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THE ROLE OF SECURITY IN THE SUPPLIER SELECTION DECISION

By

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ABSTRACT

THE ROLE OF SECURITY IN THE SUPPLIER SELECTION DECISION

By

Michael Douglas Voss

This research investigates firm trade-offs related to supplier security in the food industry. This research provides practitioners with empirical evidence to support supply chain security change management initiatives. This research also informs suppliers of the trade-offs their customers are willing to accept for increased security. The study further provides insight regarding the importance of security as a supplier selection criterion. The results provide academics insight into the importance of security as it relates to price and delivery reliability, two important supplier selection criteria. The results are also useful to practitioners to evaluate if their firm should invest in supply chain security measures. It is often difficult for practitioners to justify investments in the absence of government regulation or evidence supporting that the initiative is beneficial. This research provides supporting, or dissenting, evidence related to a supplier's ability to reap rewards from security implementation. The results of the research are also of interest to public policy makers. The results allow public policy makers to determine if regulation is necessary to induce firms to increase security, or if there is a demand for increased supplier security. In the latter case, the free market could substitute for burdensome regulation.

To Lee Ann, Mason, and any future additions

ACKNOWLEDGEMENTS

As I sit down to write these simple words of acknowledgement to those who have made the conclusion of this journey possible, I'm reminded of a scene that occurred at the conclusion of another journey. As an undergraduate at The University of Arkansas at Fayetteville I was blessed with a group of friends who were more like brothers. We spent countless hours together during our first four years in college doing things that we both should and should not do. The good stories usually came out of those things we should not have been doing, but I digress. While some of us stayed on longer than four years (including yours truly) a few members of this group departed Fayetteville "on time". The same spring that these friends left, I was also leaving Fayetteville for an internship in Atlanta. While I would return to Fayetteville for my last semester of college, I knew that many of these friends would not be there in the same capacity. Similarly, we all knew that the life, and friendships, we had known would never be the same. Yet this knowledge was kept in the back of our minds. We didn't want to admit the impending change. So sets the stage for a night out in which we all ventured to a local concert hall to watch Texas musician Robert Earl Keen (I dare say that there is not another dissertation acknowledgement that mentions Robert Earl Keen). While Robert Earl Keen has many songs, he closes his shows with one entitled "The Road Goes on Forever and the Party Never Ends." This song seemed particularly appropriate that night and, in fact, has remained very appropriate. My group of brothers remains extremely close and the road truly goes on forever with the proverbial never-ending party in tow.

I also feel that completing the doctoral program is but the beginning of a never-ending road and a life full of "partying" where partying is defined as enjoying ones work, making more money than one deserves (thank you to the taxpayers), and having enough free time to enjoy the fruits of ones labor with family and friends. It is said that being a college professor is the second best job to being a rock star. I'm convinced this is the truth, but I've gotten too old for the activities that go along with being a rock star, so I guess I'll stick this college professor thing out for a while.

Many have contributed to the successful completion of my doctoral program and thus my ability to party down this road. First, I would like to thank God for the many blessings he has bestowed upon my family and I. Without Him, no great accomplishment is attainable, but with Him all things are possible.

Second, my loving wife. I would like to thank my wife Lee Ann for all of her love and support. There can be no better person in the world than her. There is also absolutely, positively, without a doubt, no chance that I would have finished the program without her. Her hard work as an extraordinarily skilled nurse also allowed us to do so many things during our time in Michigan that we never would have been able to do otherwise. I will always remember our time here and the special memories that we will keep for the rest of our lives together.

Next, my family. My parents are the two hardest working people I know and they sacrificed a great deal over the years to make sure that I never wanted for anything. They also made doctoral program success possible by providing me with love, a strong work ethic, guidance, and a desire to do the right thing. I would also like to thank my two grandmothers, Jean Voss and Martha Oliver, for their love and support before, during,

and after my undergraduate, masters, and doctoral programs. Further, I would be remiss if I didn't acknowledge my "new" family: Warren, Pat, and Jason Campbell. While Warren left us too early, I would like to thank he and Pat for raising such a wonderful daughter, who I love with all my heart, for taking a risk and allowing Lee Ann to venture up to the "Frozen Tundra", and for being such fantastic people. I would also like to thank Jason for keeping Lee Ann in line before I arrived on the scene.

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Fifth, a man is nothing without his friends. Specifically, I would like to thank the friends I referenced in the opening of this section and others that have joined our merry band of malfeasants. In no particular order: Scott McDaniel, Clay Campbell, Brandon Timbes, Barrett Hunter, Chad Smith, Steven Bauer, Cliff Pumphrey, Stephen Terrill, J.D. Robbins, and Ben Dorman. I could truly never hope for better friends/brothers and I thank you all for your support over the years. Specifically, with regard to doctoral program success, I would like to thank Bauer for all of his help with my dissertation. Bauer took time out of his schedule and shared his contacts with me such that I was able to complete my work. Another friend that I must mention is my office mate for my first four years at Michigan State, Gilbert Nyaga. Gilbert was as true a friend as I could hope for and we certainly went through many trials and tribulations together. However, through all these trials and tribulations, Gilbert was always positive, supportive, and the perfect office mate. Through our time together I learned a great deal about the Kenyan culture, ate some incredible Kenyan food, and met some wonderful friends of his as well as his wonderful wife Lucy. I would also like to thank Gilbert for putting up with me. I know it was not easy. Finally, thanks to Drew and Holly Shull for their friendship and the lamp they sent me a few weeks after I arrived in Michigan. I used it every day, Shull!

Finally, I would like to extend my sincere gratitude to the wonderful ladies who work in the Marketing and Supply Chain main office. Laurie Fitch, Cheryl Lundeen, Sherry Danner, Kathy Mullins, Kathy Waldie, as well as others who have come and gone have all been a source of assistance, laughter, and generosity. I appreciate them greatly.

In sum, Lord knows I could not have completed this journey on my own. The above parties have made possible any success I have had. To each of them: Thank you from the bottom of my heart. May the road go on forever and the party never end.

One more thing:

Pure as the dawn on the brow of thy beauty
Watches thy soul from the mountains of God
Over the Fates of thy children departed
Far from the land where their footsteps have trod.
Beacon of hope in the ways dreary lighted;
Pride of our hearts that are loyal and true;
From those who adore unto one who adores us—
Mother of Mothers, we sing unto you.

Hit that line, hit that line, keep on going
Take that ball right down the field
Give a cheer, RAH!! RAH!!
Never fear, RAH!! RAH!!
Arkansas will never yield
On your toes, Razorbacks, to the finish
Carry on with all your might
For it's A-A-R-K-A-N-S-A-S for Arkansas
Fight! Fight! Fight!

WOOOOOOOOOOOOOOOO PIG SOUIEEEE, RAZORBACKS!

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CHAPTER 1

INTRODUCTION

This research investigates firm trade-offs related to supplier security in the food industry. This research provides practitioners with empirical evidence to support supply chain security change management initiatives. This research also informs suppliers of the trade-offs their customers are willing to accept for increased security. The study further provides insight regarding the importance of security as a supplier selection criterion. First, this chapter provides background information supporting the need for security. Second, the chapter introduces supply chains and supply chain security. Third, the chapter discusses the importance of the food supply and food supply chain security. Fourth, the chapter dissects the impact of security on suppliers' price and delivery reliability performance. Fifth, the chapter addresses objectives of the current research and specific research questions. Finally, the chapter describes the scope, theoretical and managerial contributions, and organization of the proposed research.

THE NEED FOR INCREASED SECURITY

The United States is increasingly aware of the threat posed by terrorists. Seldom before has such a clear and present danger to the homeland been at the forefront of the Nation's collective consciousness. Sadly, it took the events of September 11th, 2001 to expose the vulnerability of the United States. Supply chain infrastructure and assets are particularly vulnerable as targets and tools used to carry out terrorist acts. The bombing of the World Trade Center in 1993 and the Murrah Federal Building on Oklahoma City in 1995 were accomplished through utilization of transportation assets to deliver weapons.

The supply chain infrastructure, and accompanying passengers, was the target of the Aum Shinrikyo sarin gas attack on a Tokyo subway in 1995, the Spanish commuter train bombing of 2004, and the London tube and bus attacks of 2005. These events, and those of 9/11, heightened public and private awareness of the need to secure supply chain infrastructure and assets.

Terrorist motivations

Terrorists hold many reasons for attacking the United States (Transportation Security Agency, 2003). The United States now enjoys the benefits and pitfalls of its status as the world's only remaining super power. In this role, U.S. policies and culture receive global media attention. Terrorists often use these policies, and their disdain for U.S. culture, to justify their actions. For example, United States support of Israel is diametrically opposed to some terrorist goals and they seek to punish the United States as a form of retaliation. The culture of the United States is often thought to be sacrilegious by many of these groups. This predominantly Christian culture, characterized by some as placing worldly possessions over religious priorities, leads terrorists to view attacks against the United States as part of a "jihad" (holy war). Finally, U.S. led coalitions have participated in the Gulf Wars of the early 1990's and 2000's. The stationing of U.S. troops in this region has led terrorists to seek retribution for the perceived occupation of their holy land.

Impacts of terrorism

Few of these cultural and geopolitical terrorist motivations are likely to change soon. Thus, the United States should be aware that a terrorist threat is imminent and could severely impact the country. Wolfe (2001) posits three classes of impact resulting from a terrorist attack. *Primary impacts* represent the actual damage, casualties, and disruption that result. These are the primary motivations of terrorists seeking notoriety for their cause. *Direct secondary impacts* include the cost of rescue and recovery efforts, such as clearing damage and mobilizing resources. Both primary and direct secondary impacts impose a heavy cost on the victimized nation. However, the primary economic impact of a successful terrorist attack lies in the resulting *indirect secondary impacts*. Indirect secondary impacts represent the countermeasures taken by the victim to prevent further damage. A short-term example of an indirect secondary impact is the closing of U.S. airspace after 9/11, which cost air carriers millions in lost revenue. In the long-term, continuing security efforts cause inconvenience to passengers and may cause them to utilize other modes of transportation. The total cost of post-9/11 security efforts to the U.S. economy, also an indirect secondary impact, is anticipated to exceed $151 billion annually (Russell and Sandalha, 2003).

SUPPLY CHAINS AND SUPPLY CHAIN SECURITY

Over the past thirty years, eighty percent of terrorist attacks against U.S. interests have targeted business entities (Bremmer, 2001; Dobie et al., 2000). A major focus of these attacks is the supply chain infrastructure and assets that can serve as a target or weapon delivery system. Therefore, it is necessary for industry to protect their supply

chains from terrorist intrusion in order to prevent undue harm to the populace and protect firm viability.

Consequences of supply chain security failure

Radjou (2003) provides several adverse consequences of supply chain security failures. First, a terrorist attack levied upon a firm's supply chain is likely to cause widespread disruption in the delivery of goods to customers. This leads to a loss of revenue derived from these deliveries. Second, a loss in brand equity could occur if customers believe the attack was successful due to a systemic failure of the firm's security measures, or that the firm is likely to be a target in the future. Third, this loss of short-term and long-term revenue could lead to investor discontent with firm performance and subsequent sale of equity investments. A major supply chain disruption has been shown to devalue stock price by as much as nine percent (Radjou, 2003). Fourth, this disruption also stands to bring about regulatory scrutiny if the loss in sales is large enough to prevent the firm from meeting financial predictions. Finally, a successful terrorist attack against a firm could result in severe legal consequences and their associated costs.

Vulnerability of the U.S. supply chain

Unfortunately, protecting the U.S. supply chain is difficult at best. Several factors make it vulnerable to attack (Blalock, 2003). Large portions of the supply chain are unguarded. Only the most important, or visible, parts of the supply chain are regularly protected. Furthermore, the size of the supply chain infrastructure makes complete

protection nearly impossible. The domestic infrastructure includes roughly 47,000 miles of interstate, 99,000 miles of class I railroad track, 26,000 miles of navigable waterways, 64,000 miles of oil pipeline, 5,200 airports, and 9,400 commercial waterway facilities (DOT, 2005).

The interconnectedness of this infrastructure, one of the greatest assets of the U.S. supply chain, also renders it vulnerable. A major disruption in one mode stands to have deleterious effects on the capabilities of another. There are also a large number of stakeholders involved and the capability to secure a supply chain is only as strong as its weakest link. These stakeholders include the government, customers, suppliers, service providers (e.g. carriers and warehouses), and the human resources that enable efficient and effective supply chain operations. Finally, there are significant funding limitations available to protect this infrastructure.

It is also important to consider the difficulty in securing supply chain assets, particularly those used in international trade. Ninety percent of international trade, and almost one-half of U.S. imports, are transported via cargo containers (United States Customs and Border Protection, 2004). This figure represents almost nine million containers unloaded annually in the United States. Ensuring that these containers carry only appropriate cargo is a daunting task, not to mention the difficulty in securing the thousands of containers, trailers, and railcars used for domestic shipments.

Supply chain security management

The serious repercussions of terrorist attack, and the difficulty of preventing such an attack, have led to the study of supply chain security management. In order to

understand how to secure a supply chain, one should first understand how a supply chain is defined. A supply chain is defined as, "The combination of organizations and service providers that manage the raw material sourcing, manufacturing, and delivery of goods from the source of the commodities to the ultimate users" (Closs and McGarrell, 2004 p. 8). Thus, supply chains consist of a network of organizations beginning with raw material suppliers, concluding with the end consumer, encompassing manufacturers charged with changing product form, and the service providers who transport and store the products. Supply chains, and the management of the activities involved in their efficient and effective operation, have come to represent a source of competitive advantage for many firms (Bowersox, Closs, and Stank, 1999; Kent and Flint, 1997). However, the circumstances inherent to the post-9/11 world have added significant complexity and cost to supply chain management. This has led to the concept of supply chain security management.

Closs and McGarrell (2004, p. 8) define supply chain security management as "The application of policies, procedures, and technology to protect supply chain assets (product, facilities, equipment, information, and personnel) from theft, damage, or terrorism, and to prevent the introduction of unauthorized contraband, people, or weapons of mass destruction into the supply chain." A number of observations can be drawn from this definition. First, supply chain assets are defined as not only the equipment and facilities used to carry out supply chain processes, but also the product, information, and human resources required to operate the supply chain. Therefore, supply chain protection does not stop with securing a facility through gates and locks, but also encompasses the product and people involved in supply chain activities, as well as the internal and external

information flows between supply chain partners and functional silos. Second, supply chain security is not simply a matter of ensuring the safety of these assets, but also preventing theft, damage, and unintended intrusions into their physical domains for the purpose of preventing disruption of supply chain operations and maintaining acceptable performance levels.

THE IMPORTANCE OF FOOD AND FOOD SUPPLY CHAIN SECURITY

Food supply chains are an important subset of the broader supply chain concept due to their importance to the populace, the U.S. economy, and their vulnerability. A safe food supply is a primary foundation upon which society is built. Agricultural products, and their related industries, significantly contribute to the economic welfare of the United States through jobs and exports (Rand Corporation, 2003). Furthermore, of seven general areas of U.S. vulnerability to terrorism, five are related to the food supply chain (Harl, 2002). This level of vulnerability, coupled with the lack of U.S. food supply chain preparedness and potentially disastrous effects of such an attack (Rand Corporation, 2003), has led to the United States Food and Drug Administration (2003) to classify the potential for a terrorist attack on the U.S. food supply as a real and current threat.

The importance and vulnerability of food supply chains has not gone unnoticed by terrorists. The United States has recently uncovered Al Qaeda plans to attack crops, livestock, and food processing operations (USFDA, 2003). To the extent that the United States has obtained credible evidence that the food supply is a potential target, it is important that efforts be made to secure the food supply from agro-terrorism. The World

Health Organization (2002, p. 4) defines agro-terrorism as, "An act or threat of deliberate contamination of food for human consumption with chemical, biological, or radio nuclear agents for the purpose of causing injury or death to civilian populations and/or disrupting social, economic, or political stability." Drawing from Closs and McGarrell (2004), the definition of food supply chain security to be used throughout this research is given as:

> The application of policies, procedures, and technology to protect food supply chain assets from theft, damage, or terrorism, and to prevent the introduction of unauthorized contraband, people, or weapons of mass destruction into the food supply chain.

IMPACT OF SECURITY ON SUPPLIER EVALUATIONS

As previously noted, one of the factors making the supply chain vulnerable to attack is the limitation in the amount of funding available to pay for security. It is estimated that the U.S. economy incurs an extra annual cost of $151 billion to fund these initiatives (Russell and Sandalha, 2003). Motor and air carriers alone pay $2 billion for locks, cameras, employee training, among other expenses (Wolfe, 2001). The inevitable question arises: Who *should* pay for security? EyeforTransport (2004) conducted a survey of supply chain professionals to answer this question. Four possible groups were identified: shippers, consignees, transportation providers, and the government. In the short-term, the answer seems to be all of the above, but fifty-five percent of the respondents indicated that they are bearing the costs internally with little hope of recovering them. The practice of bearing costs internally likely cannot continue forever. In the long-term, the cost of security is likely to be passed down to the customer.

Cost is not the only issue. Supplier delivery reliability also stands to be affected by increased security (Hannon, 2004; Jorgensen 2003). Security inspections occurring

inside the firm, at border crossings, and points of embarkation and disembarkation, add another layer of activities to the order cycle. With any added activity comes greater process variability. This added order cycle variability decreases suppliers' ability to meet promised delivery dates.

