manage product liability risk (Boys 2013). Among the most important interventions are the 2011 Food Safety Modernization Act (FSMA) and the Global Food Safety Initiative (GFSI)[3]. Due to increased outbreaks of food borne illness associated with fresh produce and strict government policies and industry standards, fruit and vegetable producers maybe more aware of product liability risk. Producer perceptions of product liability risk may be affected by farmer and farm business characteristics.

Tennessee fruit and vegetable farms are on average smaller in physical size (i.e., acres) and sales volume compare to produce farms in surrounding states (USDA-NASS 2007). Small producers may be more likely to be uncertain about the impact of new food safety regulatory frameworks on their operations (Markley 2010). Therefore, evaluating the factors that affect Tennessee fruit and vegetable farmer perceptions of product liability risk when marketing their produce may help Extension educators as well as policy makers better assess farmer information needs on this topic and identify measures producers may need to take to help them stay competitive under a new regulatory environment.

Methods and Procedures

Data

The scope of the study includes 495 Tennessee fruit and vegetable producers. The list of producers was provided by the Tennessee Department of Agriculture and came from a list of all fruit and vegetable producers participating in the Pick Tennessee Products program[4]. On April 1,

[3] GFSI is a business-driven initiative for the continuous improvement of food safety management systems to ensure confidence in the delivery of safe food to consumers not only within a country but worldwide.
[4] Pick Tennessee Products (PTP) was created by the Tennessee Department of Agriculture in 1986. PTP program promotes all products available from Tennessee farms, farmers markets, and other retail outlets with attempt to link producers with local products marketing channels and educate consumers about opportunities to purchase local food (Davis et al., 2012).

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2013, the survey, a cover letter explaining the importance of the survey, and a postage paid return envelope were sent to all of the producers using first class mail. Post cards were sent on April 19, 2013 as a reminder to farmers to complete the survey. A second wave of surveys was sent to producers who had not already responded to the initial mailing on April 29, 2013. Out of 495 questionnaires mailed, 163 were returned completed for a rate of response of approximately 32%. After eliminating respondents who, by the time of the survey, were no longer producing and/or selling fruits and vegetables (26), there were 137 observations for analysis.

The survey requested information about the sources of risk fruit and vegetable producers think they face (i.e. perceptions) when selling produce (e.g., customer liability associated with injuries caused by harmful products such as contaminated fresh produce, product recall or warning because of foodborne illness outbreak) and general farmer and farm business characteristics. Secondary data about the number of farms with vegetable harvested for fresh market per county were obtained from the Food Environmental Atlas (USDA-ERS 2011).

Empirical Model

Perception of product liability risk when selling fruit and vegetables by producer i is hypothesized to be a function of observable exogenous variables such that:

(1) $$y_i = x_i'\beta + \varepsilon_i$$

where $y_i = 1$ if producer i thinks that product liability risk is a potential risk he/she faces when selling fruits and vegetables, zero otherwise; x_i' is a set of observed farmer/farm business characteristics and county specific variables; β is a set of unknown parameters to be estimated, and ε_i is a random disturbance term. Although the risk of product recall or warning because of a foodborne illness outbreak is different from product liability risk, it was still included in the

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analysis because it affects farmer income as a consequence of foodborne illness outbreaks. Both product recall and product liability risk are consequences of foodborne illness outbreaks. Also in this sample, there are 52 respondents only perceiving product liability risk, there are 23 respondents perceiving both product liability risk and risk of product recall or warning because of a foodborne illness outbreak. Two respondents only perceived risk of product recall or warning because of a foodborne illness outbreak. These results indicate that respondent perceptions of product liability risk are highly correlated with perceptions of product recall or warning because of a foodborne illness outbreak. The number of respondents out of the total 136 indicating product liability risk and/or risk of product recall or warning because of a foodborne illness outbreak as risks face when marketing fruits and vegetables are presented in Figure 1 (see Appendix). A description of the variables used in this analysis is presented in Table 1 (see Appendix).

Hypothesis

Producer characteristics hypothesized to influence perception of product liability risk are: age (AGE); primary occupation, expressed in a dichotomous variable for full time farmers (OCCUP); total household income, expressed in a dichotomous variable for household income greater than $50,000 (HHINCO).

It is hypothesized that age is positively related with perception of product liability risk. It is expected that older farmers may have gained more information about food borne illness outbreaks and lawsuits associated with these events than younger farmers over time through media, other farmers or their own experiences (Jackson et al. 2013). Hence older producers may have a higher probability to be aware of product liability risk than younger producers. Therefore

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older producers may be more likely to perceive or be aware of product liability risk as a risk they face when marketing produce.

Full time farmers are expected to be more likely to perceive product liability risk. Prior research has shown that perceptions of risk differed significantly between full time farmers and part time farmers (Lien et al. 2006). Part time farmers are more likely to perceive off-farm work as an important risk management strategy compared to full-time farmers, therefore additional income from off-farm jobs may increase their ability to handle risk associated with farming activities and therefore less likely to perceive product liability as a risk(Lien et al. 2006).

Finally household income is assumed to be positively associated with producer perceptions of product liability risk. Farmers with higher levels of income tend to be more risk averse (Toledo and Engler 2008). Farmers with higher household incomes may have greater ability to handle risk but they may be also more afraid to lose their assets, since they have more to lose, in case a customer sues them because of injuries caused by harmful products such as contaminated fresh produce. Therefore, farmers with higher incomes may be more likely to be aware or perceive product liability risk as a potential source of risk when marketing fruits and vegetables.

The farm operation and marketing characteristics included in this analysis are: total acres used to produce fruit and vegetable in 2012 (ACRES); whether the farmer produces lettuce, cantaloupes, and strawberries for sale, (LETTUCE, MELON, BERRY); percentage of farm's gross annual sales from fresh produce in 2012 (PFRESH); and percentage of sales made through retail outlets (e.g., institution, grocery and restaurant) in 2012 (RETAIL).

It is hypothesized that the size of the producer fruit and vegetable farm operation will be positively correlated with perceptions or awareness of product liability risk. Larger farm

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operations are likely to face higher amounts of risk and therefore more likely to be aware of the different sources of risk (Uematsu and Mishra 2011). Therefore, larger scale fruit and vegetable operation may be more likely to perceive product liability as a risk when selling produce.

Some fruits and vegetables are more susceptible to bacterial contamination and therefore more likely to be associated with product liability risk (Redman 2007). It is assumed that farmers producing "high risk" fruits or vegetables (e.g., lettuce, cantaloupes, and strawberries) are more likely to perceive risks related to customer liability associated with injuries caused by harmful products such as contaminated fresh products and/or product recalls or warnings because of a food borne illness outbreak.

Farmers with a higher percentage of farm's gross annual sales from fresh produce may be more likely to perceive or be aware of product liability risk. The number of foodborne illness outbreaks reported to the United States Center of Disease Control Prevention associated with fresh produce has increased in recent years (Ribera et al., 2012; Dewaal and Glassman, 2013; Painter et al., 2013). Therefore farms with a higher percentage of annual gross sales from fresh produce may be more likely to be exposed to product liability risk compared to those with a larger percentage of sales coming from processed products or produce sold to be processed.

An increasing number of businesses such as grocery stores, restaurants, and institutions such as schools and hospitals require that farmers selling produce to them carry insurance that provides product liability coverage (Boys 2013). Therefore, it is hypothesized that farmers selling produce through grocery stores, restaurants, and/or institutions are more likely to perceive or be aware of product liability as a risk.