It has been proposed that security may actually decrease costs and increase delivery reliability. These improvements will likely come from the use of tracking technologies, such as RFID and smart-seals, and process improvements (Rice and Spayd, 2005). Most firms have not progressed beyond implementation of physical security measures (e.g. gates, guards, and cameras) and have not garnered the advantages that may come from tracking technologies and process improvements (EyeforTransport, 2005). While physical security measures are valuable, they hold little promise for lowering costs and improving delivery reliability (Wolfe, 2005).

As noted above, certain security measures could lead to improvements in supplier performance. However, since most firms have not progressed beyond the implementation of physical security measures, the end result is that suppliers must now shift their focus from delivering required service at the lowest total cost, to accomplishing this task under new security initiatives. This is a difficult proposition. A supplier that increases its security capability is faced with the unpleasant notion of increasing the product price and decreasing the reliability of product delivery. As a result, customer evaluations of a supplier on these criteria could be negatively impacted. Complicating the problem, price and delivery reliability are two of the most important criteria used by firms to evaluate suppliers (Lehman and O'Shaughnessy, 1974; Evans, 1982; Wilson, 1994). Suppliers are also faced with a lack of knowledge concerning how much price

and delivery reliability their customers might be willing to sacrifice for increased security and under what conditions these customers might be more willing to make these trade-offs.

RESEARCH OBJECTIVES

This research explores the extent to which food purchasing managers are willing to trade-off price and delivery reliability for increased supplier security. These findings provide practitioners empirical evidence to support security related change management initiatives by increasing awareness of the trade-offs their customers are willing to accept for increased security. This study also provides academics insight into the role of security in relation to important supplier selection criteria. The specific objectives of this research are:

A) To (re) establish how product quality, product price, delivery reliability, and supplier security influence supplier preference.

B) To determine if purchasing firms are willing to trade-off price and delivery reliability for increased supplier security.

C) To identify if 1) concern over past security related incidents and 2) international sourcing increase the amount of price and delivery reliability purchasing firms are willing to trade-off for increased supplier security.

RESEARCH QUESTIONS

These research objectives result in a series of specific research questions. The first set of research questions examines purchasing firms' willingness to sacrifice price and delivery reliability for increased supplier security. The answers to research questions posed in section "A" are obvious. Firms are unlikely to prefer suppliers with lower

quality, higher prices, lower delivery, and lower security *ceritus paribus*. However, these research questions are necessary to set the stage for those posed in sections "B" and "C".

A) To (re) establish how product quality, product price, delivery reliability, and supplier security influence supplier preference.

    1. Do purchasing firms prefer suppliers who deliver higher product quality over those that delivery lower product quality?

    2. Do purchasing firms prefer suppliers who charge lower prices over those that charge higher prices?

    3. Do purchasing firms prefer suppliers who provide higher delivery reliability over those that provide lower delivery reliability?

    4. Do purchasing firms prefer suppliers who provide greater security over those that provide less security?

B) To determine if purchasing firms are willing to trade-off price and delivery reliability for increased supplier security.

    1. Are purchasing firms willing to pay a price premium for increased supplier security?

    2. Are purchasing firms willing to sacrifice delivery reliability for increased supplier security?

The second set of research questions builds upon the findings of questions B.1 and B.2. These questions examine two conditions that could affect purchasing firms' willingness to sacrifice for increased supplier security.

C) To identify if 1) concern over past security related incidents and 2) international sourcing increase the amount of price and delivery reliability purchasing firms are willing to trade-off for increased supplier security.

    1. Does concern over security related incidents that have occurred at the purchasing firm influence respondents to place more value on increased supplier security?

    2. Do purchasing firms that source goods internationally place more value on increased supplier security?

SCOPE OF RESEARCH

This research surveys food purchasing managers and the trade-offs they are willing to make to receive increased supplier security. The food industry represents a particularly important target population for many reasons. First, food is of great importance important to society and the United States economy. Providing information to food suppliers regarding the trade-offs their customers are willing to accept for increased security could provide the impetus for those suppliers to begin a security initiative. This, in turn, helps to protect society and the economy from attack. Second, perhaps more than most industries, the food industry has a vested interest in ensuring their suppliers' product is prepared and processed safely. Consumers are particularly averse to consuming food prepared by firms who have experienced a contamination incident and may engage in litigious actions against companies involved in a contamination incident. It is therefore in the purchasing firm's best interest that their suppliers operate in a secure manner. Third, food protection has recently received media attention, which makes it a timely topic. Perhaps more importantly, this media attention may have increased the likelihood of the food supply becoming a target.

Interviews are to be conducted with food industry representatives to identify how much price and delivery reliability they are willing to trade-off for increased supplier security. This information is used to create the scenarios presented to respondents in a survey instrument. These surveys were sent to food industry purchasing managers. Each respondent was then asked to evaluate a set of scenarios. These scenarios present different levels of the factors under investigation, including basic and advanced supplier security. A vignette describing a supplier employing basic security measures, and one

describing a supplier employing advanced security measures, were provided with the survey. The basic and advanced security characteristics are drawn from Closs and McGarrell (2004).

The sample of firms was drawn from the Institute for Supply Management (http://www.napm.org) and from the American Purchasing Society (http://www.american-purchasing.com). Choice-based conjoint analysis was used to analyze the factors. Further discussion of methodological issues can be found in Chapter Three.

CONTRIBUTIONS TO THEORY AND MANAGEMENT PRACTICE

This project represents one of the few empirical works investigating supply chain security, and therefore stands to be of import to future academic research. Further, the results provide academics insight into the importance of security as it relates to price and delivery reliability, two important supplier selection criteria. The results are also useful to practitioners to evaluate if their firm should invest in supply chain security measures. It is often difficult for practitioners to justify investments in the absence of government regulation or evidence supporting that the initiative is beneficial. This research provides supporting, or dissenting, evidence related to a supplier's ability to reap rewards from security implementation. The results of the research are also of interest to public policy makers. The results allow public policy makers to determine if regulation is necessary to induce firms to increase security, or if there is a demand for increased supplier security. In the latter case, the free market could substitute for burdensome regulation.

RESEARCH ORGANIZATION

The remainder of this research is organized into four chapters. Chapter Two examines the relevant literature with respect to supply chain security in general, and particularly protection of the food supply chain. Chapter Three provides an in-depth discussion of the research methodology, reviews the research objectives, outlines data collection methods, and explains the analytical methods applied. Chapter Four presents the research results and interprets the findings of each research question. Finally, Chapter Five explains the conclusions drawn from these results and the implications for academia, industry, and government. The final chapter also includes limitations and directions for future research.

CHAPTER 2

INTRODUCTION

Chapter Two synthesizes the supply chain security literature. First, the chapter overviews supply chain security. Second, the chapter focuses on food and food supply chain security. Third, the chapter reviews the criteria used by firms to choose suppliers. Finally, the chapter integrates these literature streams and identifies the issues that are the focus of the current research.

OVERVIEW OF SUPPLY CHAIN SECURITY

Supply chain security has become a priority in the post-9/11 world. Firms are faced with the challenge of protecting complex supply chains from terrorist attack. Terrorists are commonly thought of as part of an organized group, which may not always be the case. Disgruntled employees or disenfranchised individuals are also a threat. These employees often have access to sensitive areas in the firm and could sabotage or contaminate product. Therefore, supply chain security is not only a matter of protecting assets from external threats, but also from the enemy within. The term terrorist is used throughout this research to imply any individual who would seek to do harm to others. No distinction is made between terrorists that are a part of an organized group or those that act alone.

Furthermore, supply chain security should not be confused with risk. Risk is context specific in that different industries define risk in different ways (Spekman and Davis, 2004). An accountant may think of risk as the inability to detect irregularities in audit data, whereas a logistician might view risk as the possibility that inventory could

become obsolete. Johnson (2001) characterizes supply chain risk as consisting of two facets: demand risk and supply risk. Demand risk occurs as a result of factors that make demand unpredictable or might negatively skew demand. These factors may include seasonality, volatility of fads, short product life cycles, or the public's perception of the safety and ethics of the firm. Supply risk involves, "the probability of an incident associated with inbound supply from individual supplier failures or the supply market occurring, in which its outcomes result in the inability of the purchasing firm to meet customer demand or cause threats to customers life and safety" (Zsidisian, 2003 p. 222). Supply chain security management, as previously defined, serves as a way to mitigate demand and supply risk. Security mitigates demand risk by helping to protect a firm from terrorist activity and thereby protect its brand image from harm in the eyes of the public. Security mitigates supply risk in that it helps to protect the safety of a firm's customers and also helps to ensure supply to that firm by improving the quality of goods delivered.

The previous discussion of risk also allows one to differentiate between the concepts of security, protection, and defense. In this research, security is conceptualized as a method of protecting the supply chain by defending against terrorist induced demand and supply risk. Said differently, security *protects* supply chain assets by *defending* against external threats. To put this in a more understandable context, think of a football offensive lineman as supply chain security and the opposing team as potential terrorists. In passing situations, the job of the offensive lineman is to *protect* the quarterback by *defending* against the threat posed by the opposing team. Therefore, security *protects* by

defending. In this sense, security is a method of protecting "internal" assets by defending against "external" threats.

PRESSURES LEADING TO SECURITY IMPLEMENTATION

The terrorist threat has increased pressure on firms to improve their supply chain security capability. The threat of future terrorist acts is the primary driver of security initiatives, but secondary drivers that occur as a result of this threat are important as well. The Aberdeen Group (2004) and EyeforTransport (2004) conducted research into these secondary drivers. Respondents were asked what drove their firms' decision to enhance security. The results are presented in Table 2.1:

TABLE 2.1 DRIVERS OF SECURITY INITIATIVES

Study	Drivers
Aberdeen Group (2004)	Brand damage from product recall or regulatory non-compliance (i.e. protect brand equity)
	Brand piracy, gray market activity, and product counterfeiting
	Customer and trading partner requirements
	Increased product safety and traceability concerns due to outsourcing activity
EyeforTransport (2004)	Customer requirements
	Government pressure

The Aberdeen Research Group (2004) respondents reported their firms' primarily enhanced security to protect brand equity. Practitioners fear that contamination of their product will damage customer perceptions of their brand. An example of this can be

found in the recent fast food contamination in California. In this case, a well-known fast food franchise suffered a loss in business due to a human digit being found in their food. This incident later turned out to be a hoax, but the company lost brand equity that required expensive recovery efforts.

Related to brand equity is the issue of brand piracy, gray markets, and product counterfeiting. Firms secure supply chain assets in order to reduce theft and provide assurance to their customers of product origin. This issue has come to the forefront in recent discussions over senior citizen's ability to purchase pharmaceuticals from Canada. The Food and Drug Administration (FDA) claims that unregulated pharmaceutical imports stand a greater chance of being ineffective or harmful.

Customer security requirements are cited as a driver of security programs in both studies. To protect themselves, firms have begun requiring their suppliers to increase security. Working with suppliers and customers to ensure their supply chains are secure is a primary tenet of the Customs-Trade Partnership Against Terrorism (C-TPAT). C-TPAT is a voluntary, joint public-private initiative encouraging firms to secure their supply chains, and those of their trading partners. The goal of C-TPAT is to certify enough firms to create a critical mass of supply chain protection.

Government pressure is another significant driver. While C-TPAT is voluntary, the government has also taken a regulatory stance. The Bioterrorism Act of 2002 requires that firms engaged in food processing be able to trace raw materials and output one step up, and one step down, the supply chain (USFDA, 2003).

These drivers are prompting firms to be proactive in establishing their security programs. Other firms are less prepared. Rogers et al. (2004) report that many managers

feel their firm will not be the target of a terrorist attack because they only sell certain commodities. Other managers feel their security obligations end when they transfer goods to a carrier. Both of these findings indicate that supply chain security is not a priority for many firms.

THE STATE OF SUPPLY CHAIN SECURITY BEST PRACTICE

Despite the previously mentioned incentives for supply chain security, effective security processes are still quite rare. Few academic works provide guidance into the most efficient and effective means to secure a supply chain and even fewer are empirical. The two primary academic works providing guiding recommendations are Closs and McGarrell (2004) and Rice and Caniato (2003). A summary of their findings can be found in Tables 2.2 and 2.3 below:

TABLE 2.2 SUPPLY CHAIN SECURITY BEST PRACTICE I

Relationships	Internal Security Initiatives	Incident Security Management
Suppliers	Personnel	Planning
Government	Information	Mitigation
Carriers	Facility(ies)	Detection
Terminal/Port operators	Inventory	Response
Customers	Transportation	Recovery
	Transportation tracking and visibility	
	Receiving management	
	Storage management	
	Shipping management	
	Internal operations management	
	Supply chain education	

Source: Closs and McGarrell (2004)

TABLE 2.3 SUPPLY CHAIN SECURITY BEST PRACTICE II

Physical Security	Information Security	Freight Security
Background checks	Hardware: firewalls, dedicated networks, etc.	Inspections
Vulnerability checks by outside experts	Software: intrusion detection, anti-viruses, passwords	Compliance with U.S. government initiatives (C-TPAT, CSI, OSC, etc...)
Access control, badges	Audits of partners IS security	Cargo seals
Gates, guards, camera systems	Education and training for IS security	Documented standards of care, use of certified 3rd parties, defined chain of custody
		Industry initiatives to establish standards of care among shippers and carriers
		Use of technology (GPS, RFID, e-seals, biometrics, etc...)

Source: Rice and Caniato (2003)

Key to the discussion of supply chain security is the notion that a supply chain protection program is only as strong as its weakest link. Sheffi (2001) posits collaboration with external entities is necessary to ensure that security procedures are communicated and followed. Closs and McGarrell (2004) posit five general stakeholders with whom a firm should maintain relationships and communicate security information. For example, firms should maintain collaboratory relationships with the government in order to remain abreast of security regulations. The government also serves as a source of threat information and provides guidance regarding methods to secure the supply chain through certification programs such as C-TPAT.

Maintaining these relationships are necessary for firms to effectively implement the disaster management process (labeled "incident security management" in Table 2.2). The disaster management process consists of five stages and documents the actions that a firm will undertake before, during, and after a security incident (Helferich and Cook, 2003). *Planning* represents the firm's efforts to formulate actions in anticipation of an incident. *Mitigation* is the action taken prior to an incident that prevents or reduces supply chain damage. Examples of mitigating actions include instituting parallel production processes in case one is contaminated, or forming an emergency response center to serve as a central point of contact. *Detection* is the firm's ability to recognize an incident. While incidents are sometimes easy to detect, such as those of 9/11, others are not (National Academy of Sciences, 2004). Contamination of food products with a biological agent may be mistaken for a batch of spoiled product. The real challenge of detection is to ascertain that an incident has occurred prior to it doing any harm. The *response* stage begins as soon as the incident is detected and involves mobilizing equipment to respond to an emergency, removing people from danger, providing for those affected by the incident, and bringing affected services and systems back on-line. Response represents the firm's short-term actions following an incident. The long-term efforts fall under *recovery*. Recovery often places the most strain on involved parties. Long-term effects of morbidity and mortality can be devastating to families, financial institutions, firms involved in the attack, and the government. The long-term effects of 9/11 on the airline industry, and the U.S. Government's effort to assist them through expensive loan guarantees, serve as an example.

The actual actions that must be taken to secure the supply chain, and entities that must be secured, are given under internal security initiatives in Table 2.2. The Closs and McGarrell (2004) model presented in Table 2.2 is more prescriptive in this respect when taken at face value. Steps to assess supply chain security are provided as an appendix in their work. This appendix also delineates characteristics of firms who have achieved basic and advanced levels of security implementation. The Rice and Caniato (2003) model presented in Table 2.3 provides more in the way of actual security measures, but is not as thorough as the Closs and McGarrell (2004) appendix. Detailing the actual methods of securing the supply chain is beyond the scope of this work. Many resources, both private and public, provide suggestions (e.g. www.dhs.gov). Identifying what actually constitutes best practice is a matter of ongoing research. Such research is being conducted by Michigan State University, where investigations into food supply chain security best practice are ongoing (http://www.fpd.umn.edu). The preliminary results of this investigation will be discussed subsequently.