The number of farms with vegetables harvested for fresh market per county according to the 2007 Census of Agriculture (USDA-NASS 2007) was also included in this analysis

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(NUMFARM). County-specific characteristics could influence producer access to information and therefore affect perception of risk (Kisaka-Lwayo and Obi 2012). Producers may be more aware of product liability risk if their farm is located in a county with a higher number of farms harvesting vegetables for fresh market because they may be more likely to hear or know about product liability risk through other farmers. Therefore, a producer whose farm is located in a county with a large number of farms selling fresh vegetables may be more likely to be aware or perceive product liability as a risk when selling fruits and vegetables.

Estimation Methods

Probit Model

The error terms in equation (1) ε_i are assumed to be normally distributed; therefore a probit regression was used to identify the farmer, farm business, and county specific characteristics that influence producer perceptions or awareness of product liability risk. The probabilities entering the likelihood function for a probit regression are (Greene 2003):

$$
\begin{aligned}
&\Pr(y_i = 1 \mid x_i) = \Pr(y_i > 0 \mid x_i) \\
&= \Pr(x_i'\beta + \varepsilon_i > 0 \mid x_i) \\
&= \Pr(\varepsilon_i > -x_i'\beta) \\
&= 1 - \Phi(-x_i'\beta) \\
&= \Phi(x_i'\boldsymbol{\beta})
\end{aligned}
\tag{2}
$$

Φ is the standard normal distribution. Therefore the likelihood function is defined as:

$$
\mathcal{L} = \prod_{i=1}^{n} \Phi(x_i'\beta)^{y_i} [1 - \Phi(x_i'\beta)]^{1-y_i} \tag{3}
$$

Taking the logs of (3) we obtain

$$
\ell n\mathcal{L} = \sum_{i=1}^{n} y_i \ln \Phi(x_i'\beta) + (1 - y_i) \ln[1 - \Phi(x_i'\beta)] \tag{4}
$$

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The marginal effect of a continuous variable x_j is the effect of a unit change of this variable on the probability $P(y_i = 1 | x_i)$, given that all other variables are constant at their means:

$$\frac{\partial P(y_i = 1 | \bar{x})}{\partial x_{ij}} = \frac{\partial E(y_i | \bar{x})}{\partial x_{ij}} = \varphi(\bar{x}\beta)\beta_j \quad (5)$$

The marginal effect of a dummy variable x_d on the probability $P(y_i = 1 | x_i)$, given that all other variables are constant at their means is:

$$\text{Marginal Effect} = \text{Prob}(y_i = 1 | \bar{x}, x_d = 1) - \text{Prob}(y_i = 1 | \bar{x}, x_d = 0), \quad (6)$$

where $\bar{x}$ represents the means of all other variables in the model.

Results and Discussion

Sample Overview and Descriptive Statistics

This analysis included 100 observations after excluding those observations with missing values from the regression analysis. Definitions and descriptive statistics of famer, farm business, and location characteristics are presented in Table 1. Age of the respondents ranged from 22 years to 82 years with a mean of 58 years old of age, which is equal to the average farmer age in Tennessee according to the 2007 Census of Agriculture (USDA/NASS). The age distribution of the respondents follows closely the age distribution of vegetable and melon farmers, and fruit and nut farmers in Tennessee (Figure 2). The proportions of survey respondents in each age category are similar to the proportion of Tennessee fruit and vegetable farmers in the same age categories according to census data. The sample used in this study had a larger proportion of farmers in the under 34 years, 55 to 64 and 65 and over age categories when compared to Tennessee fruit and vegetable farmers. However, the proportion of Tennessee fruit

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and vegetable farmers in the 35 to 44 and 45 to 54 was larger compared to the proportion of respondents in these same age categories. About 46% of respondents indicated full-time farming as their primary occupation. About 63% of respondents reported more than $50,000 in annual household income in 2012.

More than half (64%) of respondents indicated risk from customer liability associated with injuries caused by contaminated fresh produce or product recall because of foodborne illness outbreaks as risks they face when selling fruits and vegetables. The average acreage used to produce fruit and vegetable in 2012 was 11.7 acres. The percentage of respondents, who produced lettuce, cantaloupes, and strawberries in the last two years are 30, 26, and 25 percent, respectively. Additionally, on average, 59% of the farms' gross annual sales were from fresh fruits and vegetables. Finally, approximately 5% of fruit and vegetable sales were made through retail outlets (e.g., grocery stores, restaurants, and institutions). On average there were 22 farms with vegetables harvesting vegetables for fresh market per county in Tennessee according to the 2007 Census of Agriculture.

Comparisons of the mean values for farmer, farm business, and county characteristics, on the basis of perceptions or awareness of risk related to customer liability associated with injuries caused by harmful products or product recall or warning because of foodborne illness outbreaks, are presented in Table 2. The average age of those respondents who indicated not facing customer liability associated with injuries caused by harmful products or product recall or warning because of foodborne illness outbreaks (i.e., product liability risk) when selling fruits and vegetables was higher (60 years) than the average age of respondents who indicated facing these risks (57 years). The percentage of full time farmers among respondents who indicated facing product liability risk was significantly larger (59%) compared to the percentage of full

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time farmers among those who indicated not facing this risk when selling fruits and vegetables (22%). This result suggests that full timer farmers are more likely to perceive product liability risk of fruit and vegetable production. A higher proportion of producers who perceived product liability to be a risk reported total household incomes about $50,000 (75%) than the proportion of those who did not perceive product liability as a risk (42%). A possible explanation for this result is that producers with higher household incomes may face greater potential for a loss when a consumer sues them because of illness caused by a harmful product sold to them, as explained in the empirical model section, and therefore they are more likely to perceive this type of risk. In addition, on average, producers who perceive product liability as a risk had more acres in commercial fruit and vegetable production (13 acres) than those who did not perceive product liability as a risk (10 acres). A larger percentage of producers who indicated facing product liability risk grow lettuce (39%), cantaloupes (34%) and strawberries (32%) than those who did not perceive product liability as a risk (14%, 11% and 11%, respectively). This result is consistent with the hypothesis that some fruits and vegetables (e.g. lettuce, cantaloupes, and strawberries) are more susceptible to bacterial contamination and therefore more likely to be associated with product liability risk (Redman 2007). In contrast, respondents who indicated not facing product liability risk had on average a significantly higher percentage of their farm's gross annual sales from fresh fruits and vegetable (67%) compared to the average percentage of sales from fresh produce reported by those perceiving product liability risk when selling fruits and vegetables (55%). Respondents perceiving product liability risk as a risk face when selling fruits and vegetables reported an average of 4% of their fruit and vegetable sales were made through retail outlets while those not perceiving this type of risk reported 6% of their sales were made through retail outlets. Finally, on average there were 20 farms with vegetable harvested for fresh

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market in the county where the farming operation is located for farmers indicating facing product liability risk when selling fruits and vegetables, while the average number of farms with vegetable harvested for fresh market in the county where the farm operation is located was 24 for those who reported not facing product liability risk.

Probit Model Estimations: Parameters and Marginal Effects

A Probit model was used to evaluate the influence of farm business, farmer, and location characteristics influences on Tennessee fruit and vegetable producer perceptions about product liability risk. Table 3 shows estimated parameters and marginal effects for all explanatory variables. According to the likelihood ratio test the model was significant at the 1% level. Seven variables had statistically significant marginal effects on the perception of facing product liability risk when selling fruits and vegetables. A farmer producing lettuce (LETTUCE), cantaloupes (MELON), or strawberries for sale (BERRY) was more likely to indicate facing product liability risk when selling fruits and vegetables. Farmers producing "high risk" fruits and vegetables (i.e., lettuce, strawberries, and cantaloupes) were about 20% more likely to perceive customer liability associated with injuries caused by harmful products such as contaminated fresh products and product recall or warning because of foodborne illness outbreaks as risks face when selling fruits and vegetables. Farmer primary occupation (OCCUP) and household income had positive and significant marginal effects on the likelihood of perceiving product liability risk when selling fruits and vegetables. Respondents who indicated full-time farming as their primary occupation were 28% more likely to perceive product liability risk as a risk face when selling fruits and vegetables. Additionally, results suggested that if the respondents reported more than $50,000 in total household income they were 39% more likely to perceive product liability risk. Finally, the number of farms with vegetables harvested for fresh market in the county where the farm

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operation is located (NUMFARM) and the percentage of farm gross's annual sales from fresh fruits and vegetables had negative and significant marginal effects on the perceptions of product liability risk. An additional farm growing vegetables for fresh market in the county where the farmer operation is located will reduce the probability of perceiving product liability risk by 1%. A possible explanation for this result is that being surrounded by more farms with vegetable harvested for fresh market could make the producer feel safer when selling his/her produce and therefore less likely to perceive product liability risk when selling produce.

In summary, producers who are full time farmers, earn more than $50,000 in total household income, produce lettuce, cantaloupe, and strawberries are more likely to perceive product liability risk as a potential risk when selling fruits and vegetables. On the other hand, producers whose farm is located in a county with more farms harvesting vegetables for fresh market sales and have a larger percentage of the farm's annual gross sales from fresh market, are less likely to perceive product liability risk when selling fruits and vegetables.

Conclusions

Concern associated with food safety of fresh produce has increased due to the number of foodborne illnesses reported to be acquired through produce consumption in the past few years. The mitigation of this potential risk through new regulations, certification, and standards has left produce farmers, especially those with medium and small operations, wondering about the impact of these changes on their production systems, production costs, and therefore profitability. A first step in identifying farmer information needs to face changes in policies, regulations, and standards designed to mitigate product liability risk are to better understand farmer perceptions of product liability risk. A probit regression was used to measure the association between the characteristics of Tennessee produce farmers, farm operation, and the

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county in which the fruit and vegetable operation is located and producer awareness of product liability risk.

Farmer occupation, household income, percentage of annual gross farm sales from fresh produce, whether a famer is harvesting "high risk" produce for sale or not (e.g., lettuce, cantaloupes, strawberries), and the number of farms in the county where the farm operation is located that harvest vegetables for fresh market were characteristics influencing farmers perceptions of risk Results suggest that full time farmers are more likely to perceive product liability risk when selling fruits and vegetables. Nonetheless results from a recent survey of fruit and vegetable farmers in Tennessee (Velandia et al., 2012) suggests a large percentage of fruit and vegetable producers are part-time farmers. This result may suggest the need of putting information about product liability risk and measures to be taken to mitigate this risk in the hands of part-time farmers.

In general, policymakers such as the Tennessee Department of Agriculture, as well as University/Extension personnel may benefit from this information to better target information needs regarding product liability risk and strategies to be taken to mitigate this risk. This information may specifically help policy makers and University/Extension personnel to better target farmers in greater need of information that could help them better face policy and standard changes associated with mitigation of product liability risk. In the second essay we will address the influence perceptions of product liability risk have on the adoption of product liability insurance as a risk management tool.

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Appendix

Table 1. Description of Variables used in the Model for Evaluating Factors Affecting Tennessee Fruit and Vegetable Farmers' Perception of Product Liability Risk (n=100)

Variable	Description	Mean	Std. Dev.
A. Dependent Variable			
RISK_P	=1 if selects customer liability associated with injuries caused by harmful products such as contaminated fresh produce or product recall or warning because of foodborne illness outbreak, 0 otherwise	0.6400	0.4824
B. Independent Variables			
AGE	age in years	58.2600	13.2128
OCCUP	=1 if the farmer is full time farmer, zero otherwise	0.4600	0.5009
ACRES	=total acres used to produce fruit and vegetable in 2012	11.6602	26.7441
HHINCO	=1 if total household income is more than $50,000 in 2012, zero otherwise	0.6300	0.4853
LETTUCE	=1 if the farmer produced lettuce for sale in the last two years, zero otherwise	0.3000	0.4606
MELON	=1 if the farmer produced cantaloupes for sale in the last two years, zero otherwise	0.2600	0.4408
BERRY	=1 if the farmer produced strawberries for sale in the last two years, zero otherwise	0.2500	0.4352
FRESH	=percentage of the farm's gross annual sales came from fresh market sales of fruit and vegetable in the last two years	58.9450	37.9883
RETAIL	=percentage of sales made through retail outlets in 2012	4.8083	15.2447
NUMFARM	=number of farms with vegetables harvested for fresh market at the farmer's county in 2007	21.5600	13.9894

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Table 2. Variable Means for Farmers who Indicated Facing Customer Liability Associated with Injuries Caused by Harmful Products such as Contaminated Fresh Produce or Product Recall or Warning Because of Foodborne Illness Outbreak (n=100)

Independent Variables[a]	Perceive Product Liability Risk when Selling Produce (n=64)	Did not Perceive Product Liability risk When Selling Produce(n=36)
AGE	57.1094	60.3056
OCCUP	0.5938***	0.2222
ACRES	12.5828	10.0200
HHINCO	0.7500***	0.4167
LETTUCE	0.3906***	0.1389
MELON	0.3438**	0.1111
BERRY	0.3281**	0.1111
FRESH	54.6875	66.5139
RETAIL	4.2785	5.7500
NUMFARM	20.2031	23.9722

*, **, *** denotes significance at the 10%, 5%, and 1% levels respectively.
[a] For variable definitions see Table 1.

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Table 3. Estimated Parameters and Marginal Effects from Probit Model for Evaluating Factors Influencing Tennessee Fruit and Vegetable Farmer Perceptions of Product Liability Risk (n=100)

	Probit Model	
Independent Variables[a]	Estimated Parameters[b]	Marginal Effects
AGE	0.0004	0.0001
	(0.0124)	(0.0042)
OCCUP	0.8696**	0.2826**
	(0.3926)	(0.1174)
ACRES	-0.0073	-0.0025
	(0.0076)	(0.0026)
HHINCO	1.1082***	0.3869***
	(0.3273)	(0.1093)
LETTUCE	0.7048*	0.2156**
	(0.4034)	(0.1091)
MELON	0.7962*	0.2345**
	(0.4215)	(0.1025)
BERRY	0.6685	0.2009*
	(0.4548)	(0.1162)
FRESH	-0.0080*	-0.0027*
	(0.0045)	(0.0015)
RETAIL	0.0002	0.0001
	(0.0125)	(0.0042)
NUMFARM	-0.0277**	-0.0094**
	(0.0132)	(0.0044)
Likelihood value	-44.1945	
Likelihood ratio	42.29***	

*, **, *** denotes significance at the 10%, 5%, and 1% levels respectively.

[a] For variable definitions see Table 1.

[b] Standard errors are in parenthesis.