COST AND SERVICE IMPLICATIONS OF SECURITY IMPLEMENTATION

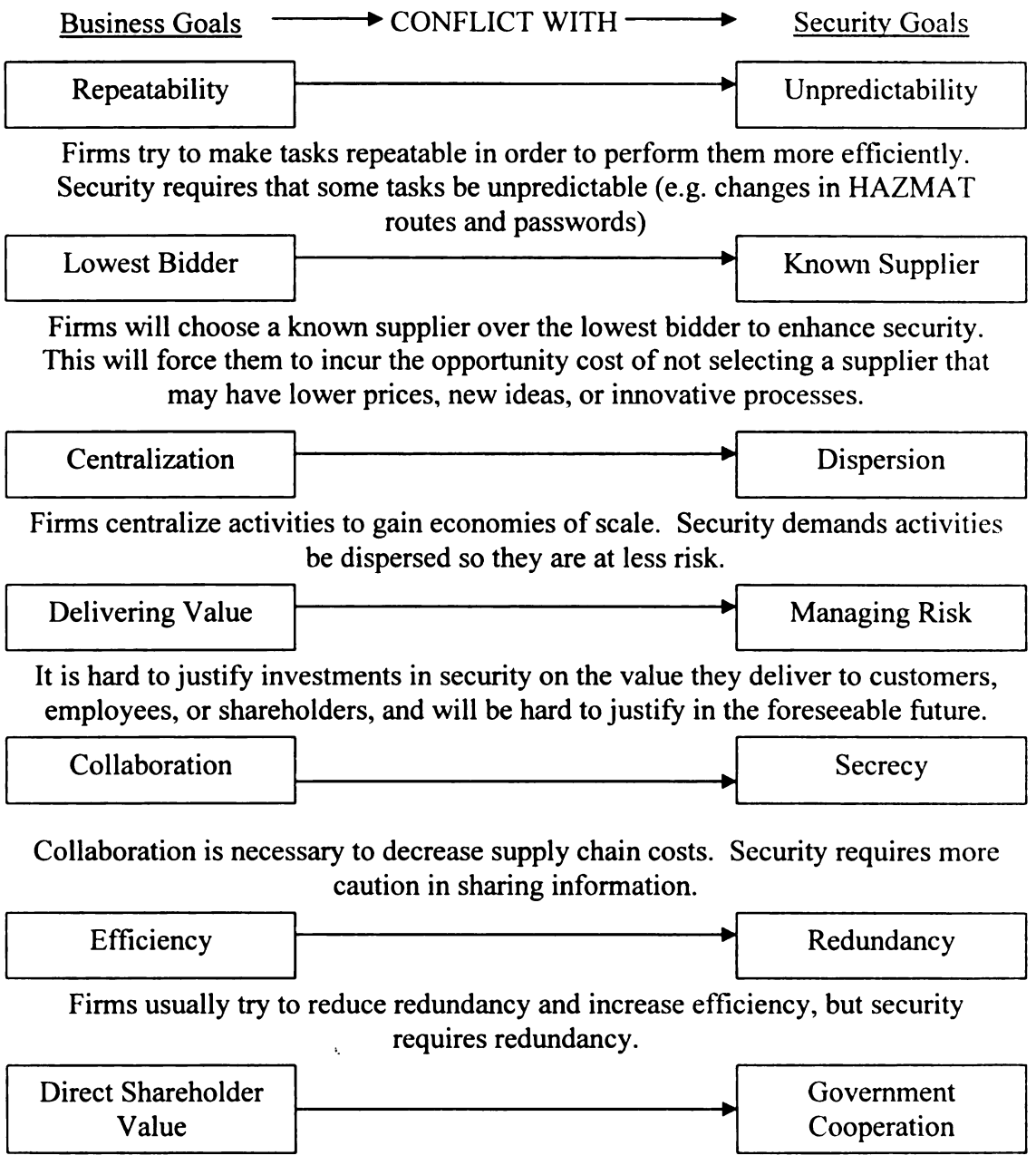
The current research is grounded in the notion that firms who endeavor to secure their supply chain incur a cost and service penalty. For example, Closs and McGarrell (2004) advocate securing the receiving department through cargo inspections. While this secures the firm's receiving function, it also adds cost. Receiving personnel must be dedicated to (at least part-time) performing the inspections. Further, the time it takes to perform the inspection adds greater variability to the receiving activity. This adds greater

variability to the firm's entire process. This added variability slows the process and makes it more difficult to predict delivery dates, ultimately decreasing service levels.

As stated in Chapter One, the U.S. economy will incur $151 billion annually in additional costs to secure the supply chain (Russell and Saldanha, 2003). From a macro-level, these expenditures reallocate public and private resources away from investments that would improve supply chain efficiency and effectiveness, to those that ensure safety and security (Phillips, 2001). This leads to higher long-term costs for shippers.

From a more micro-perspective, the cost and service penalties incurred by U.S. businesses are the result of conflicts between security and business goals. Sheffi (2001) posits the following ways in which this occurs (see Figure 2.1). Note that the security goals and business goals presented in Figure 2.1 are not necessarily ends of a continuum or mutually exclusive. This figure is meant to simply convey that trade-offs may be necessary in order to implement supply chain security measures.

FIGURE 2.1 THE CONFLICT BETWEEN BUSINESS AND SECURITY PRIORITIES



Source: Sheffi (2001)

There are a number of other mechanisms by which security investments can increase costs. For example, the cost of security to warehouses is estimated to be $1 to $2 per square foot of storage space (Warehouse Education Research Council, 2004). This includes the cost of installing cameras and fences, training personnel, and dedicating labor to the security function. Motor carriers must incur the cost of locks for trailers, installation of these locks, added labor, extra administration, key distribution, and backup systems. These costs could reach $150 per trailer (Kahaner, 2003). For motor carriers to become C-TPAT compliant, they must also utilize remote camera systems, electronic gates, and security guards at storage facilities. The cost of screening and training personnel alone could reach $50 per driver (Cullen and Kilcarr, 2004).

There exist cost and service implications for international trade as well. One facet of the U.S. Government's plan to increase security is to increase container inspections at U.S. and foreign ports. The Container Security Initiative (CSI) seeks to extend the zone of security surrounding the United States to the foreign ports where cargo is inspected before being loaded onto a vessel. The cost of these inspections is borne by the importer and can cost $125 - $250 if the inspection is conducted on-site. If conducted off-site, the price increases to $600 - $900 (Jorgensen, 2003). These inspections also cause delays, which adds greater variability to the process and can potentially cause the container to miss its sailing date, with little or no recourse available for the shipper (Hannon, 2004).

Several observations can be drawn from the supply chain security literature. First, firms are motivated by many factors to improve their security capability. These include a desire to protect their brand equity and to meet customer demands. Second, relatively little has been published with regard to the most effective means to secure the supply

chain. Finally, firms that increase their security capability stand to incur greater costs and decrease their service capability. Sheffi (2001) implies that cost and service penalties are an inherent part of security initiatives, but does not examine if a market exists for these initiatives. Suppliers cannot be expected to engage in security initiatives if they stand to lose business because of these penalties. Purchasing firms should be willing to trade-off price and reliability of delivery if they expect to obtain higher security from their suppliers. This will be explored further subsequently. The next section will describe the role of food and food supply chain security in the context of the previous discussion.

FOOD AND FOOD SUPPLY CHAIN SECURITY

As with the broader topic of supply chain security, food supply chain security has received little in the way of empirical research. What has been published primarily deals with the vulnerabilities of food, how it may be attacked or used as a weapon, and various government recommendations pertaining to securing the food supply. This section will begin with a general overview of food and where it is vulnerable. Following this discussion, the Michigan State University food supply chain security best practice research is provided.

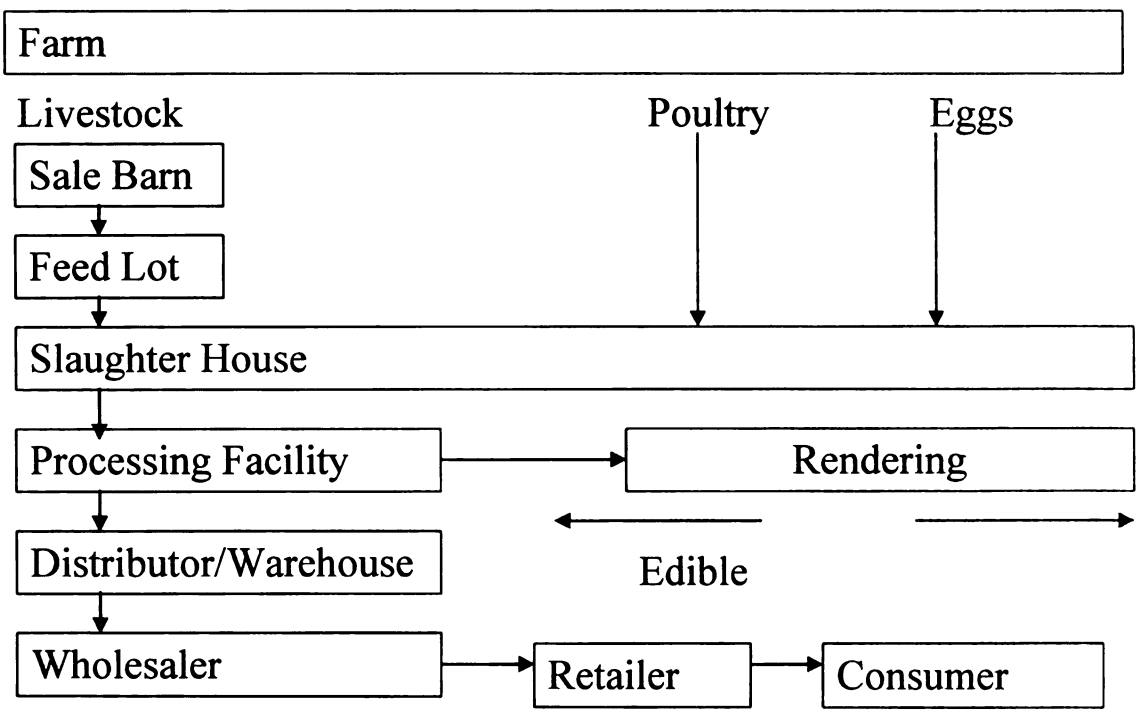
Food is defined by the United States Food and Drug Administration (2004) as articles used for food or drink for man or other animals, chewing gum, or articles used for components of other foods. As described in Chapter 1, food is a likely target for terrorism due to its importance to society, vulnerability, and terrorist awareness of these. Meriwether and Goodell, (2004a, p. 1) define food security as, "The prevention or elimination of deliberate contamination of food [by method of]...chemical, physical,

nuclear, or radioactive [agents]." The definition of food supply chain security used in the current research is adapted from Closs and McGarrell (2004) and given as:

> The application of policies, procedures, and technology to protect food supply chain assets from theft, damage, or terrorism, and to prevent the introduction of unauthorized contraband, people, or weapons of mass destruction into the food chain.

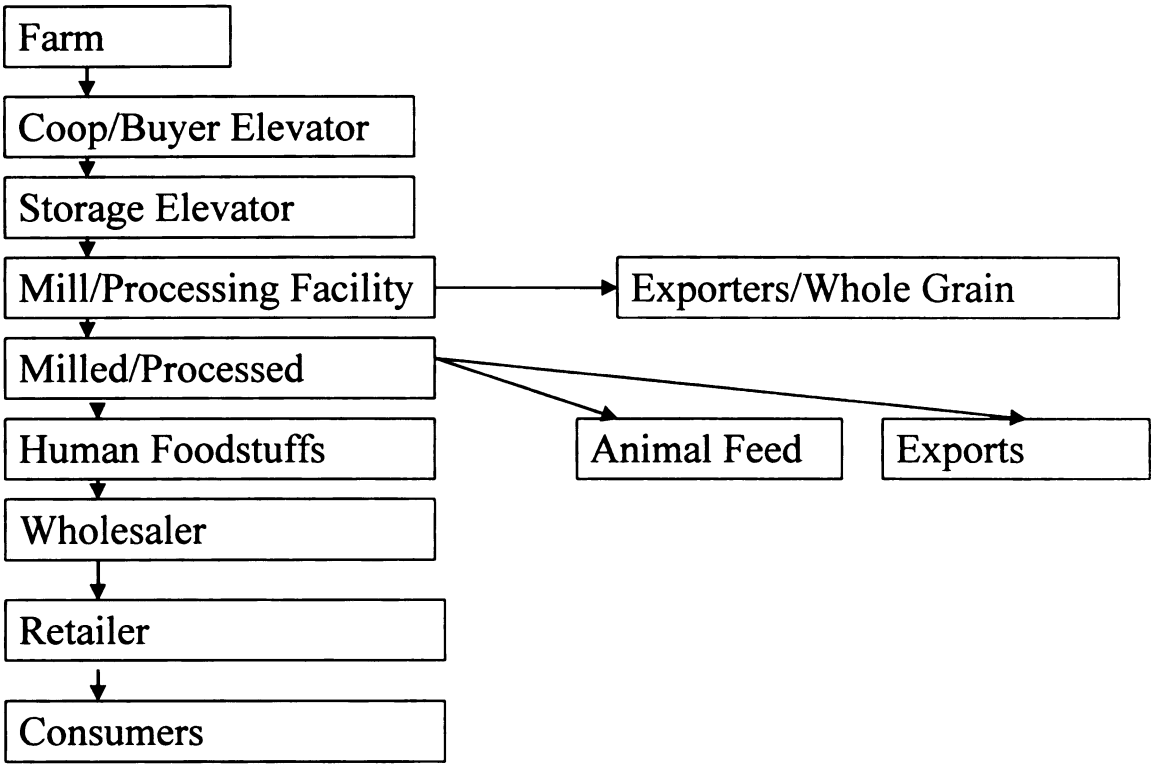
Different types of food require different amounts of processing (World Health Organization, 2002). This compounds the difficulty of protecting the food supply because the production system and steps vulnerable to attack will be different for each commodity (World Health Organization, 2002). Examples of the supply chains for livestock (hoof to plate) and grain (seed to plate) are provided in Figures 2.2 and 2.3 (Cupp et al. 2004):

FIGURE 2.2 HOOF TO PLATE SUPPLY CHAIN



Source: Cupp et al. (2004)

FIGURE 2.3 SEED TO PLATE SUPPLY CHAIN



Source: Cupp et al. (2004)

FOOD VULNERABILITY

To secure the food supply chain one must examine where it is most vulnerable. The literature provides us some guidance in that respect (see Table 2.4):

TABLE 2.4 AREAS OF FOOD VULNERABILITY

Author	Vulnerability
Bledsoe and Rasco (2002)	Targets include corporations, universities, and government research facilities
Bruemmer (2003)	Perishable foods are a likely target as they require little processing and their lower shelf life means they are less likely to be recalled in time
Chalk (2001)	Small food processors
Cremin (2001)	Small to medium sized firms
	Products that don't require cooking or extensive preparation
	Products that will elicit an emotional response (e.g. baby food)
Gips (2003)	Any area that is highly accessible from multiple modes (e.g. air, road, and rail)
	Bulk milk tanks are very vulnerable to contamination b/c they combine the milk of many cows and one infected cow could contaminate the whole tank
Nganje et al. (2003)	High volume grain elevators
Strozniack (2004)	Average, medium sized firms are
Wheelis et al. (2002)	Farms/ranches next to international borders
World Health Organization (2002)	Slaughterhouses
	Bulk foods
	The most readily accessible food processes
	Foods that are most vulnerable to undetected tampering
	Foods that are the most widely disseminated
	The least supervised food production areas or processes

Synthesizing the information in Table 2.4 uncovers several common themes. First, accessibility is an issue. Accessibility is a factor because it makes securing a location more difficult. The more avenues through which a location is accessible, the more vulnerable that location. For example, a food manufacturer accessible by three

modes of transportation would be more vulnerable than one only accessible by two. A location accessible by fewer modes is easier to control.

The second issue contributing to vulnerability is consolidation. Consolidation is a concern for a number of reasons. First, livestock and grain are regularly stored in large quantities. This allows a terrorist to contaminate large quantities of product in a single attack. Second, should a terrorist contaminate a single shipment pre-consolidation, this contamination stands to contaminate a large quantity of product post-consolidation. Bulk milk is provided as an example by Gips (2003). The milk from many cows is combined into a bulk milk tank during shipment. Contaminated milk from one cow could then contaminate the entire shipment. This could cause morbidity or mortality in a large number of consumers with little terrorist effort.

Third, the level of security protecting a location contributes to its vulnerability. The least supervised areas, firms, or processes, are the most vulnerable. This explains several authors' emphasis on the vulnerability of small to medium sized firms (see Table 2.4). These firms are perceived to be less prepared and guarded against intrusion.

FOOD SUPPLY CHAIN SECURITY BEST PRACTICE

Michigan State University, in conjunction with the Department of Homeland Security, is currently engaged in assessing best practice in protecting food from the aforementioned vulnerabilities. Through this research, investigators have found there to be ten competencies, encompassed by four general themes, which make up food supply chain security best practice. These themes and competencies closely resemble the security best practices described above in Closs and McGarrell (2004).

TABLE 2.5 MSU FOOD SUPPLY CHAIN SECURITY COMPETENCIES AND CAPABILITIES

Strategy

1. Process Strategy – Executive commitment to fostering an enterprise-wide environment conducive to security and protection.

Operations

1. Process Management – Procedures and actions taken to ensure the safety of each activity involved in the product flow into, through, and out of a facility.

2. Infrastructure Management – The presence of hardware and personnel responsible for ensuring the physical domain of a space is not breached.

3. Metrics and Measurement – The continuous development, use, testing, and redefinition of guidelines measuring security related procedures, plans, and capabilities.

Collaboration

1. Communication Management – The security related intra-firm relationships and exchange of information.

2. Relationship Management – The security related inter-firm relationships and exchange of information.

3. Public Interface Management – The security related relationships and exchange of information with the government and public.

4. Service Provider Collaboration Management – The security related relationships and exchange of information with 3rd party service providers.

Technology

1. Management Technology – The presence, use, and ability of information systems to provide accurate, timely, and reliable security information internally, across the supply chain, to the government, and to the public.

2. Process Technology – The presence, use, and ability of information systems to track movement of products and monitor processes internally and across the supply chain.

Source: MSU Food Supply Chain Security Research Team (research in progress)

The literature relating to food supply chain security reveals several themes. First, food is a likely target for terrorists. Second, food supply chains are vulnerable for reasons including accessibility, consolidation, and lack of preparedness. Finally, the Michigan State University research team is uncovering what constitutes food supply chain security best practice. No works are available that examine the trade-offs food manufacturers might be willing to make in order to receive security from their suppliers. Furthermore, no literature exists detailing the attitudes of food manufacturers toward security.