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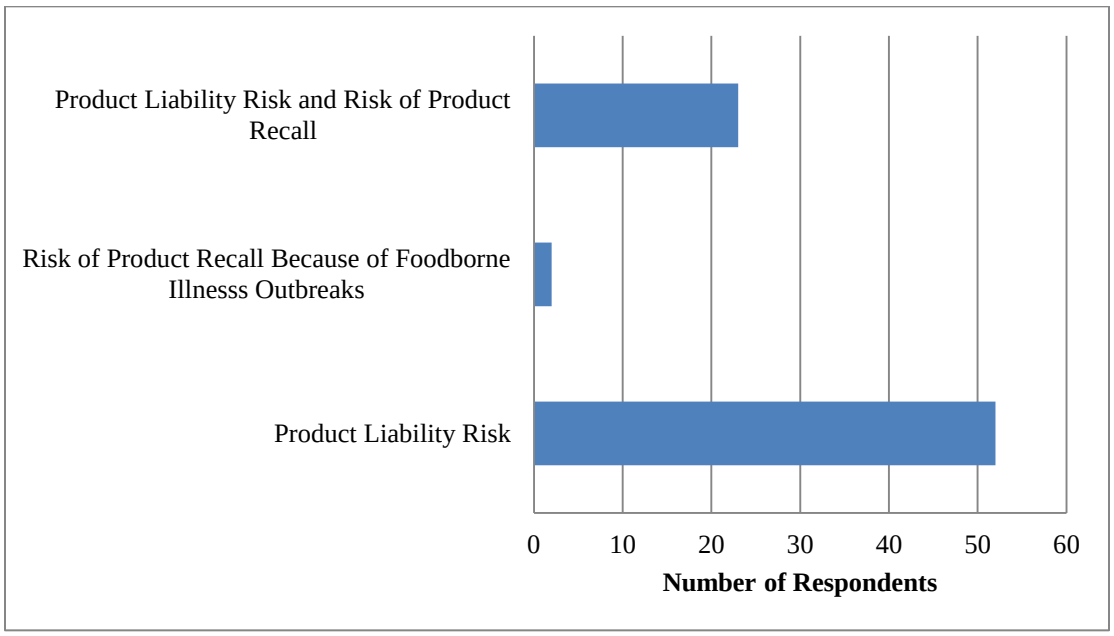

Figure 1. Number of respondents out of 136 indicating product liability or/and product recall as risks face when marketing fruits and vegetables.

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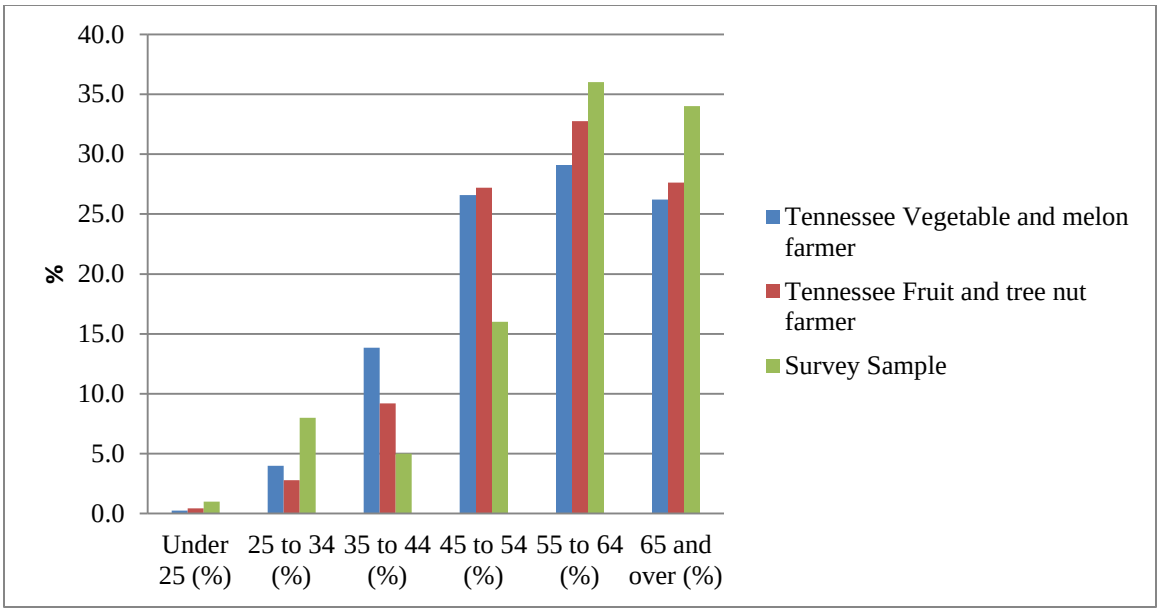

Figure 2. Age distribution of sample data (n=100) compared with Tennessee vegetable andmelon, fruit and tree nut farmers from 2007 Census of Agriculture

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Part 2: Factors Affecting Producer Adoption of Product Liability Insurance: The Case of Fruit and Vegetable Growers in Tennessee

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Abstract

In recent years foodborne illness outbreaks associated with fresh produce reported to the U.S. Centers for Disease Control and Prevention have increased. As a response to these events government and retail interest in improving food safety through policies and standards have also increased. Private mechanisms of food safety control, such as third party certifications and product liability insurance have developed to help producers supply safer food to consumers as well as protect themselves from product liability risk. Using a probit regression with instrumental variables and a simple probit regression without endogenous variables, this study evaluates factors influencing Tennessee fruit and vegetable producer decisions to adopt insurance providing product liability coverage. Results from the probit model with instrumental variables suggest that only percentage of sales made through retail outlets (e.g., institution, grocery and restaurant) significantly influence the decision to adopt product liability insurance. In contrast, the results from the simple probit model excluding potential endogenous variables suggest that farmer decisions to adopt product liability insurance was associated with producer age, gender, and number of years selling fruit and vegetables. This information should be useful for Extension educators as well as policy makers to better assess Tennessee fruits and vegetable producer information needs and barriers impeding adoption of product liability insurance. Additionally, these findings should help insurance companies as they become aware of those producers who are more likely to adopt insurance that provides product liability coverage and therefore they may be able to better target potential clientele for these products.

Introduction

With the increase of food borne illness outbreaks the risk of economic loss to farmers marketing fresh produce has also increased (Ribera et al. 2012; Painter et al. 2013). An event associated with product liability risk may have a very low probability of occurrence but may

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result in a large economic loss (Miller et al. 2004). Producers may be unaware of the product liability risk they face, the potential cost of this risk and, therefore their need to adopt measures against this risk. Although producer adoption of management strategies to improve food safety in their operations such as Good Agricultural Practices (GAP) certification reduce the likelihood of economic loss due to product liability risk, this risk may still exist and therefore other risk management tools such as an insurance that provides product liability coverage may be considered. An insurance policy that provides product liability coverage may help protect producers by limiting their possible exposure to the risk associated with consumers' claims of injury caused by contaminated products (Rejesus and Dunlap 2009).

Although product liability insurance seems to be an effective instrument to shift costs of food borne illness from the consumer who became ill to the firm (e.g. producer) that produce the contaminated product, high transaction and information costs, and the structure of the legal system reduces the efficacy of a lawsuit in compensating an affected consumer. Therefore, producers may not have the right incentives to produce safer food or protect themselves against product liability risk (Buzby, Frenzen, and Rasco 2001). In contrast increased attention in recent years regarding foodborne illness outbreaks have made the medical community more aware and informed about foodborne diseases and have also increased governmental efforts to identify sources of foodborne illness, increasing litigation effectiveness for compensating ill consumers, and therefore increasing producer incentives to adopt measures to reduce or protect their operations from product liability risk (Buzby, Frenzen, and Rasco 2001; Pflumm 2011; Porter, Baker, and Agrawal 2011). Producer adoption of insurance providing product liability coverage may be influenced by farmer and farm business characteristics.

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In Tennessee it is not very common to find local agencies offering insurance products providing product liability coverage (Holland 2007). Additionally, Tennessee fruit and vegetable farms are on average smaller in acreage and sales volume when compare to produce farms in surrounding states (i.e. Alabama, Georgia, Kentucky, Mississippi, North Carolina, Virginia and Arkansas) and at the national level (USDA-NASS 2007). Product liability insurance requirements may affect market access especially for small producers (Markley 2010). Therefore, evaluating the factors that affect Tennessee fruit and vegetable farmer adoption of product liability insurance may help Extension educators as well as policy makers to better assess measures they may need to take to help producers stay competitive under a new food safety regulatory environment proposed by the Food Safety Modernization Act (FSMA)[5] and increased emphasis on the Global Food Safety Initiative[6] (GFSI) by manufacturing and retail businesses (Holcomb, Palma, and Velandia 2013). Additionally, this information may be useful for insurance companies as they become aware of those producers more likely to adopt insurance that provides product liability coverage and therefore they may be able to better target potential clientele for product liability insurance.

The goal of this study is to identify factors influencing the adoption of insurance that provides product liability coverage among Tennessee fruit and vegetable farmers. The next section of this second essay includes data description, conceptual framework, empirical model, and estimation methods used to evaluate the factors influencing Tennessee fruit and vegetable producer adoption decision. The results of this analysis are discussed next and the final section concludes.

[5] The FSMA is the most comprehensive reform to U.S. food safety laws since the 1950s, and it's aiming to ensure the U.S. food supply safety (U.S. FDA 2013).

[6] "The GFSI began in 2000 as an international food safety and traceability benchmarking effort by food industry leaders, but now promotes an internationally harmonized approach to food safety that emphasizes following one of a handful of food safety protocols." (Holcomb, Palma, and Velandia 2013).

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Methods and Procedures

Data

The data for this research were gathered from a survey of Tennessee fruit and vegetable producers participating in the Pick Tennessee Products program. The survey questionnaires were mailed on April 1st, 2013. Reminder post cards were sent on April 19, 2013. On April 29, 2013, a second wave of surveys was sent to the producers who had not responded to the initial mailing. Out of 495 surveys mailed, 163 were returned for a response rate of 32%. A total of 137 observations were available for analysis of the factors influencing adoption of product liability insurance after eliminating respondents who, by the time of the survey, were no longer producing and/or selling fruits and vegetables. Fruit and vegetable producers responded to the survey providing information about their opinions regarding sources of risk they face when selling produce (e.g., customer liability associated with injuries caused by harmful products such as contaminated fresh produce, product recall or warning because of foodborne illness outbreak), the risk management tools use to manage various types of risk (e.g., product liability insurance, homeowners' policy, savings) in their operation, understanding and familiarity with insurance coverage option for farmers, and general farm business and farmer characteristics.

Conceptual Framework

When confronted with the decision to adopt insurance providing product liability coverage an individual will find the level of coverage that maximizes his/her expected utility, such that:

(1) $$\max_{a=0,1}\left[\, pU\left(W_L; x\right)+\left(1-p\right)U\left(W_{NL}; x\right)\right]$$

where p is the probability of loss in case of product liability risk; $\left(1-p\right)$ is the probability of no loss; W_L is the farmer's wealth in the event of a customer suing him/her due to illness/death

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caused by the consumption of contaminated produce; W_{NL} is the farmer's wealth if there is no event associated with product liability risk; a is the coverage level choose by the farmer. In this study we will assume coverage of zero ($a = 0$) is equivalent to a producer not adopting product liability insurance. On the other hand $a = 1$ is equivalent to the selection of full coverage which implies adoption of product liability insurance.

The wealth levels W_L and W_{NL} can be explicitly defined as:

(2) $$W_L = W_0 - L - \theta a + a$$

(3) $$W_{NL} = W_0 - \theta a$$

where θ is the premium to pay to the insurance company, and L is the loss associated with product liability risk (Mas-Colell, Whinston, and Green 1995).

Empirical Model

The decision to adopt product liability insurance is hypothesized to be a function of farmer, farm operation, and county specific characteristics such that:

(4) $$a = \delta_0 + \delta_1 RISK\_P + \delta_2 RETAIL12 + \delta_3 AGE + \delta_4 GENDER + \delta_5 YEARSSELLING + \delta_6 LETTUCE + \delta_7 MELON + e_i$$

Definitions of the independent variables use in this analysis with means and standard deviations are presented in Table 4.

Hypotheses

Producer characteristics hypothesized to affect the decision to adopt product liability insurance by fruit and vegetable farmers are: age (AGE); gender (GENDER), expressed in a dichotomous variable for female producers; number of years selling fruits and/or vegetables (YEARSSELL); perceptions of product liability risk (RISK_P), expressed as an index of

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awareness with higher values representing higher awareness of product liability risk. In essay one, perceptions of product liability risk (RISK_P) is treated as a dichotomous variable. In this essay, RISK_P is a potential endogenous variable in the adoption equation. In this essay the predicted probability associated with perceiving product liability risk is not of interest. Therefore RISK_P is treated as a continuous endogenous variable that will be estimated in a first stage using a multiple regression and therefore the predicted values for RISK_P to be used in the adoption equation can take any value and will not be restricted to the zero and one values. It is hypothesized that farmers perceiving product liability risk as a potential risk face when selling fruits and vegetables are more likely to adopt product liability insurance. Previous studies suggest producer perceptions of sources of risks may have an influence on the use of risk management tools or interest on acquiring information about the use of risk management tools (Boggess, Anaman, and Hanson 1985; Hall et al. 2003; Harwood et al. 1999; Le and Cheong 2010). When describing the main aspects of risk management Harwood et al. (1999) described the identification of potential sources of risks as a factor affecting the decision to adopt risk management tools.

Age is expected to be positively related with the likelihood of adopting product liability insurance because older producers tend to have shorter planning horizons and therefore they are more reluctant to take risks (Uematsu and Mishra 2011). Sherrick et al. (2004) suggested that more experienced farmers are more likely to use insurance as risk management tool in their farm operations. Nonetheless, it is important to notice that previous studies evaluating the relationship between age and the use of risk management tools (Sherrick et al. 2004; Velandia et al. 2009; Uematsu and Mishra 2011) have mainly focused on the adoption of risk management tools associated with price and production risk, rather than product liability risk. Therefore the

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relationship between age and the adoption of product liability risk may be different to the association between age and the adoption of more traditional risk management tools such as crop insurance.

It is hypothesized that female producers who are the primary decision makers of the farm are less likely to adopt product liability insurance compared to male producers. Female farm operators are older and usually became primary farm decision makers late in life so they have less experience as primary decision makers (Dismukes et al. 1997; USDA NASS 2007). Less experience operators may result in less informed operators about risk such as product liability risk and tools available to manage this risk.

Experienced farmers are assumed to more accurately foresee potential risks face in the production and marketing of agricultural products (Velandia et al. 2009; Sherrick et al. 2004). Therefore it is hypothesized that as producers' experience in selling fruit and vegetable increases, so does their understanding of potential risks face when selling produce and therefore their likelihood of adopting insurance providing product liability coverage.

Characteristics of the producer farming operation and marketing practices included in equation (4) are: whether the farmer produces lettuce and cantaloupes for sale, (LETTUCE, MELON); and percentage of sales made through retail outlets (e.g., institution, grocery and restaurant) in 2012 (RETAIL).

Leafy vegetables such as lettuce and greens and fruits such as cantaloupes are more susceptible to bacterial contamination and therefore more likely to be associated with product liability risk (Redman 2007). It is hypothesized that farmers producing "high risk" fruits or vegetables are more likely to adopt insurance that provides product liability coverage.

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The increase in foodborne illness outbreaks associated with produce contamination has resulted in an increase in the number of grocery stores, restaurants, and institutions such as schools and hospitals requiring food suppliers including farmers selling food products to them to carry insurance that provides product liability coverage (Boys 2013). Therefore, it is hypothesized that farmers selling produce through grocery stores, restaurants, and/or institutions are more likely to adopt product liability insurance.