SUPPLIER SELECTION CRITERIA

Suppliers are a crucial part of firm success (Porter, 1985). Supplier selection is important because it commits resources while simultaneously impacting activities such as inventory management, production planning and control, cash flow requirements, and product quality (Choi and Hartley, 1996). There are two steps involved in selecting suppliers (Braglia and Petroni, 2000). First, suppliers are evaluated to ascertain if they meet certain conditions, or choice criteria, set forth *a priori*. Second, suppliers that meet or exceed these choice criteria are selected. Choice criteria are defined as "The factor(s) [a buyer] uses to evaluate competitive offerings" (Lehmann and O'Shaughnessy, 1974, p. 36). Suppliers can be evaluated using many different criteria. The four most important are product price, delivery reliability, product quality, and service after-the-sale (Braglia and Petroni, 2000). Price is the economic outlay necessary for the purchase of the product. Quality is defined as the extent to which the supplier's product conforms to buyer specifications. Delivery reliability is the number of times the supplier's product is

available for use by a promised date. Service after-the-sale is defined as the support afforded by the supplier, to the buyer, to resolve issues pertaining to a past product purchase. Rankings of these criteria from prominent supplier selection studies are subsequently provided in Table 2.6. It should be noted that these works drew from different samples and are meant to only provide a generalized view of the importance of these supplier selection criteria.

TABLE 2.6 IMPORTANCE OF SUPPLIER CHOICE CRITERIA ACROSS STUDIES

Authors	Importance Rank of Selection Attribute			
	Price	Quality	Delivery Reliability	Service
Lehmann and O'Shaughnessy (1974)	2	3	1	4
Evans (1982)	2	3	1	4
Lehmann and O'Shaughnessy (1982)	2	1	4	3
Wilson (1993)	3	1	4	2
Min (1994)	5	1	2	12
Choi and Hartley (1996)	6	1	1	7

This research is only concerned with the trade-off of price and delivery reliability as they relate to supplier security. There is little theoretical justification to support that an inverse relationship exists between supplier security and product quality, or supplier security and service after-the-sale. Security initiatives may actually *increase* quality through reductions in lost, damaged, or destroyed product. Therefore, quality is included as a control variable in this study. No trade-off can be theoretically justified between service after-the-sale and security. Service after-the-sale is important, but not currently under investigation.

Several conclusions about product price and delivery reliability can be drawn from Table 2.6. First, delivery reliability seems to have progressed from being very

important as a supplier choice criterion, to less important, to very important. This is likely due to the growing importance of Just-In-Time (JIT) inventory policies in the early to mid 1990's. Second, price has waned in its importance since the 1970's. This phenomenon is most likely due to the growing emphasis placed on product quality and collaboration with suppliers as opposed to adversarial relationships (Bowersox et al., 2002). Taking the average of the above supplier choice criteria rankings reveals that delivery reliability is ranked second only to product quality and price follows closely behind in third place.

There are many reasons delivery reliability is highly ranked. First, delivery reliability is a very visible supplier attribute. When delivery is unreliable, it can cause severe economic consequences by shutting down a plant or delaying production (Lehmann and O'Shaughnessy, 1974). Second, delivery reliability affects the level of safety stock a firm must maintain. Money spent on safety stock could be reallocated elsewhere if the supplier were able to deliver product reliably.

Price is important because it provides the purchasing agent a way to justify selecting a supplier should a problem with them occur (Lehmann and O'Shaughnessy, 1974). Further, price bears a direct relationship with the firm's cost of goods sold, which influences profit margin and the price the firm charges for their goods.

To tie in the previous discussion with the current research, it should be noted that supplier security was not examined in any of the surveyed choice criteria literature. This is most likely due to the timeliness of security as a research topic. There does exist support that security is important to firms when choosing a transportation service provider. EyeforTransport (2004) surveyed supply chain executives and found that

ninety-four percent of respondents think security is a "very important" carrier attribute. EyeforTransport (2004) did not examine the importance of security when choosing a product supplier or if the respondents were willing to trade-off price and delivery reliability for increased security from their transportation or product suppliers.

SYNTHESIS

A survey of the literature above yields a number of lessons. First, the study of supply chain security, and particularly food supply chain security, is still in its infancy. While notable contributions have been made (Closs and McGarrell, 2004), ample opportunity for future research exists. Second, it is clear that security efforts stand to increase costs and decrease delivery reliability suppliers provide to their customers. This seems to be especially relevant to international shipments. Third, there is a lack of knowledge pertaining to the value firms place on their suppliers' security competency. Most of the literature focuses on a single firm. The supplier-customer dyad has not been investigated. No study has investigated the importance of security to the supplier selection decision. Finally, evidence exists that firms feel pressure to increase security, but it is unclear how many are actually doing something about it. If firms are taking a myopic view toward their own vulnerability, do they take this same view toward their suppliers' vulnerability? Even if they do recognize their own vulnerability, and that of their suppliers, is security important enough that firms are willing to trade-off product price and delivery reliability in order to achieve a more secure supply chain?

STATEMENT OF PROBLEM

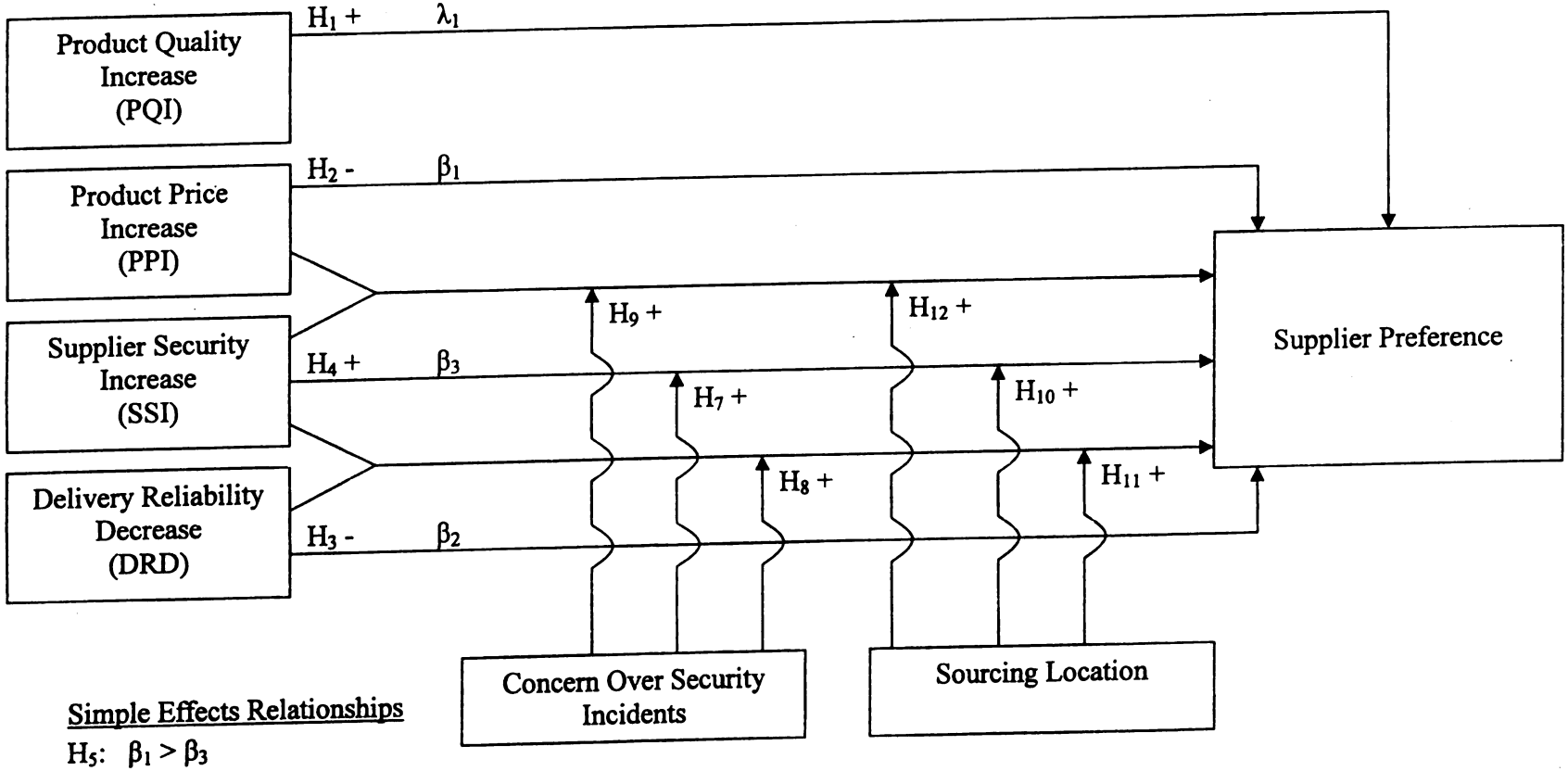
The synthesis of the literature review suggests that there remains a need for supply chain security research examining whether buyers are willing to make trade-offs that are necessary for suppliers to secure their operations. Further, the literature suggests that there is a need for any sound empirical research pertaining to supply chain security. The research objectives presented in Chapter One suggest a series of research questions. These research questions are presented below along with their accompanying hypotheses and theoretical justifications.

RESEARCH QUESTIONS AND HYPOTHESES

The literature review demonstrates the relevancy of the research questions posed in Chapter One. The following research questions and hypotheses have drawn from the literature to pose refutable, yet theoretically grounded, statements to be tested in this study. The relationships described in the following hypotheses are depicted in Figure 2.4.

The first four research questions pertain to the relationship between product quality, product price, delivery reliability, and supplier security as they pertain to supplier preference. Drawing from Lehmann and O'Shaughnessy (1974; 1982), Evans (1982), Wilson (1993), Min (1994), and Choi and Hartley (1996) it is proposed that higher levels of product quality and delivery reliability, and lower levels of product price, are positively associated with supplier preference. These are rather obvious hypotheses, but are needed to set the stage for future research questions/hypotheses. The Aberdeen Group (2004) and EyeforTransport (2004) both report that security is important to firms. Therefore, higher levels of supplier security are proposed to be preferred.

FIGURE 2.4 HYPOTHESIZED MODEL



Simple Effects Relationships

H_5: $\beta_1 > \beta_3$

H_6: $\beta_2 > \beta_3$

1. **Do purchasing firms prefer suppliers who deliver higher product quality over those that delivery lower product quality?**

   H_1: Higher product quality is preferred over lower product quality.

2. **Do purchasing firms prefer suppliers who charge lower prices over those that charge higher prices?**

   H_2: Lower product price is preferred over higher product price.

3. **Do purchasing firms prefer suppliers who provide higher delivery reliability over those that provide lower delivery reliability?**

   H_3: Higher delivery reliability is preferred over lower delivery reliability.

4. **Do purchasing firms prefer suppliers who provide greater security over those that provide less security?**

   H_4: Higher supplier security competence is preferred over lower supplier security competence.

This chapter illustrated several reasons why security implementation could cause suppliers to raise their prices. These include the cost of gates, guards, locks, seals, and labor. Research Question Five concerns whether firms are willing to sacrifice price for their suppliers to increase security.

5. **Are purchasing firms willing to pay a price premium for supplier security?**

   H_5: Product price has a greater influence on supplier preference than supplier security competence.

Widespread implementation of supply chain security has not occurred due to many managers' myopic view about their firm's vulnerability (Rogers et al., 2004). Many firms are thinking about security, but may not have implemented a comprehensive program (Rogers et al., 2004). Further, EyeforTransport (2004) finds that suppliers are not currently recouping the cost of their security initiatives through price increases passed

on to their customers. This leads one to believe that they do not believe that their customers are willing to pay for security at this time. Eventually these costs will be passed down if free-market demands for security increase, or if the government mandates security. For now, it appears that firms are not willing to pay more for their suppliers to operate in a secure manner, but no conclusive evidence to that effect has been found in the literature. Therefore, H_5 posits that firms are not willing to pay a price premium to their suppliers in order to receive increased security from them.

This chapter described how suppliers' capability to provide reliable delivery service could be adversely affected by their security initiatives. Research Question Six concerns whether firms are willing to sacrifice delivery reliability for their suppliers to operate in a secure manner.

6. **Are purchasing firms willing to sacrifice delivery reliability for increased supplier security?**

   H_6: Delivery reliability has a greater influence on supplier preference than supplier security competence.

It is not believed that firms are currently willing to sacrifice delivery reliability in return for increased supplier security. The supplier choice criteria literature posits that delivery reliability is more important than price. Evidence exists that firms are not willing to sacrifice price for their suppliers to increase security (EyeforTransport, 2004). Delivery reliability is more important than price (Lehmann and O'Shaughness, 1974; Evans, 1982; Choi and Hartley, 1996; Min, 1994) because price increases can be passed on to customers whereas low levels of delivery reliability can lead to the idling of expensive production equipment. Logically then, suppliers would not be willing to sacrifice delivery reliability for their suppliers to increase security. Therefore, H_6 posits

that firms are not willing to sacrifice delivery reliability in order to receive increased security from their suppliers.

The previous research questions operated under the assumption that no potentially confounding influences moderated the amount of price or delivery reliability firms are willing to trade-off in return for increased supplier security. Research questions Seven and Eight present two potential moderators to these relationships.

7. **Does concern over security related incidents that have occurred at the purchasing firm influence respondents to place more value on supplier security?**

   H_7: An increase in concern over security incidents experienced by the purchasing firm positively affects preference for suppliers with higher security competence.

   H_8: An increase in concern over security incidents experienced by the purchasing firm positively affects preference for suppliers with lower delivery reliability and higher security.

   H_9: An increase in concern over security incidents experienced by the purchasing firm positively affects preference for suppliers with higher prices and higher security.

Research Question Seven concerns whether respondent concern over their firms' past security incidents are more willing to trade-off price and delivery reliability for increased supplier security. Rogers et al. (2004) show that many managers are unwilling to accept that their supply chain may be the target of a terrorist attack. This myopic, "it could never happen to me" view of security is likely to change should they experience a security event. Preliminary interviews with industry executives conducted for the Michigan State University food supply chain security best practice research have provided support for H_7, H_8, and H_9. One executive stated that security was not a concern to his firm until an employee contaminated a vat of product with smokeless tobacco. This ruined the product and forced the company to realize that the employee

could have placed a more serious contaminant into the product causing morbidity or mortality in their customers. After this incident, the firm began a security program and also began auditing their suppliers' security measures. The notion of a security incident providing food manufacturers incentive to improve their security has also been cited by others (Hulme 2005). Hulme (2005) reports the case of a food processor who had not considered security a security event occurred. This incident caused the processor to implement security measures to protect against possible intrusion. Therefore, H_7, H_8, and H_9 posit that firms who have experienced a security incident place more value on supplier security.

8. Do purchasing firms that source goods internationally place more value on increased supplier security?

H_{10}: International sourcing by the purchasing firm positively affects preference for suppliers with higher security competence.

H_{11}: International sourcing by the purchasing firm positively affects preference for suppliers with lower delivery reliability and higher security.

H_{12}: International sourcing by the purchasing firm positively affects preference for suppliers with higher prices and higher security.

International sourcing presents added security difficulties for firms. While the product is being produced (i.e. harvested, mined, manufactured, etc...) overseas, the firm is unable to monitor their supplier and protect against theft, contamination, or insertion of unauthorized counterfeit cargo. The Aberdeen Group (2004) identified several reasons firms' initiate security programs (see Table 2.1). Two of these drivers are *increased product and traceability concerns due to outsourcing activity*, and *brand piracy, gray market activity, and product counterfeiting*. Due to purchasing firm's decreased ability to monitor their international suppliers and shipments it is likely that the purchasing firm will be more apt to sacrifice in order to protect themselves from the concerns raised by

The Aberdeen Group (2004) respondents. Sheffi (2001) also suggests that security concerns will cause buyers to move from purchasing product from the lowest bidder to purchasing product from a known supplier. In turn, they stand to incur the opportunity cost of utilizing a supplier lower cost or higher delivery reliability. H_{10}, H_{11}, and H_{12} therefore posit that to assure firms of product origin, they will place more value on supplier security.

CONCLUSION

Chapter Two presents a literature review related to the current study. This review examined previous research pertaining to supply chain security. Chapter Two also reviewed two generalized food supply chains and discussed the reasons food is vulnerable to terrorist attack. This Chapter further examined supplier selection criteria as they relate to the current research. Following a synthesis of the literature, the research problem was formalized. Research questions and hypotheses were subsequently provided. Chapter Three describes the methods used to test the hypotheses.

CHAPTER 3

INTRODUCTION

Chapter Three describes the research design and methods used to test the hypotheses. First, this chapter begins with a review of the research purpose and objectives. Second, the chapter outlines the research methodology including elaboration on the unit of analysis, sampling procedure, data collection and implementation, instrumentation, and the data analysis procedures. Finally, the chapter concludes by bringing the research proposal to a close and directs attention toward results and implications.

RESEARCH PURPOSE AND OBJECTIVES

The purpose of this research is to determine if firms are willing to sacrifice price and delivery reliability in return for supplier security and the conditions under which firms are more willing to sacrifice price and delivery reliability. Specifically, the research objectives are:

A) **To (re) establish how product quality, product price, delivery reliability, and supplier security influence supplier preference.**

B) **To determine if purchasing firms are willing to trade-off price and delivery reliability for increased supplier security.**

C) **To identify if 1) concern over past security related incidents and 2) international sourcing increase the amount of price and delivery reliability purchasing firms are willing to trade-off for increased supplier security.**

RESEARCH METHODOLOGY

This section describes the specific research methodology utilized in this work. First, this section describes the relevant unit of analysis. Second, this section defines the sampling procedure to be used. Third, this section outlines the proposed data collection and instrumentation. Finally, this section closes with the proposed data analysis procedures.

UNIT OF ANALYSIS

The unit of analysis in this research is the supplier selection decision. Supplier selection is important because it commits resources while simultaneously impacting activities such as inventory management, production planning and control, cash flow requirements, and product quality (Choi and Hartley, 1996). Food purchasing managers were presented with five criteria defining a potential supplier and then asked to rate the likelihood that they would purchase from that supplier. Respondents were also be asked to answer a question designed to assess their concern over security incidents that have occurred at their firm.

SAMPLING PROCEDURE

The sampling procedure utilized in this research consists of six steps (Churchill and Iacobucci, 2002). First, the target population is defined. In this step the researcher must define the target population about which one wishes to make an inference (e.g. firms, households, etc...). The current research assesses the willingness of food manufacturer purchasing managers to trade-off price and reliability of delivery for

supplier security. Therefore, the target population in this research is purchasing managers employed by domestic firms in the food industry.

Second, the sampling frame must be identified. A sampling frame is a listing of the elements from which the actual sample will be drawn (e.g. phone book, industry group membership list) and should be consistent with, and representative of, the phenomenon under study. The sampling frame for this research consists of the Institute of Supply Management and American Purchasing Society membership lists. Prior to selection, each industry group was evaluated for its applicability to the current research.

Third, a sampling procedure must be selected. Churchill and Iacobucci (2002) recommend probability samples. Probability samples enable the researcher to ensure that each population element has a known, non-zero chance of being included in the sample. This allows the results of the investigation to be generalized across the larger population. A random probability sample drawn from the sample frame was used.

Fourth, the sample size needed for the research must be determined. In order to determine the sample size needed, one must take into account the statistical technique to be used and the anticipated power level necessary to detect significant differences (Hair et al. 1998). In this case, choice based conjoint analysis is utilized. Louviere and Woodworth (1983) recommend thirty or more respondents for choice based conjoint analysis. Given the number of factors and interactions proposed in the current research, Orne (2006) recommends a minimum sample size of fifty (N = 50).

Fifth, one must select the sample elements. Sample elements are the key informants who will serve as the respondents in the research. The key informant in this research will be the purchasing managers in domestic food manufacturers.

Finally, data is collected from these sample elements. The method for data collection and analysis is described in the next section.

DATA COLLECTION AND IMPLEMENTATION

This study collects data by surveying food purchasing managers and their willingness to trade-off price and delivery reliability for greater supplier security. Conjoint analysis is used to determine the value placed on each of these attributes. Without providing a full elaboration of the advantages and disadvantages of surveys relative to experimental designs, this section briefly identifies the primary reasons for using a survey method to collect data. In addition, this section details the data collection method. This section also describes the survey instrument to be used and methods of data analysis.

The choice of survey versus experiment is one of trading-off external versus internal validity. Through sampling procedures, surveys achieve a high degree of external validity, which allows the results to be generalized to a larger population. Experiments allow the researcher a high degree of control in data collection and therefore allow any external influences to be removed. Experiments therefore provide a high degree of accuracy in their results, but these results may not be accurate in less controlled environments (Dunn, Seaker, and Waller, 1994).

The following criteria make surveys the chosen method for this research. First, this research requires a sample size equal to fifty. Due to the geographical dispersion of respondents, travel costs of administering experiments across this distance would be prohibitive. Second, there is a need for respondent anonymity when researching

potentially sensitive topics such as supply chain security. Surveys allow the researcher to afford anonymity to respondents in order to increase their willingness to participate.

As recommended by Dunn, Seaker, and Waller (1994), this research combines both qualitative and quantitative methods. Research began by conducting a series of interviews with purchasing managers. These interviews consisted of a series of structured and open ended questions regarding the value they place on supplier security and how much they are willing to sacrifice price and delivery reliability in order to receive higher levels of supplier security. This information was used to form the relevant levels of price, delivery reliability, and security.

A survey instrument was then developed to assess the relationships under investigation. Due to the nature of the research questions, the instrument must be designed to allow respondents to evaluate the utility of price, delivery reliability, and security. The multivariate methodology best suited to this type of research question is conjoint analysis. Conjoint analysis is a multivariate technique used specifically to understand how respondents develop preferences for products or services (Hair et al. 1998). It is based on the premise that respondents evaluate the value of a product or service by combining the separate amounts of utility, or part-worths, provided by each attribute. In conjoint analysis, the researcher constructs a set of hypothetical products or services by combining different levels of each attribute. The researcher then asks the respondent to perform the task of choosing among a set of products defined by these attribute levels. The influence of each attribute, and each level of each attribute, on the respondent's utility function can then be determined from the respondent's overall ratings.

Data collection began with a pretest of the survey instrument as recommended by Churchill (1979). The following steps are recommended when performing a pretest (Dillman, 2000).

TABLE 3.1 PRETEST STEPS

Stage 1: Review by knowledgeable colleagues and analysts
• Have I included all the necessary questions?
• Can I eliminate some of the questions?
• Did I use categories that will allow me to compare responses to census data or results of other surveys?
• What are the merits of modernizing categories versus keeping categories as they have been used in past studies?
Stage 2: Interviews to evaluate cognitive and motivational qualities
• Are all of the words understood?
• Are all of the questions interpreted similarly by all respondents?
• Do all of the questions have an answer that can be marked by every respondent?
• Is each respondent likely to read and answer each question?
• Does the mailing package (envelope, cover letter, and questionnaire) create a positive impression?
Stage 3: A small pilot study
• Have I constructed the response categories for scalar questions so people distribute themselves across categories rather than being concentrated in only one or two of them?
• Do any items from which I hope to build a scale correlate in a way that will allow me to build scales?
• What kind of response rate is the survey likely to obtain?
• Are some questions generating a high non-response rate?
• Do some variables correlate so highly that for all practical purposes I can eliminate one or more of them?
• Is useful information being obtained from open-ended questions?
• Are entire pages or sections of the questionnaire being skipped?
• What response rate can I expect?

Source: Dillman (2000)

Levels of price, delivery reliability, and security were then be modified. The survey instrument was then sent out to a larger sample of respondents.

INSTRUMENT

As recommended by Hair et al. (1998) a vignette was presented at the beginning of the survey instrument describing the levels of quality, price, delivery reliability, security, and supplier location. These represent the factors in the conjoint analysis. Hair et al. (1998) define a factor as, a "variable the researcher manipulates that represents a specific attribute...the factors (independent variables) are non-metric (and are) represented by two or more values (or levels), which are also specified by the researcher" (p. 390). The factors and levels examined in this research are presented below:

TABLE 3.2 FACTORS AND LEVELS

	Level 1	Level 2	Level 3
Product Quality	Equal to or below industry average	Moderately higher than industry average	Significantly higher than industry average
Product Price	Equal to or below industry average	1-2% higher than industry average	3% or more higher than average
Delivery Reliability	Equal to or above industry average	1-2% below industry average	3% or more below industry average
Supplier Security Competence	Basic	Advanced	
Location of Supplier	Domestic	Middle East	
Concern Over Security Incidents	Concerned	Unconcerned	

This creates a 3 x 3 x 3 x 2 x 2 matrix of possible scenarios evaluated by respondents, and yields a total of one-hundred eight scenarios, or stimuli. The various stimuli combinations are presented in Appendix A. Note that respondent concern is not a supplier characteristic and is therefore not presented in conjoint scenarios. Therefore, concern is not represented in the 3 x 3 x 3 x 2 x 2 matrix of possible scenarios, but is included in Figure 3.2 as a reference. Table 3.3 provides the definitions of each of these factors, and their corresponding levels. These definitions were presented to respondents at the beginning of the survey. If respondents needed to refresh their memory of how each factor and factor level was defined, they had the option of retrieving these definitions from a "pop-up" window while completing the conjoint scenarios.

The reader should note that Level One for quality, price, and delivery reliability are designed such that this level is equal to or better than industry average. Another way of presenting this information would have been to add a fourth level to each of these factors that delineated "equal to industry average" and "better than industry average". The choice was made to combine these two levels to conform with the purpose of this research and to reduce sample size requirements. One purpose of this research is to assess how much price and delivery reliability purchasing managers are willing to trade-off for supplier security. In that sense, the "worse" values of price and delivery reliability are of more interest than the "better" values. Thus, there are two levels of "worse" values and one combined level of "better" values. With respect to sample size requirements, the greater the number of levels present in any one factor, the greater the sample size that is required to accurately estimate part-worth values (Orne 2006). Thus, adding more levels would have increased the sample size required for this research. The determination was made that it was better to have fewer levels, reduce the sample size needed, and simultaneously focus on the levels that were most pertinent.

There are three approaches to presenting the stimuli in conjoint analysis (Hair et al. 1998). The first approach is the trade-off method. The trade-off method compares attributes two at a time by asking respondents to rank order all combinations of levels in terms of preference. The second approach is the full-profile method. The full-profile method presents each stimulus separately and allows the respondent to view a "full-profile" of all product (service) attributes under examination. The respondent then ranks or rates each full-profile in terms of preference or intention to purchase. The third approach is termed the pairwise comparison method. Pairwise comparison combines the

trade-off method and the full-profile method. The respondent is asked to compare two full-profiles and choose/rate which one is most preferred. The choice of presentation method depends on a number of factors, but the most commonly used method is the full-profile approach (Hair et al. 1998).

The full-profile approach has the following advantages (Green and Srinivasan, 1978). First, it requires the respondent to make fewer evaluations, reducing the chance of respondent fatigue. Second, the full-profile approach allows interaction effects to be modeled. Third, the full-profile approach gives a more realistic stimuli description by simultaneously defining the levels of each attribute. This more accurately depicts the simultaneous trade-offs encountered when a respondent makes a purchasing decision.

TABLE 3.3 FACTOR AND FACTOR LEVEL DEFINITIONS PRESENTED TO RESPONDENTS

Factor Factor Level	Definition
Product Quality	Product quality is defined as how well a supplier's product conforms to your firm's pre-set specifications.
Equal to or below industry average	The supplier's product quality is equal to or below the industry average.
Moderately higher than industry average	The supplier's product quality is moderately better than the industry average.
Significantly higher than industry average	The supplier's product quality is significantly higher than the industry average.
Product Price	Product price is defined as the monetary amount a supplier charges your firm for their product.
Equal to or below industry average	The supplier's price is equal to or below the industry average.
Above industry average	The supplier's price is moderately higher than the industry average (1-2% above industry average).
Significantly above industry average	The supplier's price is significantly higher than the industry average (3% or more above industry average).
Delivery Reliability	Delivery reliability is defined as the percentage of time that a supplier delivers product at the promised delivery time.
Equal to or above industry average	The supplier's delivery reliability is equal to or above the industry average.
Below industry average	The supplier's delivery reliability is moderately worse than the industry average (1-2% below industry average).
Significantly below industry average	The supplier's delivery reliability is significantly worse than the industry average (3% or more below industry average).

TABLE 3.3 CONT

Supplier Security Competence	Security is defined as the application of policies, procedures, and technology to protect food supply chain assets from theft, damage, or terrorism, and to prevent the introduction of unauthorized contraband, people, or weapons of mass destruction into the food supply chain.
Basic	Suppliers with a basic security competence *only utilize limited measures* to protect their product, processes, and facilities from internal (e.g. disgruntled employee) and external (e.g. terrorist) food contamination threats. A supplier with a basic security competence typically does not employ any, or at least very few, of the following security measures: lock their doors, employ guards, have fences around their facilities, perform background checks on employees, secure inventory, and inspects product for possible contamination before it is shipped to your firm.
Advanced	Suppliers with an advanced security competence *make every effort* to protect their product, processes, and facilities from internal (e.g. disgruntled employee) and external (e.g. terrorist) food contamination threats. A supplier with an advanced security competence typically does employ most, or the majority, of the following actions: lock their doors, has fences and gates protecting their facilities, employ guards protecting entrances, perform thorough background checks on all employees and contractors, constantly tracks inventory in a secure environment to make sure it is not contaminated, and thoroughly inspects product for possible contamination before it is shipped to your firm.
Location of Supplier	Supplier location is defined as the location where the supplier manufactures the food product that is then shipped to you via the most appropriate mode of transportation.
Domestic	Located in Iowa and employs only U.S. residents.
Middle East	Located in Saudi Arabia and employs only Saudi residents.

Fourth, the full-profile approach has been shown to be superior to the other two in terms of predictive validity, the extent to which the actual choices of the respondent are predicted by conjoint analysis (Segal, 1982). Finally, the full-profile approach has been shown to be more reliable in terms of test-retest correspondence (Segal, 1982).

The primary disadvantage of the full-profile approach is that the respondent's task is more complicated in that he/she must evaluate a level of each factor simultaneously (Green and Srinivasan, 1978). It is recommended that no more than six factors (Green and Srinivasan, 1978), or a total of twenty stimuli (Hair et al. 1998), be examined using this presentation method to prevent information overload and respondent fatigue.

The current study examines five factors with one-hundred eight total stimuli. This is greater than the twenty stimuli (Hair et al. 1998) guideline. Therefore, respondent fatigue is a concern. Sawtooth Software's choice-based conjoint analysis package was used (http://www.sawtoothsoftware.com) to alleviate this problem. Choice-based conjoint analysis allows a large number of factors to be included in a survey by randomly selecting scenarios to be included. This random selection of scenarios prevents respondent fatigue. The program then calculates the part-worths respondents attach to each factor by their responses to each scenario.

DATA ANALYSIS

Choice-based conjoint analysis was used for data analysis. Choice-based conjoint allows the simultaneous modeling of main and interaction effects (Hair et al., 1998). The outcome of this analysis will be the part-worths respondents attach to each factor (Hair et al. 1998). As one part-worth is higher than another, the independent variable to which

that part-worth relates is deemed to be more important in determining supplier preference than those with lower part-worths. For example, if the part-worth for price is higher than the part-worth for supplier security then price is more important in determining supplier preference than is supplier security. The same logic could be applied to reliability of delivery and security. Alternatively, if the part-worth of security is higher than either price or reliability of delivery, then security is more important than one (or both) of those supplier attributes.

CONCLUSION

Chapter Three provided an overview of the research design and method of this study. This chapter first reviewed the research purpose and objectives. Second, the specific research method for this research was examined, including the unit of analysis, sampling procedure, data collection and implementation framework, and a description of the survey instrument to be employed. Finally, the data analysis section described the proposed methods of examining the data and assessing goodness of fit. This research continues by discussing the results in Chapter Four, and the implications of the research in Chapter Five.

CHAPTER 4: ANALYSIS OF DATA

INTRODUCTION

Chapter Four details the research results. First, the preliminary analysis section describes the survey mailing procedure, sample size obtained, and sample characteristics. Second, the hypothesis testing section presents each research question, corresponding hypotheses, and relevant results. The Chapter concludes with a summary of the research findings.

While reading through the following results, one should keep in mind the definitions of basic and advanced security used by respondents when completing the conjoint scenarios. Suppliers with a basic security competence *only utilize limited measures* to protect their product, processes, and facilities from internal (e.g. disgruntled employee) and external (e.g. terrorist) food contamination threats. A supplier with a basic security competence typically does not employ any, or at least very few, of the following security measures: 1) lock their doors, 2) employ guards, 3) have fences around their facilities, 4) perform background checks on employees, 5) secure inventory, and 6) inspects product for possible contamination before it is shipped. Suppliers with an advanced security competence *make every effort* to protect their product, processes, and facilities from internal (e.g. disgruntled employee) and external (e.g. terrorist) food contamination threats. A supplier with an advanced security competence typically does employ most, or the majority, of the following actions: 1) lock their doors, 2) has fences and gates protecting their facilities, 3) employ guards protecting entrances, 4) perform thorough background checks on all employees and contractors, 5) constantly tracks inventory in a secure environment to make sure it is not contaminated, and 6) thoroughly

inspects product for possible contamination before it is shipped. In sum, in this research supplier security competence is conceptualized to encompass the extent to which suppliers: 1) lock doors, 2) use fences and gates to protect facilities, 3) employ guards to protect facility entrances, 4) perform background checks on all employees and contractors, 5) track inventory, and 6) inspect product for possible contamination before shipment occurs.

PRELIMINARY ANALYSIS

This section examines the mailing procedures utilized, sample size obtained, and sample characteristics. Sample characteristics include both respondent and firm level data.

MAILING PROCEDURES AND FINAL SAMPLE SIZE

Three waves of mailings were utilized to obtain responses. In the first wave, a postcard was mailed informing respondents they had been selected to participate and detailing the goals of the research. This postcard was mailed in late March 2006.

The second mailing was sent four days after the first. This letter reminded respondents they had been selected and provided them with the URL address and password to access the on-line survey. Respondents were offered the opportunity to receive an executive summary of the results. Sixty-four respondents completed the survey after this mailing.

Another request for participation letter was mailed four weeks later in April 2006. An additional forty-three completed surveys were returned for a final sample of one-hundred seven responses (N = 107). A sample size of fifty (N = 50) is needed in order to

accurately estimate the conjoint part-worths (Orne 2006). A sample size of one-hundred seven exceeds this criterion.

CHARACTERISTICS OF SAMPLE

Respondents were drawn from the membership lists of two professional purchasing organizations. All respondents indicated to these organizations that their firms primarily operated in the food industry. Respondent characteristics are detailed in Table 4.1. Respondents most commonly indicated that they held the title of "manager" (38.31 percent). Examination of responses to the "other" title category shows that these respondents were employed in various purchasing related roles, such as a buyer (34.57 percent). The majority of the respondents classified their position as purchasing (79.43 percent), had spent between five and fourteen years in the industry (37.38 percent), two to nine years in their position (68.61 percent), and five to nine years with their employer (24.29 percent).