Estimation Methods

Probit Model

The error term in equation (4) e_{pl} is assumed to be normally distributed; therefore a probit regression may be used to identify the farmer, farm business, and county specific characteristics that influence producer adoption of insurance providing product liability coverage. The probabilities entering the likelihood function for a probit regression are (Greene 2003):

$$\begin{aligned} &\Pr(a=1 \mid w) = \Pr(w'\boldsymbol{\delta} + e_{pl} > 0 \mid w) \\ &= \Pr(e_{pl} > -w'\boldsymbol{\delta}) \\ &= 1 - \Phi(-w'\boldsymbol{\delta}) \\ &= \Phi(-w'\boldsymbol{\delta}) \end{aligned} \quad , \tag{5}$$

where w is a set of observed farmer/farm business characteristics, δ_{pl} is a set of unknown parameters to be estimated, $\Phi(.)$ is the standard normal cumulative distribution function. Therefore the likelihood function is defined as:

$$\mathcal{L} = \prod_{i=1}^{n} \Phi(w'\boldsymbol{\delta})^{a} \left[1 - \Phi(w'\boldsymbol{\delta})\right]^{1-a} \tag{6}$$

Taking the logs of (6) we obtain

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(7) $$\ell n\mathcal{L} = \sum_{i=1}^{n} \{a \ln \Phi(w'\boldsymbol{\delta}) + (1-a)\ln[1-\Phi(w'\boldsymbol{\delta})]\}.$$

The marginal effect of a continuous variable w_j is the effect of a unit change of this variable on the probability $\mathrm{P}(a=1|\overline{\mathrm{w}})$, given that all other variables are held constant at their means can be represented as:

(8) $$\frac{\partial P(a=1|\overline{w})}{\partial w_j} = \frac{\partial E(a|\overline{w})}{\partial w_j} = \delta\phi(\overline{w}\boldsymbol{\delta}).$$

The marginal effect of a dummy variable w_d on the probability $P(a=1|\overline{w})$ given that all other variables are held constant at their means is:

(9) $$\frac{\partial P(a=1|\overline{w})}{\partial w_d} = \mathrm{Prob}(a=1|\overline{w}, w_d=1) - \mathrm{Prob}(a=1|\overline{w}, w_d=0),$$

where $\overline{w}$ represents the means of all other variables in the model.

Exogeneity Test

Percentage of sales made through retail outlets (e.g. grocery stores, restaurants, and/or institutions) (RETAIL) and farmer perceptions of product liability risk (RISK_P) maybe correlated with the error term in equation (4). It is hypothesized that farmers selling produce through grocery stores, restaurants, and/or institutions are more likely to adopt product liability insurance. In contrast, producers who have adopted insurance providing product liability coverage may be also more likely to sell produce through retail outlets such as grocery stores, restaurants, and/or institutions. It is likely that perceptions of product liability risk and the adoption of an insurance product to manage this risk may be determined by similar variables. If we identify that at least one of the variables included in the analysis is endogenous the estimation

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of equation (4) is inconsistent for $\boldsymbol{\delta}$. It is necessary to test for the endogeneity of perceptions of product liability risk (RISK_P) and percentage of sales made through retail outlets (RETAIL) in order to determine whether an alternative approach is necessary to estimate the parameters of interest in equation (4). We use the Rivers and Voung (1988) approach to test for endogeneity of the RISK_P and RETAIL.. In this procedure, the potentially endogenous variables (b_1, b_2) are regressed against all other exogenous variables (z_i) and a vector of instrumental variables (c_1, c_2):

(10a) $$b_1 = z_i\gamma_1 + c_1\theta_1 + \upsilon_1$$

(10b) $$b_2 = z_i\gamma_2 + c_2\theta_2 + \upsilon_2 .$$

Then residuals ($\hat{\upsilon}_1, \hat{\upsilon}_2$) from each of these regressions are included as explanatory variables in equation (4) and a separate estimation of the adoption equation is made:

(11) $$a = w'\delta + \hat{\upsilon}_1\alpha_1 + \hat{\upsilon}_2\alpha_2 + \mu .$$

The estimated coefficients (α_1, α_2) associated with the residuals ($\hat{\upsilon}_1, \hat{\upsilon}_2$) from equation (11) are tested for significance using a Wald test. Failure to reject the null hypothesis that $\alpha_1 = \alpha_2 = 0$ provides evidence to conclude that variables associated with perceptions of product liability risk (RISK_P) and percentage of sale made through retail outlets (RETAIL) are exogenous. If the null hypothesis is rejected there is evidence to conclude that at least one of these variables is endogenous and therefore an alternative estimation procedure should be used to obtain consistent estimators of $\boldsymbol{\delta}$.

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A probit regression with instrumental variables could be used to obtain consistent estimators of $\boldsymbol{\delta}$ when one or more variables are endogeneous (Wooldridge 2002). In this case, a latent variable model with two endogenous variables can be represented as:

(12) $$a = z_i'\beta + b_1\delta_1 + b_2\delta_2 + e_{pl}$$

(13) $$\begin{aligned} b_1 &= z_i'\gamma_1 + c_1'\theta_1 + v_1 \\ b_2 &= z_i'\gamma_2 + c_2'\theta_2 + v_2 \end{aligned},$$

where β, δ_1,and δ_2 are vectors of parameters associated with the exogenous, and the two endogenous variables, respectively. Additionally, γ_1, γ_2 , θ_1, and θ_2 are vectors of parameters associated with exogenous and instrumental variables in equation (13). Equation (12) is called the structural equation, and equation (13) is called the reduced form equation.

The log likelihood for observation i is:

(14) $$\ell n\mathcal{L}_i = \left[a \ln \Phi(\mathrm{m}_i) + (1-a) \ln\left\{1 - \Phi(\mathrm{m}_i)\right\} + \ln f\left(b_{1i} b_{2i} \left| \mathrm{z}_i, c_{1i}, c_{2i} \right.\right) \right]$$

where $$\ln f\left(b_{1i} b_{2i} \left| \mathrm{z}_i, c_{1i}, c_{2i} \right.\right) = -\frac{p}{2} \ln 2\pi - \frac{1}{2} \ln \left|\sum_{vv}\right| - \frac{1}{2} V \sum_{vv}^{-1} V'$$

and $V = \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$, $\mathrm{m}_i = \left(1 - \sum_{ve_{pl}}' \sum_{vv}^{-1} \sum_{ve_{pl}}\right)^{-\frac{1}{2}} \left\{ w_i \delta + V \sum_{vv}^{-1} \sum_{ve_{pl}} \right\}, w_i = (b_i, z_i),$

where the variance-covariance matrix terms included in (14) are describe as:

(15) $$\sum = \begin{bmatrix} \sum_{e_{pl} e_{pl}} & \sum_{ve_{pl}}^{-1} \\ \sum_{ve_{pl}} & \sum_{vv} \end{bmatrix},$$

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It is imposed that $\sum_{e_{pl}e_{pl}}$ is equal to $Var(e_{pl})$ and $Var(e_{pl})=1$ to identify the model. $\sum_{ve_{pl}}$ is equal to $\text{cov}(V, e_{pl})$.

Multicollinearity Tests

Multicollinearity may compromise inferences by inflating variance estimates (Greene 2003; Judge et al. 1988). The presence of multicollinear relationships among explanatory variables may influence the significance of estimated coefficients. A condition index was used to detect collinear relationships (Belsley, Kuh, and Welsch 1980). Condition indexes between 30 and 100 indicate that the explanatory variables have moderate to strong association with each other. A condition index accompanied by a proportion of variation above 0.5 indicates potential collinearity problems (Belsley, Kuh, and Welsch 1980).

Results and Discussion

Sample Overview and Descriptive Statistics

A total of 107 observations were available for the evaluation of factors influencing adoption of insurance providing product liability coverage after eliminating observations with missing data. Detailed definitions and descriptive statistics of producer and farm business characteristics are presented in Table 4. The average age of respondents in this sample is 58 years old. A comparison of age distribution between this sample data and data from the 2007 Census of Agriculture (USDA-NASS 2007) is shown in Figure 3. The proportion of Tennessee fruit and vegetable farmers in each age category according to 2007 Ag Census data (USDA-NASS 2007) are similar to the proportion of survey respondents in the same age categories. The sample used in this study had a larger proportion of farmers in the under 34 years, 55 to 64, and 65 years and over age categories when compared to Tennessee fruit and vegetable farmers.