Respondents' firms were for-profit, food manufacturers with most of their employees in the United States. Roughly one-half of the respondents indicated that their divisions encompassed more than two-hundred fifty employees. The other half employed less than two-hundred fifty. This allows results to be adequately generalized across firms of different sizes.

To address the issue of non-response bias (Armstrong and Overton 1977) the sample was segmented into early and late respondents. Demographic data for early and late respondents were compared using chi-square difference tests. Results are presented in Table 4.2. Early and late respondents are indifferent with respect to each demographic criterion except the number of employees in their division (note: profit

orientation was not examined due to the presence of only one "non-profit" respondent). Early respondents tended to have fewer employees in their division than did late respondents. However, there was no significant difference in the groups with respect to number of employees in the United States. Number of employees in the United States is a more aggregate measure of firm size. Therefore, early and late respondents appear to be possess similar demographic characteristics. Utility preference patterns for the two groups were visually compared (note: CBC does not allow one to assess significant differences across the utility values of different samples). Early and late respondents' utility preference patterns were similar for each factor-level under investigation. Therefore, data analysis proceeds treating early and late respondents as a single sample.

TABLE 4.1 SAMPLE CHARACTERISTICS

N = 107		Frequency Count	% of Respondents
Respondent Title	Vice President	8	7.47
	Director	21	19.62
	Manager	41	38.31
	Other	37	34.57
Respondent Position	Purchasing	85	79.43
	Supply Chain/Logistics	14	13.08
	Other	8	7.47
Time in Industry	0-1 years	6	5.60
	2-4 years	12	11.21
	5-9 years	20	18.69
	10-14 years	20	18.69
	15-19 years	13	12.14
	20 or more years	36	33.64
Time in Position	0-1 years	17	15.88
	2-4 years	34	31.77
	5-9 years	33	30.84
	10-14 years	7	6.54
	15-19 years	7	6.54
	20 or more years	9	8.41
Time with Employer	0-1 years	14	13.08
	2-4 years	21	19.62
	5-9 years	26	24.29
	10-14 years	14	13.08
	15-19 years	9	8.41
	20 or more years	23	21.49
Employees in Division	Less than 50	27	25.23
	50 – 250	27	25.23
	250-1,000	30	28.03
	1,000 – 5,000	11	10.28
	More than 5,000	12	11.21
Employees in United States	Less than 50	5	4.67
	50 – 250	11	10.28
	250-1,000	25	23.36
	1,000 – 5,000	25	23.36
	More than 5,000	41	38.31
Scope of Market Area	Local	2	1.86
	Regional	10	9.34
	National	37	34.57
	Global	58	54.20
Scope of Supply Base	Local	2	1.86
	Regional	4	3.73
	National	38	35.51
	Global	63	58.87
Scope of Firm's Activities	Manufacturing	91	85.04
	Merchandiser/Retailer	11	10.28
	Warehouse/Distributor	3	2.80
	Logistics Service Provider	2	1.86
Profit Orientation	For-Profit	106	99.06
	Not-For-Profit	1	0.93

TABLE 4.2 EARLY AND LATE RESPONDENT CHARACTERISTICS

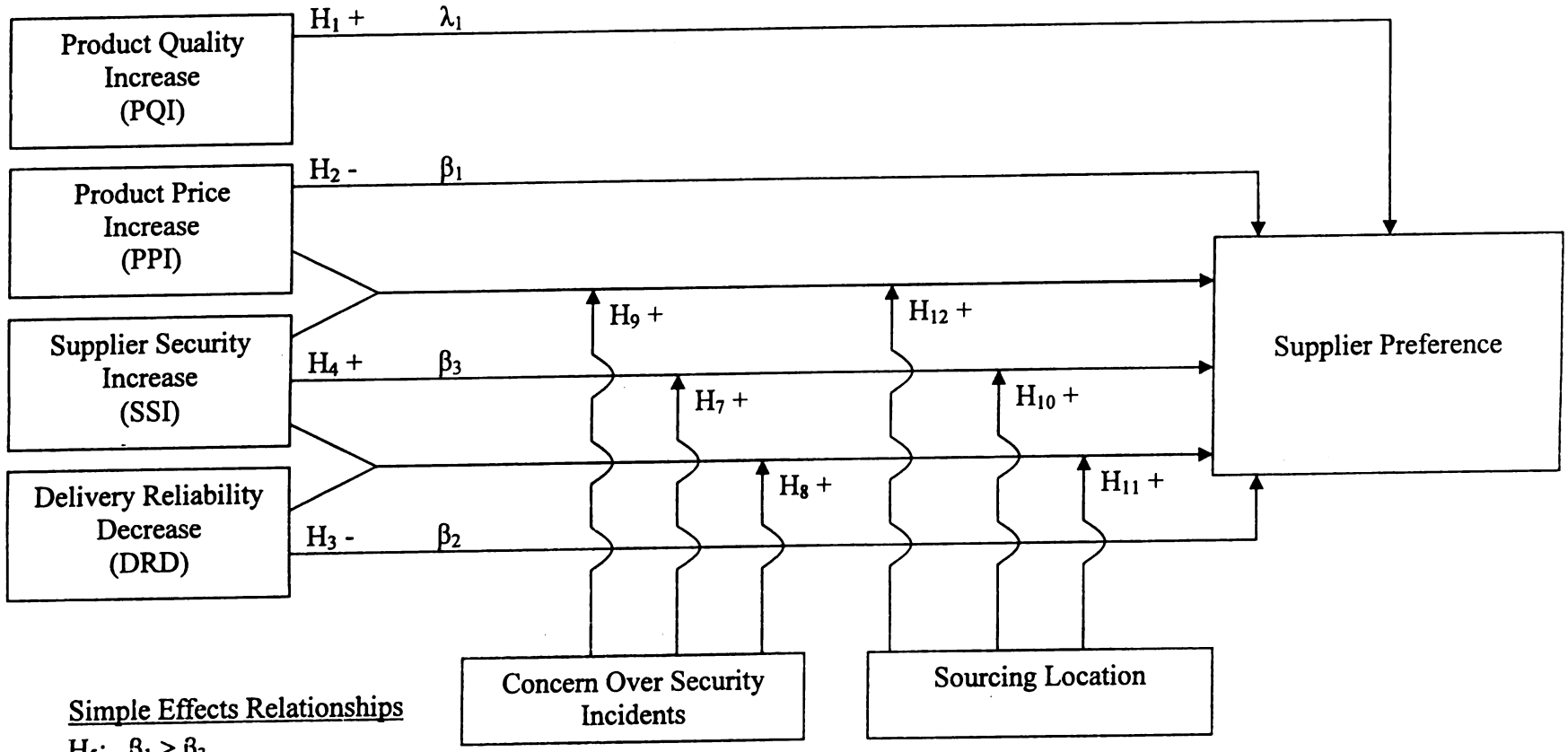
N=107 (Early Respondents=64; Late Respondents=43)		Early Respondents	Late Respondents	$\chi 2$
Respondent Title	Vice President	6	2	.250
	Director	15	6	
	Manager	20	21	
	Other	23	14	
Respondent Position	Purchasing	49	36	.614
	Supply Chain/Logistics	10	4	
	Other	5	3	
Time in Industry	0-1 years	2	4	.787
	2-4 years	8	4	
	5-9 years	12	8	
	10-14 years	12	8	
	15-19 years	7	6	
	20 or more years	8	4	
Time in Position	0-1 years	8	9	.439
	2-4 years	20	14	
	5-9 years	19	14	
	10-14 years	5	2	
	15-19 years	4	3	
	20 or more years	8	1	
Time with Employer	0-1 years	6	8	.745
	2-4 years	14	7	
	5-9 years	17	9	
	10-14 years	9	5	
	15-19 years	5	4	
	20 or more years	13	10	
Employees in Division	Less than 50	18	9	.024*
	50 – 250	21	6	
	250-1,000	11	19	
	1,000 – 5,000	6	5	
	More than 5,000	8	4	
Employees in United States	Less than 50	4	1	.580
	50 – 250	7	4	
	250-1,000	15	10	
	1,000 – 5,000	17	8	
	More than 5,000	21	20	
Scope of Market Area	Local	1	1	.491
	Regional	7	3	
	National	25	12	
	Global	31	27	.968
Scope of Supply Base	Local	1	1	
	Regional	2	2	
	National	23	15	
	Global	38	25	
Scope of Firm's Activities	Manufacturing	53	38	.148
	Merchandiser/Retailer	9	2	
	Warehouse/Distributor	2	1	
	Logistics Service Provider	0	2	

* = significant difference between early and late respondents at .05 level

HYPOTHESIS TESTS

The model proposed in this research is presented in Figure 4.1. Corresponding research questions and hypotheses are presented in Table 4.3. Choice-Based Conjoint (CBC) produces two types of results. First, utilities represent respondents' preference for each factor level as it relates to supplier preference. Utilities are zero-centered for each factor with the magnitude of the utility indicating the degree of preference. CBC utilizes Multinomial Logit Analysis (logit) to compute utilities. Similar to multiple regression, logit seeks "weights" for factor levels. These weights are analogous to "part-worth utilities" in conjoint analysis. Logit utilities represent a measure of relative desirability, or worth. The higher the utility, the more desirable the factor level. Levels with a large, positive utility have a positive impact on supplier preference. Levels with a negative utility do not necessarily denote that the level was undesirable to respondents, but that the level was less desirable than others. Utilities are estimated from "counts", the percentage of times a particular factor level was chosen. Therefore, utilities provide direct insight into the mindset of respondents. Utilities are computed for each factor separately utilizing a kind of dummy coding called "effects coding".

FIGURE 4.1 HYPOTHESIZED MODEL



Simple Effects Relationships

H_5: $\beta_1 > \beta_3$

H_6: $\beta_2 > \beta_3$

TABLE 4.3 RESEARCH QUESTIONS AND HYPOTHESES

Research Question	Corresponding Hypotheses
1. Do purchasing firms prefer suppliers who deliver higher product quality over those that delivery lower product quality?	H_1: Higher product quality is preferred over lower product quality.
2. Do purchasing firms prefer suppliers who charge lower prices over those that charge higher prices?	H_2: Lower product price is preferred over higher product price.
3. Do purchasing firms prefer suppliers who provide higher delivery reliability over those that provide lower delivery reliability?	H_3: Higher delivery reliability is preferred over lower delivery reliability.
4. Do purchasing firms prefer suppliers who provide greater security over those that provide less security?	H_4: Higher supplier security competence is preferred over lower supplier security competence.
5. Are purchasing firms willing to pay a price premium for increased supplier security?	H_5: Product price has a greater influence on supplier preference than supplier security competence.
6. Are purchasing firms willing to sacrifice delivery reliability for increased supplier security?	H_6: Delivery reliability has a greater influence on supplier preference than supplier security competence.
7. Does concern over security related incidents that have occurred at the purchasing firm influence respondents to place more value on increased supplier security?	H_7: An increase in concern over security incidents experienced by the purchasing firm positively affects preference for suppliers with higher security competence.
	H_8: An increase in concern over security incidents experienced by the purchasing firm positively affects preference for suppliers with lower delivery reliability and higher security.
	H_9: An increase in concern over security incidents experienced by the purchasing firm positively affects preference for suppliers with higher prices and higher security.
8. Do purchasing firms that source goods internationally place more value on increased supplier security?	H_{10}: International sourcing by the purchasing firm positively affects preference for suppliers with higher security competence.
	H_{11}: International sourcing by the purchasing firm positively affects preference for suppliers with lower delivery reliability and higher security.
	H_{12}: International sourcing by the purchasing firm positively affects preference for suppliers with higher prices and higher security.

In effects coding, the utilities for each factor sum to zero. Therefore, utility figures are interval data with an arbitrary origin, or zero point, which prevents one from comparing the relative importance of two factors by simply comparing the utility for one level of one factor versus the utility of one level for a second factor [e.g. the utility for basic security = (- 0.400) and the utility for delivery reliability three percent or more below industry average = (- 1.049), but since an arbitrary zero is set for each of these factors, one cannot say that basic security is preferred over poor delivery reliability simply because basic security is "less negative" than poor delivery reliability]. However, factor levels can be compared when an interaction is present. Significant differences between factor levels in interactions can also be assessed and are presented in the following results.

The ability of a logit utility run to assess respondent preferences is determined by a significant χ^2 value. All utility runs reported in this chapter have highly significant χ^2 values ($p < 0.01$). Thus, respondent choices are significantly affected by the factors under investigation and data analysis can proceed.

The second type of results is derived from market simulations. Through market simulations, one has the ability to estimate the effects of various combinations of levels on the market preference of a product. In the context of this research, market simulation gives the percentage of market preference garnered by hypothetical suppliers characterized by different factor levels. Market simulation is based on logit utilities, but differs from logit in that it uses algorithms to group respondents with similar preferences and estimate part-worths within these segments. This information is then used to determine preference for a group of levels that have been combined to simulate a

hypothetical supplier. These group preferences are then used to calculate the market preference of each hypothetical supplier.

There are several reasons for using market simulations. First, market simulations transform raw utility data into a managerially useful and appealing model for predicting the market preference of product mix combinations. Second, simulations can capture idiosyncratic respondent preferences, not discernable through utilities, that may have a significant impact on overall preference. Third, simulations reveal the extent to which respondents are willing to substitute one factor for another. This is particularly valuable given the goals of this research. Fourth, simulations reveal three-way interaction effects between attributes, whereas CBC only provides utility values for two-way interactions. Again, this capability is particularly valuable given the present research questions.

In each market simulation scenario in this research, all other potential supplier attributes other than those under evaluation are held constant at their most desirable level as determined by the individual factor level utilities (e.g. in the case of price vs. security: delivery reliability is equal to or above industry average, supplier location is United States, and quality is significantly higher than industry average). This allows the researcher to focus on the security by price interaction (in this case) without other confounding influences. As a caveat, market simulations are only meant to provide supporting or dissenting evidence for the hypothesized relationship between variables under investigation. Market simulation results presented in this chapter are not meant to capture the influence of other supplier characteristics and will not necessarily hold true if these other characteristics, a greater number of suppliers, or other factors such as level and effectiveness of advertising, product availability, and newness of a product or

supplier were taken into account. Market simulation results will also not hold true in every industry. It is beyond the scope of this research to include every possible supplier characteristic, market factor, or industry specific influence. Therefore, the term "market share" is replaced with "market preference" in the preceding discussion and following results. As another caveat, efforts were made in this research to determine significant differences between market preferences of interest through use of the Wilcoxon rank-sum test (Lehmann 1975), however, due to the limited number of observations few significant differences were found. Without use of further statistical techniques, such as bootstrapping, caution should be taken when interpreting these insignificant findings (see Appendix C). This limitation does not severely hamper the overall goal of this research in as much as market simulations are but one of several evaluation methods used.

The choice of results to interpret depends on the research question under investigation. Utilities are sufficient for determining preference for one level over another in a single factor or two-way interactions in the same logit run. Utilities cannot be used to compare preference patterns across different factors (where an interaction is not examined) and logit runs. When three-way factor interactions, substitutability, and demand elasticity are examined, market simulation provides information over and above what can be obtained via utilities.

It should be noted that utility preferences and market simulation data may not always agree. It is possible that respondents may prefer one factor level over another, but other information is included in the simulation to determine supplier market preference. Therefore, utilities provide insight into managerial thought processes, but market simulations provide further insight into choices groups of managers might make. H_1

through H_4 examine simple preferences of one factor level over another. Therefore, only the utilities for each level are examined.

H_1 through H_4 examine respondent preferences for three levels of supplier product quality, price, delivery reliability, and two levels of supplier security. Utility figures for each factor level are presented in Table 4.4.

TABLE 4.4 HYPOTHESES 1-4 RESULTS: UTILITIES

Hypothesis	Factor	Level	Utilities
H_1	Quality	Significantly Higher than Industry Average	0.528
		Moderately Higher than Industry Average	0.378
		Equal to or Below Industry Average	(0.906)
H_2	Price	Equal to or Below Industry Average	0.763
		1-2% Higher than Industry Average	0.148
		3% or more Higher than Industry Average	(0.911)
H_3	Delivery Reliability	Equal to or Above Industry Average	0.986
		1-2% Below Industry Average	0.064
		3% or more Below Industry Average	(1.049)
H_4	Security	Advanced	0.400
		Basic	(0.400)

RQ1: Do purchasing firms prefer suppliers who deliver higher product quality over those that delivery lower product quality?

H1: Higher product quality is preferred over lower product quality.

H_1 proposes that respondents prefer suppliers who deliver higher levels of product quality over those that deliver lower levels of product quality. H_1 is supported. Comparing higher quality levels to lower quality levels, utilities indicate that respondents

significantly prefer suppliers with higher quality product over those with lower quality ($p<0.05$) for each level of quality.[1]

H_2 examines respondent preferences for three price levels.

RQ2: Do purchasing firms prefer suppliers who charge lower prices over those that charge higher prices?

H2: Lower product price is preferred over higher product price.

H_2 proposes that respondents prefer suppliers who charge a lower price for their product over those that charge a higher price for their product. H_2 is supported. Comparing higher price levels to lower price levels, utilities indicate that respondents significantly prefer suppliers with lower prices over suppliers with higher prices ($p<0.05$) for each price level.

H_3 examines respondent preferences for three levels of delivery reliability.