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However, the proportion of Tennessee fruit and vegetable farmers in the 35 to 44 and 45 to 54 years categories was larger compared to the proportion of survey respondents in these same age categories. Overall, this sample is representative of the whole population of fruit and vegetable growers in Tennessee. About 21% of respondents were female operators.

While there were more than half of respondents (63%) indicating risk from customer liability associated with injuries caused by contaminated fresh produce or product recall because of foodborne illness outbreaks as risks they face when selling fruits and vegetables, only about 36% of respondents have used an insurance that provides product liability coverage. The average number of years respondents have been selling fruits or vegetables were 15 years. The percentage of respondents who produced lettuce and cantaloupes in the last two years was 30 and 26 percent, respectively. Additionally, on average 5% of the sales made by fruit and vegetable farmers were made through retail outlets (e.g., grocery stores, restaurants, and institutions).

Differences in farmer, farm business, and county characteristics between respondents who adopted insurance providing product liability coverage and those who did not adopt it are presented in Table 5. Comparisons of adopters and non-adopters characteristics were made to provide further insight into the factors motivating adoption of an insurance providing product liability coverage. Comparisons of observed farmer and farm business characteristics variables' means were made using t-tests.

A larger proportion of adopters indicated perceiving product liability risk as a potential risk when selling fruits and vegetables (79%) compared to the proportion of non-adopters perceiving this type of risk (54%). Adopters had more years of experience selling fruits and vegetables (17 years) when compared to non-adopters (13 years). The percentage of female producers among respondents who did not adopt product liability insurance was significantly

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larger (28%) than the percentage of female producers among adopters of this risk management tool (11%). These results suggest that producers who adopted insurance providing product liability coverage were more likely to perceive product liability risk, had more years of experience selling fruits and vegetables, and were more likely to be male.

Model Evaluation

The selected instrument variable are hypothesized to be correlated with endogenous variables but should not be correlated with error terms in equation (10a) and (10b). The wald test associated with the Rivers and Voung (1988) approach to test for endogeneity of the variable associated with perceptions of product liability risk and percentage of sales made through retail outlets $\left(\chi^2 = 7.07, \text{d.f.} = 2\right)$ suggest at least one of these variables is endogenous. Therefore a probit regression with instrumental variables is used to evaluate the factors affecting the adoption of insurance providing product liability coverage. In addition, no evidence of multicollinearity problems was found given that all condition indexes were less than 30.

Probit Regression with Instrumental Variables: Parameters and Marginal Effects

Estimated parameters and marginal effects for all explanatory variables are presented in Table 6. A wald test ($\chi^2 = 21.35, \text{d.f.} = 7$) for the overall significance of the model indicated the model was not significant. In this model only one explanatory variable had statistically marginal effects on the adoption of insurance providing product liability coverage. Percentage of fruit and vegetable sales made through retail outlets (RETAIL) was positively associated with the likelihood of adopting product liability insurance.

Probit Regression: Parameters and Marginal Effects

Results from a probit regression excluding potential endogenous variables are presented in Table 7 for comparison purposes. According to the likelihood ratio test the model was

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significant at the 1% level. Three of the explanatory variables had statistically significant marginal effects on the adoption of insurance providing product liability coverage. Age of the producers (AGE) and number of years in selling fruit and vegetable (YEARSSELL) were positively associated with the likelihood of adopting an insurance providing product liability coverage. An increase in one year of experience selling fruits and vegetables will increase the likelihood of adopting insurance providing product liability coverage by 0.6%. One year increase in farmer's age will decrease the likelihood of adopting product liability insurance by 1%. As hypothesized, a female producer is about 18% less likely to adopt product liability insurance.

In summary, producers who are younger, male, and have more years of experience selling fruits and vegetables are more likely to adopt an insurance that protects them against product liability risk.

Conclusion

Product liability risk is associated with consumer liability of personal injuries caused by defective products such as contaminated fresh produce. Product liability insurance is one of the tools available to help fruit and vegetable farmers in Tennessee to protect their farm enterprise against this type of risk. Using a probit regression with instrumental variables and a probit model without inclusion of endogenous variables this essay evaluated the influence of producer and farm operation characteristics on the decision to adopt product liability insurance.

Results from the probit regression with instrumental variables suggest that the only variable influencing the adoption of product liability coverage is percentage of sales made through retail outlets. It is important to notice that after controlling for endogeneity of some explanatory variables producer perceptions of product liability risk do not significantly affect the decision to adopt insurance providing product liability coverage. This result suggests that

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although litigation concerns may be a motivation behind the adoption of insurance providing product liability coverage, for Tennessee fruit and vegetable farmers other factors may be relevant in the adoption of this type of insurance. Some motivations stronger than the perceptions of potential liability risk behind the adoption of product liability insurance may be access to particular market outlets, such restaurants and grocery stores (Boys 2013). This hypothesis is supported by the findings that suggest the percentage of sales made through retail outlets significantly influence the likelihood of adopting insurance providing product liability coverage from probit model with instrument variables.

Additionally, results from the probit rgerssion when excluding endogenous variables point that female and older producers are less likely to adopt insurance providing product liability coverage. Therefore, policy makers and Extension educators in Tennessee should provide more information about product liability insurance specifically to female and younger producers. Additionally results suggest that one of the major factors motivating the adoption of product liability insurance is years of experience selling fruits and vegetables. Therefore, Extension educators in Tennessee should provide more information about product liability insurance to producers with limited experience selling fruits and vegetables. .

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Appendix

Table 4. Description of Variables used in the Model Evaluating Factors Affecting Tennessee Fruit and Vegetable Farmers' Adoption of Product Liability Insurance (n=107)

Variable	Description	Mean	Std. Dev.
A. Dependent Variable			
ADOPTION	=1 if adopts product liability insurance which protects producers against consumer claims of injury caused by harmful products such as contaminated fresh or value added products, 0 otherwise	0.3551	0.4808
B. Independent Variables			
RISK_P	Index of risk awareness associated with customer liability associated with injuries caused by harmful products such as contaminated fresh produce or product recall or warning because of foodborne illness outbreak	0.6262	0.4861
AGE	=Age of producers in years	58.3458	13.1888
GENDER	=1 if producer is female, zero otherwise	0.2150	0.4127
EDU	=1 if producer has attained a bachelor's or graduate degree, zero otherwise	0.5234	0.5018
YEARSSELL	=Number of years have been selling fruits or vegetables	14.8505	12.5531
LETTUCE	=1 if the farmer produced lettuce for sale in the last two years, zero otherwise	0.2991	0.4600
MELON	=1 if the farmer produced cantaloupes for sale in the last two years, zero otherwise	0.2617	0.4416
RETAIL	=percentage of sales made through retail outlets in 2012	5.2881	16.2680

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Table 5. Variable Means for Farmers who Adopt Product Liability Insurance to Protect Against Consumer Claims of Injury Caused by Harmful Products Such as Contaminated Fresh or Value Added Product (n=107)

Independent Variables[a]	Adopt Product Liability Insurance to Protect Against Consumer Claims of Injury Caused by Harmful Products Such as Contaminated Fresh or Value Added Product. (n=38)	Do not Adopt Product Liability Insurance to Protect Against Consumer Claims of Injury Caused by Harmful Products Such as Contaminated Fresh or Value Added Product. (n=69)
RISK_P	0.7894***	0.5362
AGE	55.8684	59.7101
GENDER	0.1053**	0.2754
YEARSSELL	17.4474	13.4203
LETTUCE	0.2895	0.3043
MELON	0.2632	0.2609
RETAIL	5.4691	5.1884

*, **, *** denotes significance at the 10%, 5%, and 1% levels respectively based on t-tests.
[a] For variable definitions see Table 4.