RQ3: Do purchasing firms prefer suppliers who provide higher delivery reliability over those that provide lower delivery reliability?

H3: Higher delivery reliability is preferred over lower delivery reliability.

H_3 proposes that respondents prefer suppliers who provide higher levels of delivery reliability over those that provide lower levels of delivery reliability. H_3 is supported. Comparing higher levels of delivery reliability with lower levels of delivery reliability, utilities indicate that respondents significantly prefer suppliers with higher delivery reliability over suppliers with lower delivery reliability ($p<0.05$) for each delivery reliability level.

[1] Given the basic nature of Hypotheses 1-4, specific z-values indicating significant differences are not presented in tabular form.

H_4 examines respondent preferences for two levels of supplier security.

RQ4: Do purchasing firms prefer suppliers who provide greater security over those that possess less security?

H4: Higher supplier security competence is preferred over lower supplier security competence.

H_4 proposes that respondents prefer suppliers with advanced security competence over those with basic security competence. H_4 is supported. Comparing basic security with advanced security, utilities indicate that respondents significantly prefer suppliers with advanced security over suppliers with basic security ($p<0.05$).

The results of H_1 through H_4 are intuitive and require little explanation. Respondents derive more utility from "better" levels of each factor. H_1 through H_4 were necessary to set the stage for subsequent hypotheses. H_5 and H_6 explore factor interactions to determine the relationship of supplier security to price and delivery reliability respectively.

H_5 and H_6 are discussed subsequently.

RQ5: Are purchasing firms willing to pay a price premium for increased supplier security?

H5: Product price has a greater influence on supplier preference than supplier security competence.

H_5 proposes that the price charged by a supplier has a greater influence on supplier preference than the security capability of the supplier. In order to assess H_5, it is necessary to examine two criteria: 1) the importance of price and security in determining

supplier preference and 2) preferences for various price/security supplier service offerings.

First, the importance (utility) of price must be compared with the importance (utility) of security. In order to accomplish this, it is necessary to determine the relative importance of price and security via factor importance scores (see Table 4.5). Factor importance scores denote the amount of total possible utility in a model accounted for by individual factors (e.g. price and security). In order to calculate factor importance scores, one must first ascertain the total amount of utility respondents can derive from all factors under investigation.

The total utility respondents can derive from all factors under investigation is equal to the sum of the ranges of utility values for each factor. The range of utility values for a single factor is equal to the highest utility value in that factor minus the lowest utility value in that factor. Column one (from left to right) in Table 4.5 presents the five factors, and corresponding factor levels, under investigation. Column two presents the utility values for each factor level. Column three presents the range between the highest utility and lowest utility for each factor. The greater the range between the most preferred level of a factor and the least preferred level of a factor, the more that factor contributes to overall utility. This is due to the fact that respondents who place a great deal of importance on low price (for example) choose the lowest price option most frequently. Frequently choosing the lowest price level results in a very high utility value for that level and a very low utility value for the most expensive level of price. If respondents do not take price into account when making their choice, they choose a high price level in one scenario, and a low price level in another, with little consistency. This

leads to a smaller range of utility values between price levels and indicates respondents made their decisions based on factors other than price. Taking the range of all five factors (e.g. security, price, delivery reliability, supplier location, and quality) and summing these ranges yields the total amount of utility that can be derived in a given model. This total utility value is presented at the bottom of column three in Table 4.5. Dividing the range of each individual factor by this total yields the percentage of total utility accounted for by each factor (i.e. the factor importance score). Higher factor importance scores indicate that a factor accounts for a greater percentage of the total utility in a given model. Factor importance scores are presented in column four of Table 4.5. Presently, if a factor has a higher factor importance score, it accounts for a greater percentage of utility in the model and therefore is more important to respondents in their mental models of supplier preference. H_5 is partially supported if price has a higher factor importance score than security.

Second, if respondents place more value on price than security, then they would not be willing to pay a higher price in order to utilize a supplier with advanced security. In order to determine if this is true, the researcher must examine the two-way interaction of price and security. This is accomplished by examining 1) utilities and 2) market simulation results (note: utility magnitudes can be examined in H_5 because they are estimated via a two-way interaction in a single logit run). If respondents are unwilling to trade-off price for advanced security, the following must hold true: 1) utilities must indicate respondents always prefer basic security over advanced security at every price level and 2) the market preference for suppliers with basic security and a lower price level must be greater than the market share for suppliers with advanced security and a

higher price level. In order to ease the comparison of market share figures for basic security/lower price (or delivery reliability) suppliers and advanced security/higher price (or delivery reliability) suppliers, several tables are included in this Chapter that resemble Table 4.8. These tables each contain three comparisons (from top to bottom) comparing the market preference of basic security/lower price (delivery reliability) suppliers with advanced security/higher price (delivery reliability) suppliers. These comparisons are followed by an "implication" in bold that details the meaning of the directional relationship depicted above it. Utilities and market simulation results are presented in Table 4.6.

Each of these three criteria (factor importance scores and utilities/market simulations) contributes to the overall support, or lack thereof, of H_5. If results of the three criteria are congruent with each other and the hypothesized relationship, then full support is given to H_5. If one result is in disagreement, less support is afforded to H_5. If the three results are congruent with each other, but incongruent with the hypothesized relationship, then no support is found for H_5.

TABLE 4.5 FACTOR IMPORTANCE SCORES

Factor	Utilities	Utility Range for Each Factor	Factor Importance Score (%)
Security		0.800	10.64
Advanced	0.398		
Basic	(0.398)		
Price		1.674	22.27
Equal to or Below Industry Average	0.763		
1-2% Higher than Industry Average	0.148		
3% or more Higher than Industry Average	(0.911)		
Delivery Reliability		2.036	27.09
Equal to or Above Industry Average	0.986		
1-2% Below Industry Average	0.064		
3% or more Below Industry Average	(1.049)		
Location		1.571	20.91
United States	0.786		
Saudi Arabia	(0.786)		
Quality		1.435	19.09
Significantly Higher than Industry Average	0.528		
Moderately Higher than Industry Average	0.378		
Equal to or Below Industry Average	(0.906)		
	Sum	**7.515**	

TABLE 4.6 HYPOTHESIS 5 RESULTS: SECURITY BY PRICE INTERACTION

Security Level	Price Level	Utilities	Market Preference %
Basic	Equal to or below	0.083	27.06
Basic	1-2% higher	(0.076)	6.82
Basic	3% or more higher	(0.007)	2.03
Advanced	Equal to or below	(0.083)	37.11
Advanced	1-2% higher	0.076	22.50
Advanced	3% or more higher	0.007	4.48

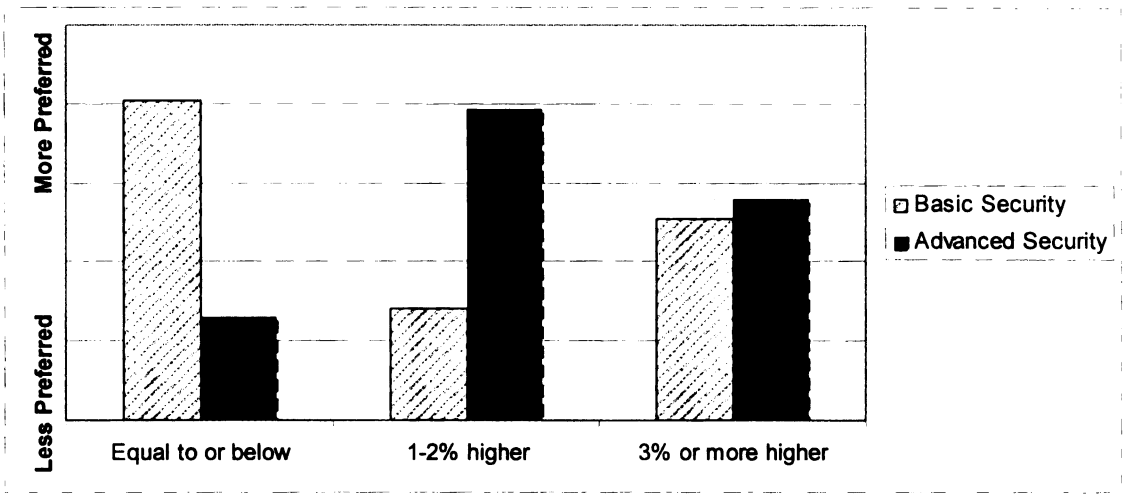
TABLE 4.7 HYPOTHESIS 5 RESULTS: ASSESSMENT OF SIGNIFICANT DIFFERENCES BETWEEN UTILITY VALUES

	Security Level	Basic	Basic	Basic	Adv	Adv	Adv
Security Level	Price Level	Equal to or below	1-2% higher	3% or more higher	Equal to or below	1-2% higher	3% or more higher
Basic	Equal to or below						
Basic	1-2% higher	2.15*					
Basic	3% or more higher	1.14	0.85				
Adv	Equal to or below	2.26*	0.10	0.95			
Adv	1-2% higher	0.10	2.03*	1.04	2.15*		
Adv	3% or more higher	0.95	1.04	0.18	1.14	0.85	

* = Significant difference at $p < 0.05$

Factor importance scores reveal that price contributes more to supplier preference (score = 22.27 percent) than does security (score = 10.64 percent). Utilities for the two-way interaction between security and price indicate that respondents prefer basic security when price is equal to or below industry average, advanced security when price is one to two percent higher than industry average, and advanced security when price is three percent or more higher than industry average. Respondents significantly prefer basic security and equal to or below prices to advanced security and equal to or below prices and advanced security and one to two percent higher prices over basic security and one to two percent higher prices. Figure 4.2 depicts these relationships graphically.

FIGURE 4.2 SECURITY BY PRICE INTERACTION: UTILITIES



Market simulation results graphically depicted in Figure 4.3 reveal that respondents would be more likely to choose a supplier with advanced security over one with basic security at each price level. Figure 4.3 also indicates that the market preference percentage of a supplier with advanced security declines linearly as price increases. The market preference percentage of a supplier with basic security drops more sharply as price increases from equal to or below average to one to two percent higher and then levels out as price increases further. This indicates that preference for suppliers with advanced security is somewhat less elastic with respect to price.

FIGURE 4.3 SECURITY BY PRICE INTERACTION: MARKET PREFERENCE

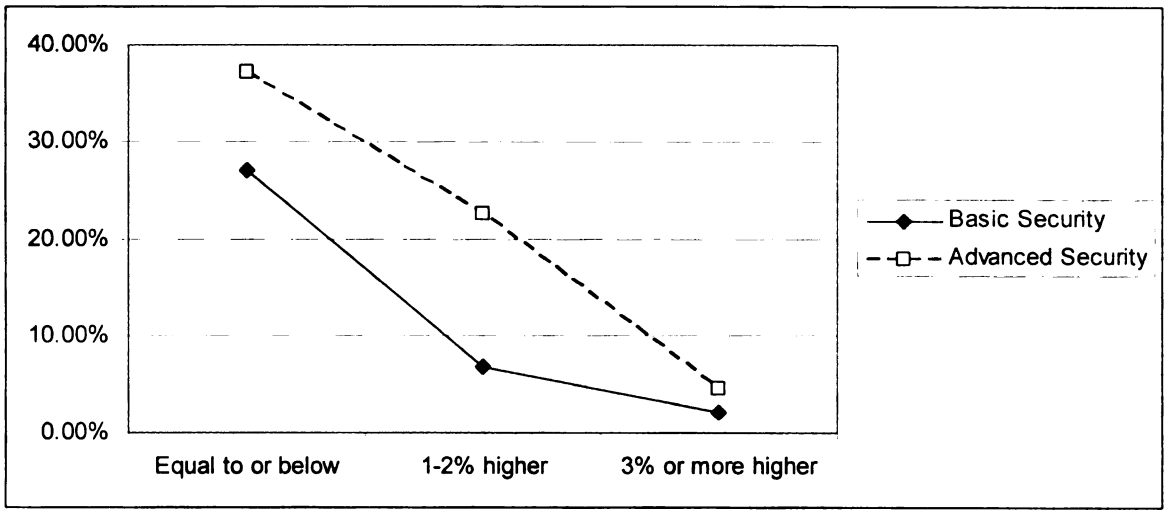


Table 4.8 compares the market preference percentages of suppliers with lower security and lower price to those with higher security and higher price in order to determine if respondents are willing to trade-off price for security. Results indicate suppliers with basic security and lower prices garner a greater percentage of market preference than suppliers with advanced security and higher prices. This indicates respondents are more likely to choose a supplier with basic security and lower prices than a supplier with advanced security and higher prices.

TABLE 4.8 SECURITY BY PRICE INTERACTION: MARKET PREFERENCE COMPARISON[2]

Security Level	Price Level	Market Preference	Directional Relationship	Market Preference	Price Level	Security Level
Basic	Equal to or below	27.06%	>	22.50%	1-2% higher	Advanced
		Implication				
Respondents chose a supplier with basic security/equal to or below prices more frequently than one with advanced security/1-2% higher prices.						

Security Level	Price Level	Market Preference	Directional Relationship	Market Preference	Price Level	Security Level
Basic	Equal to or below	27.06%	>	4.48%	3% or more higher	Advanced
		Implication				
Respondents chose a supplier with basic security/equal to or below prices more frequently than one with advanced security/3% or more higher prices.						

Security Level	Price Level	Market Preference	Directional Relationship	Market Preference	Price Level	Security Level
Basic	1-2% higher	6.82%	>	4.48%	3% or more higher	Advanced
		Implication				
Respondents chose a supplier with basic security/1-2% higher prices more frequently than one with advanced security/3% or more higher prices.						

In summary, H_5 posits that price has a greater influence on supplier preference than security. Factor importance scores support H_5 and indicate price influences supplier preference more than security. Utilities do not support H_5 and indicate that respondents prefer a supplier that charges one percent or more above industry average if that supplier employs advanced security measures. Market simulation results support H_5 and indicate that, while respondents are more likely to choose a supplier with advanced security over one with basic security at the same price level, they are also more likely to choose a

[2] Note that Table 4.7, as well as other similar tables in this Chapter, contain three comparisons (from top to bottom) comparing the market preference percentage of suppliers with basic security and "better" price/delivery reliability levels to suppliers with advanced security and "worse" price/delivery reliability levels.

supplier with lower prices and lower security over one with higher prices and higher security.

Therefore, H_5 is partially supported. Respondents place more value on price than security and are not willing to trade-off price for security, but the utility interactions are interesting in that they show some preference for higher levels of security at higher prices. This may indicate that two groups of respondents are represented: Those that focus on price and those that focus on other supplier attributes (e.g. security).

H_6 examines the relationship between security and delivery reliability.

RQ6: Are purchasing firms willing to sacrifice delivery reliability for increased supplier security?

H6: Delivery reliability has a greater influence on supplier preference than supplier security competence.

H_6 proposes that delivery reliability has a greater influence on supplier preference than security. H_6 is evaluated in the same manner as H_5. Factor importance scores presented in Table 4.4 reveal that respondents place more importance on delivery reliability (score = 27.09 percent) than security (score = 10.64 percent). Utility and market simulation results are presented in Table 4.9.

TABLE 4.9 HYPOTHESIS 6 RESULTS: SECURITY BY DELIVERY RELIABILITY INTERACTION

Security Level	Delivery Reliability Level	Utilities	Market Preference %
Basic	Equal to or Above	0.054	30.28
Basic	1-2% Below	(0.098)	5.11
Basic	3% or more Below	0.044	1.65
Advanced	Equal to or Above	(0.054)	43.36
Advanced	1-2% Below	0.098	16.90
Advanced	3% or more Below	(0.044)	2.70

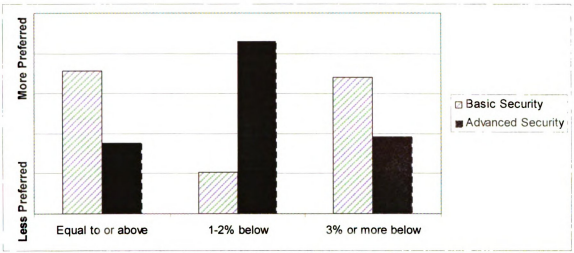
TABLE 4.10 HYPOTHESIS 6 RESULTS: ASSESSMENT OF SIGNIFICANT DIFFERENCES BETWEEN UTILITY VALUES

	Security Level	Basic	Basic	Basic	Adv	Adv	Adv
Security Level	Delivery Reliability Level	Equal to or above	1-2% below	3% or more below	Equal to or above	1-2% below	3% or more below
Basic	Equal to or above						
Basic	1-2% below	2.03*					
Basic	3% or more below	0.12	1.72				
Adv	Equal to or above	1.47	0.59	1.20			
Adv	1-2% below	0.59	2.57*	0.65	2.03*		
Adv	3% or more below	1.20	0.65	0.99	0.12	1.72	

* = Significant difference at $p < 0.05$

Utilities for the two-way interaction between security and delivery reliability indicate respondents prefer basic security at the highest and lowest levels of delivery reliability and advanced security when delivery reliability is one to two percent below industry average. Respondents significantly prefer advanced security and one to two percent below average delivery reliability over basic security and one to two percent below average delivery reliability. Figure 4.4 depicts this relationship graphically.

FIGURE 4.4 SECURITY BY DELIVERY RELIABILITY INTERACTION: UTILITIES



Market simulation results graphically depicted in Figure 4.5 reveal that respondents are more likely to choose a supplier with advanced security at each price level. Figure 4.5 also reveals similar declines in market share for suppliers with basic and advanced security as delivery reliability decreases to one to two percent below average. As delivery reliability decreases to three percent or more below average, the market preference percentage declines more for a supplier employing advanced security, but the market preference percentage for suppliers employing basic security did not have as far to fall.