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Table 6. Estimated Parameters and Marginal Effects from Probit Regression with Instrumental Variables Evaluating factors Affect Tennessee Fruit and Vegetable Farmers' Adoption of Product Liability Insurance (n=107)

Independent Variables[a]	Estimated Parameters[b]	Marginal Effects
RISK_P	0.9011	0.2793
	(0.8036)	(0.2227)
AGE	-0.0124	-0.0039
	(0.0123)	(0.0038)
GENDER	-0.4881	-0.1513
	(0.3713)	(0.1131)
YEARSSELL	0.0134	0.0041
	(0.0152)	(0.0045)
LETTUCE	-0.0811	-0.0252
	(0.3279)	(0.1007)
MELON	-0.2974	-0.0922
	(0.3454)	(0.1025)
RETAIL	0.0302*	0.0094*
	(0.0165)	(0.0054)
Likelihood value	-553.4224	
Wald chi2(7)	21.35***	

*, **, *** denotes significance at the 10%, 5%, and 1% levels respectively.

[a] For variable definitions see Table 4.

[b] Standard errors are in parenthesis.

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Table 7. Estimated Parameters and Marginal Effects from Probit Model for Evaluating Factors Influencing Tennessee Fruit and Vegetable Farmers' Adoption of Product Liability Insurance (n=126)

	Probit Model	
Independent Variables[a]	Estimated Parameters[b]	Marginal Effects
AGE	-0.0243***	-0.0089***
	(0.3147)	(0.0035)
GENDER	-0.5333*	-0.1815*
	(0.3147)	(0.0961)
LETTUCE	0.0654	0.0243
	(0.2814)	(0.1049)
MELON	-0.0885	-0.0323
	(0.2911)	(0.1053)
YEARSELL	0.0175*	0.0065*
	(0.0105)	(0.0039)
Likelihood value	-78.7984	
Likelihood ratio	10.47*	

*, **, *** denotes significance at the 10%, 5%, and 1% levels respectively.

[a] For variable definitions see Table 1.

[b] Standard errors are in parenthesis.

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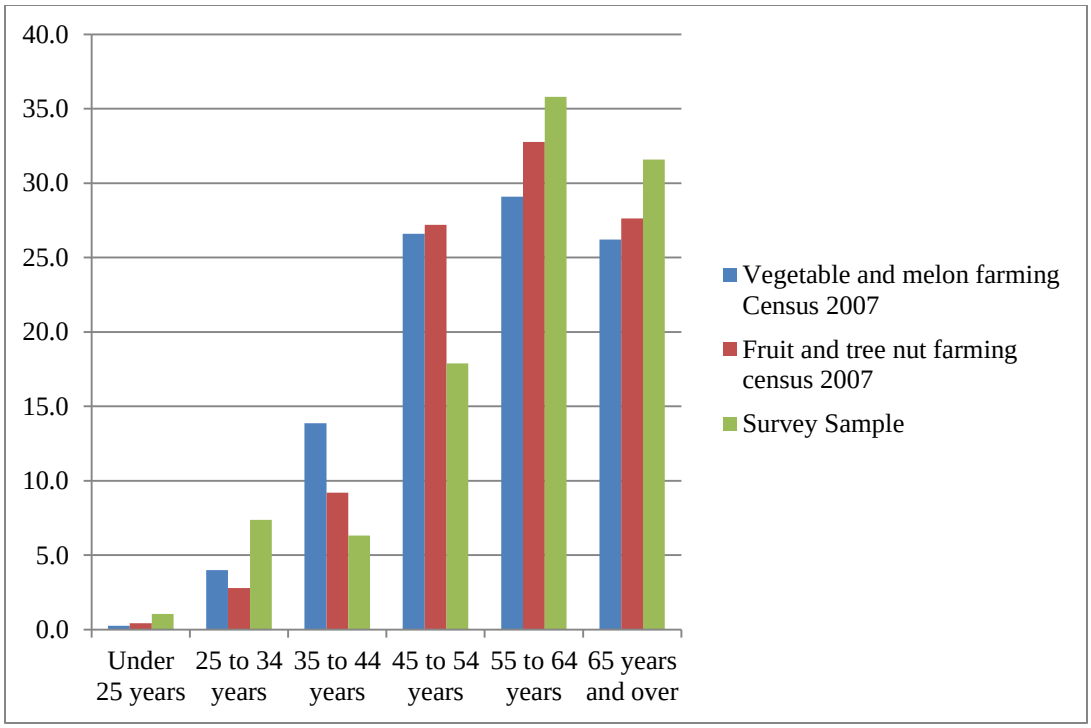

Figure 3. Age distribution of sample data compared with the 2007 Census of Agriculture

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Summary

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Summary

This study evaluated the factors affecting Tennessee fruit and vegetable producer perceptions of product liability risk and adoption of insurance providing food product liability coverage. The first essay of this study focused on the factors influencing producer perceptions of product liability risk. Univariate t-tests were used to examine differences among producers who perceived product liability risk as a risk face when selling produce and those who did not perceive this risk when marketing fruits and vegetables. A larger percentage of producers who indicated facing product liability risk when selling produce were full-time producers, earned more than $50,000 in total household income, and produced lettuce, cantaloupes or strawberries for sale compared to those producers not perceiving product liability risk.

A probit regression was used to evaluate the impact of producer, farm, and county characteristics on perceptions of product liability risk. The results from this analysis showed that primary occupation of producers, household income, production of high risk produce for sale, farms gross's annual sales from fresh fruits and vegetables, and the number of farms with vegetable harvested for fresh market in the county all significantly affected producer perceptions of product liability risk.

The second essay examined the factors influencing Tennessee fruit and vegetable producer adoption of insurance providing product liability coverage. Similar to essay one, univariate t-tests were performed on the selected producer and farm business characteristics in order to examine differences between characteristics of producers with insurance providing product liability coverage and those who indicated not having this type of insurance. Adopters of product liability insurance tended to be male producers and more likely to perceive product liability risk compared to non-adopters.

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A probit regression with instrumental variables was used at first to evaluate the producer and farm business characteristics influencing the adoption of insurance providing food product liability coverage. The factor that significantly influenced the probability of adopting product liability insurance was percentage of sales made through retail outlets. Then a probit regression without inclusion of endogenous variables was used to evaluate factors affecting the adoption of insurance providing product liability coverage. Results from this probit regression suggest that factors significantly influencing the adoption of product liability insurance were age, gender, and years of experince selling fruits and vegetables.

The information gained from this study makes a significant contribution to the body of literature concerning fruit and vegetable producer perceptions of product liability risk and adoption of insurance providing food product liability coverage given the limited number of studies analyzing these topics (Boys, 2013). Information about the type of farmers who are more likely to perceive product liability risk as a risk face when selling fruits and vegetables and that of farmers more likely to adopt product liability insurance may help University/Extension personnel to design educational materials that better target those producers who are more in need of information regarding product liability risk and risk management tools available to handle this type of risk. The findings of this research may also help insurance companies assess the potential demand for insurance products providing product liability coverage among Tennessee fruit and vegetable producers. The importance of years of experience selling fruits and vegetables on the adoption of an insurance providing food product liability coverage suggests that Extension educators and policy makers should focus on providing information about insurance products providing product liability coverage to those farms with limited experience selling fruits and vegetables to expand marketing opportunities for fruit and vegetable farms new to the marketing

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of produce under a new food safety regulatory environment. This may also increase consumer access to fresh produce in Tennessee.

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Vita

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