FIGURE 4.5 SECURITY BY DELIVERY RELIABILITY INTERACTION: MARKET PREFERENCE

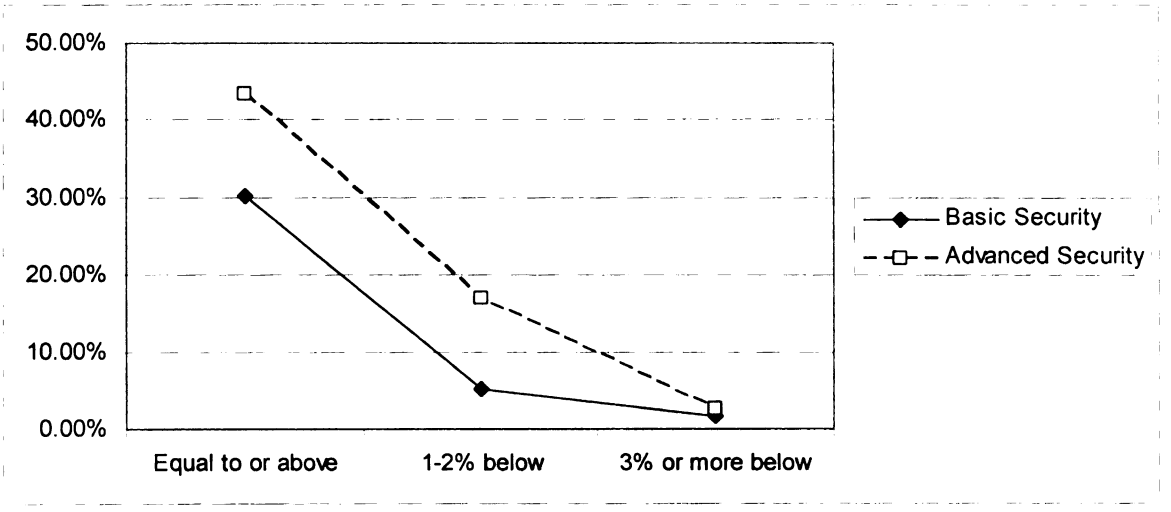


Table 4.11 compares market preference percentages for suppliers with higher delivery reliability and basic security versus those with lower delivery reliability and advanced security. Results indicate suppliers with basic security and higher delivery reliability garner more market preference than suppliers with advanced security and lower delivery reliability. This indicates respondents are more likely to choose a supplier with basic security and higher delivery reliability than a supplier with advanced security and lower delivery reliability.

TABLE 4.11 SECURITY BY DELIVERY RELIABILITY INTERACTION: MARKET PREFERENCE COMPARISON

Security Level	Delivery Reliability Level	Market Preference	Directional Relationship	Market Preference	Delivery Reliability Level	Security Level
Basic	Equal to or Above	30.28%	>	16.90%	1-2% Below	Advanced
		Implication				
Respondents chose a supplier with basic security/equal to or above delivery reliability more frequently than one with advanced security/1-2% below average delivery reliability.						

Security Level	Delivery Reliability Level	Market Preference	Directional Relationship	Market Preference	Delivery Reliability Level	Security Level
Basic	Equal to or Above	30.28%	>	2.70%	3% or more Below	Advanced
		Implication				
Respondents chose a supplier with basic security/equal to or above delivery reliability more frequently than one with advanced security/3% or more below average delivery reliability.						

Security Level	Delivery Reliability Level	Market Preference	Directional Relationship	Market Preference	Delivery Reliability Level	Security Level
Basic	1-2% Below	5.11%	>	2.70%	3% or more Below	Advanced
		Implication				
Respondents chose a supplier with basic security/1-2% below delivery reliability more frequently than one with advanced security/3% or more below average delivery reliability.						

In summary, H_6 posits that delivery reliability has a greater influence on supplier preference than security. Factor importance scores support H_6 and indicate delivery reliability influences supplier preference more than security. Utilities do not support H_6 and indicate that respondents prefer a supplier with one to two percent below industry average delivery reliability if that supplier employs advanced security measures. Market simulation results support H_6 and indicate that, while respondents are more likely to choose a supplier with advanced security over one with basic security at each level of delivery reliability, they are also more likely to choose a supplier with higher delivery

reliability and basic security over one with lower delivery reliability and advanced security.

H_6 is partially supported. While factor importance scores and market simulation results support the assertion that delivery reliability is more important than security, utilities indicate that respondents prefer one to two percent below industry average delivery reliability if the supplier employs advanced security measures. Utility results may be a function of consolidation in the food industry, which leads to the presence of few suppliers for many goods. In a situation where few suppliers exist for a given commodity, purchasing firms may be forced to accept lower levels of delivery reliability, but would place a higher priority on the security competence of these suppliers due to their strategic importance. Should one of these strategic sources of materials experience a security incident, the viability of the purchasing firm would be threatened.

H_7 through H_9 examine respondents' concern over security incidents that have occurred at their firm as it affects preference for suppliers with advanced security, lower delivery reliability, and higher prices. H_7 examines the role of respondent concern as it relates to preference for suppliers with advanced security. These results are presented subsequently.

> RQ7: Does concern over security related incidents that have occurred at the firm influence respondents to place more value on increased supplier security?
>
> **H7: An increase in concern over security incidents experienced by the purchasing firm positively affects preference for suppliers with higher security competence.**

H_7 proposes that respondents who are concerned about the security incidents that have occurred at their firm have greater preference for suppliers with advanced security. In

order to evaluate H_7 it was necessary to segment the respondents into those who were concerned about security incidents and those who were not. Respondents were asked to indicate their level of concern regarding their firm's security incidents. Table 4.12 provides the question, response options, and response frequencies and percentages.

TABLE 4.12 RESPONDENTS' CONCERN OVER SECURITY INCIDENTS

"How concerned are you about the intentional contamination/security incidents that have occurred at your firm?"		
Response Option	Number who answered this option	Percent who answered this option
Very Unconcerned	4	3.73
Unconcerned	9	8.41
Neutral	21	19.62
Concerned	37	34.57
Very Concerned	23	21.49
Not Applicable	13	12.14
Total	107	100

Respondents were then segmented into two groups: First, concerned respondents are those who indicated they were "Concerned" or "Very Concerned" about their firm's security incidents (N = 60). Second, unconcerned respondents are those who indicated they were "Very Unconcerned", "Unconcerned", "Neutral", or that the question was "Not Applicable", which would conceivably indicate that they do not believe a security incident had occurred at their firm (N = 47).

H_7 is evaluated by comparing factor importance scores, utilities, and market simulations for concerned and unconcerned respondents. In order for H_7 to be fully supported, 1) factor importance scores must indicate that security is more important for concerned respondents than unconcerned respondents, 2) utilities must indicate concerned respondents prefer suppliers with advanced security and unconcerned

respondents do not, and 3) market simulation results must indicate that concerned respondents are more likely to choose a supplier with advanced security than are unconcerned respondents. For the market simulation method, two separate simulations were performed: one for concerned respondents and one for unconcerned respondents. Both simulations held all other factors at their "best" levels in order to examine the effects of security. Table 4.13 provides factor importance scores and Table 4.14 provides utility and market share results.

TABLE 4.13 FACTOR IMPORTANCE SCORES: SEGMENTED SAMPLE

	Concerned Respondents			Unconcerned Respondents		
Factor	**Utilities**	**Range**	**Factor Importance Score (%)**	**Utilities**	**Range**	**Factor Importance Score (%)**
Security		0.981	12.79		0.602	8.16
Basic	0.491			(0.301)		
Advanced	(0.491)			0.301		
Price		1.514	19.73		1.856	25.15
Equal to or Below Industry Average	0.676			0.860		
1-2% Higher than Industry Average	0.163			0.137		
3% or more Higher than Industry Average	(0.838)			(0.996)		
Delivery Reliability		2.208	28.78		1.878	25.44
Equal to or Above Industry Average	1.060			0.911		
1-2% Below Industry Average	0.087			0.055		
3% or more Below Industry Average	(1.148)			(0.966)		
Location		1.591	20.74		1.535	20.79
United States	0.796			0.767		
Saudi Arabia	(0.796)			(0.767)		
Quality		1.379	17.97		1.511	20.47
Significantly Higher than Industry Average	0.499			(0.943)		
Moderately Higher than Industry Average	0.380			0.375		
Equal to or Below Industry Average	(0.879)			0.568		
	Sum	**7.673**		**Sum**	**7.382**	

TABLE 4.14 HYPOTHESIS 7 RESULTS: SECURITY BY INCIDENT CONCERN INTERACTION

	Concerned Respondents		Unconcerned Respondents	
Security Level	Utilities	Market Preference %	Utilities	Market Preference %
Advanced	0.491	60.20	0.301	54.92
Basic	(0.491)	39.80	(0.301)	45.09

Factor importance scores presented in Table 4.13 indicate that concerned respondents place more importance on security (score = 12.79 percent) than do unconcerned respondents (score = 8.16 percent). The magnitude of utilities for concerned and unconcerned respondents cannot be compared because they were derived from separate logit runs. However, Figures 4.6 and 4.7 illustrate that both groups prefer advanced security over basic security and this difference is significant for both concerned and unconcerned respondents ($p < 0.05$).

FIGURE 4.6 SECURITY BY INCIDENT CONCERN INTERACTION: CONCERNED RESPONDENT UTILITIES

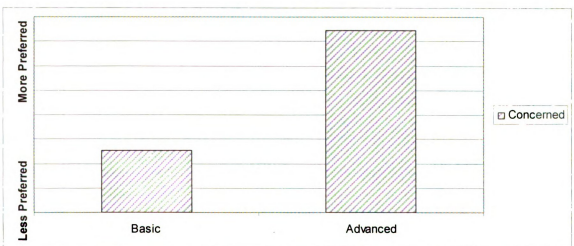
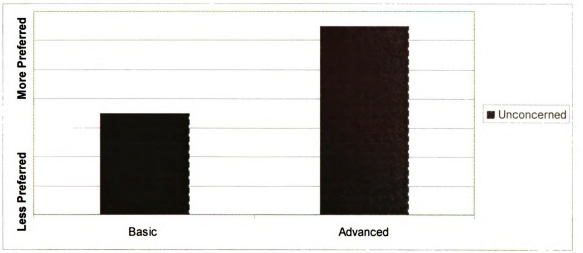
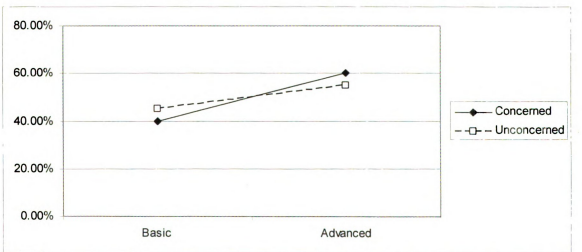


FIGURE 4.7 SECURITY BY INCIDENT CONCERN INTERACTION: UNCONCERNED RESPONDENT UTILITIES



Market simulation indicates concerned respondents choose a supplier with higher security more often (market preference = 60.20 percent) than their unconcerned counterparts (market preference = 54.92 percent). This relationship is graphically depicted in Figure 4.8.

FIGURE 4.8 SECURITY BY INCIDENT CONCERN INTERACTION: MARKET PREFERENCE



In summary, H_7 posits that respondents who are concerned about the security incidents that have occurred at their firm have greater preference for suppliers with advanced security. Factor importance scores support H_7 and indicate that security influences supplier preference more for concerned respondents (score = 12.79 percent) than unconcerned respondents (score = 8.16 percent). Utility figures do not support H_7 and indicate both groups prefer advanced security over basic security. Market simulation results support H_7 and indicate that concerned respondents are more likely to choose a supplier with advanced security than unconcerned respondents.

H_7 is partially supported. Concerned respondents place more importance on security and choose a supplier with advanced security more often than unconcerned respondents. Both groups prefer suppliers with advanced security.

H_8 examines the influence of concern on respondents' preference for suppliers with lower delivery reliability and higher security.

> **H8: An increase in concern over security incidents experienced by the purchasing firm positively affects preference for suppliers with lower delivery reliability and higher security.**

H_8 posits that concerned respondents are more willing to sacrifice delivery reliability for security than unconcerned respondents. H_8 is evaluated similarly to H_7, except that a three-way interaction of security, delivery reliability, and respondent concern over security incidents is being evaluated. For H_8 to be fully supported, 1) factor importance scores must indicate that delivery reliability is less important for concerned respondents than unconcerned respondents, 2) utilities must indicate that concerned respondents prefer higher levels of security, coupled with lower levels of delivery reliability, and

unconcerned respondents do not, and 3) market simulation results must show that concerned respondents are more likely to choose suppliers with higher security, and lower delivery reliability, than unconcerned respondents. Table 4.15 presents utility and market simulation results for concerned and unconcerned respondents.

TABLE 4.15 HYPOTHESIS 8 RESULTS: SECURITY BY DELIVERY RELIABILITY BY INCIDENT CONCERN INTERACTION

		Concerned Respondents		Unconcerned Respondents	
Security Level	Delivery Reliability Level	Utilities	Market Preference %	Utilities	Market Preference %
Basic	Equal to or Above	0.098	28.31	0.023	32.11
Basic	1-2% Below	(0.017)	5.00	(0.195)	4.90
Basic	3% or more Below	(0.082)	0.65	0.172	3.38
Advanced	Equal to or Above	(0.098)	47.18	(0.023)	38.71
Advanced	1-2% Below	0.017	15.64	0.195	18.97
Advanced	3% or more Below	0.082	3.23	(0.172)	1.94

TABLE 4.16 HYPOTHESIS 8 RESULTS: ASSESSMENT OF SIGNIFICANT DIFFERENCES BETWEEN UTILITY VALUES: CONCERNED RESPONDENTS

	Security Level	Basic	Basic	Basic	Adv	Adv	Adv
Security Level	Delivery Reliability Level	Equal to or above	1-2% below	3% or more below	Equal to or above	1-2% below	3% or more below
Basic	Equal to or above						
Basic	1-2% below	1.13					
Basic	3% or more below	1.59	0.57				
Adv	Equal to or above	1.96*	0.80	0.15			
Adv	1-2% below	0.80	0.32	0.86	1.13		
Adv	3% or more below	0.15	0.86	1.31	1.59	0.57	

* = Significant difference at $p < 0.05$

TABLE 4.17 HYPOTHESIS 8 RESULTS: ASSESSMENT OF SIGNIFICANT DIFFERENCES BETWEEN UTILITY VALUES: UNCONCERNED RESPONDENTS

	Security Level	Basic	Basic	Basic	Adv	Adv	Adv
Security Level	Delivery Reliability Level	Equal to or above	1-2% below	3% or more below	Equal to or above	1-2% below	3% or more below
Basic	Equal to or above						
Basic	1-2% below	1.92					
Basic	3% or more below	1.22	2.96*				
Adv	Equal to or above	0.41	1.51	1.60			
Adv	1-2% below	1.51	3.37*	0.19	1.92		
Adv	3% or more below	1.60	0.19	2.61*	1.22	2.96*	

* = Significant difference at $p < 0.05$

Factor importance scores presented in Table 4.13 reveal that concerned respondents actually place *more* importance on delivery reliability (score = 28.78 percent) than do unconcerned respondents (score = 25.44 percent). Utility preference patterns indicate that the two groups are generally the same, with one exception: concerned respondents preferred a supplier with advanced security and three percent or more below industry average delivery reliability, whereas unconcerned respondents did not prefer this option. Examining significant differences between utility values for concerned respondents reveals that they significantly prefer basic security and equal to or above delivery reliability over advanced security and equal to or above delivery reliability. Unconcerned respondents significantly prefer advanced security and one to two percent below delivery reliability over basic and one to two percent below average delivery reliability and basic security and three percent or more below average delivery reliability over advanced and three percent or more below average delivery reliability.

Figures 4.9 and 4.10 depict this relationship graphically for concerned and unconcerned respondents respectively.

FIGURE 4.9 SECURITY BY DELIVERY RELIABILITY BY INCIDENT CONCERN INTERACTION: UTILITIES FOR CONCERNED RESPONDENTS

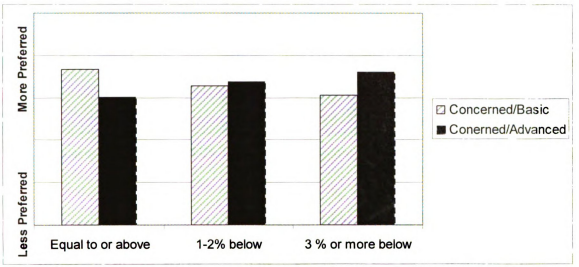


FIGURE 4.10 SECURITY BY DELIVERY RELIABILITY BY INCIDENT CONCERN: UTILITIES FOR UNCONCERNED RESPONDENTS

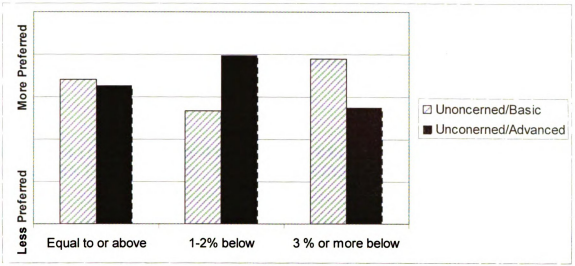
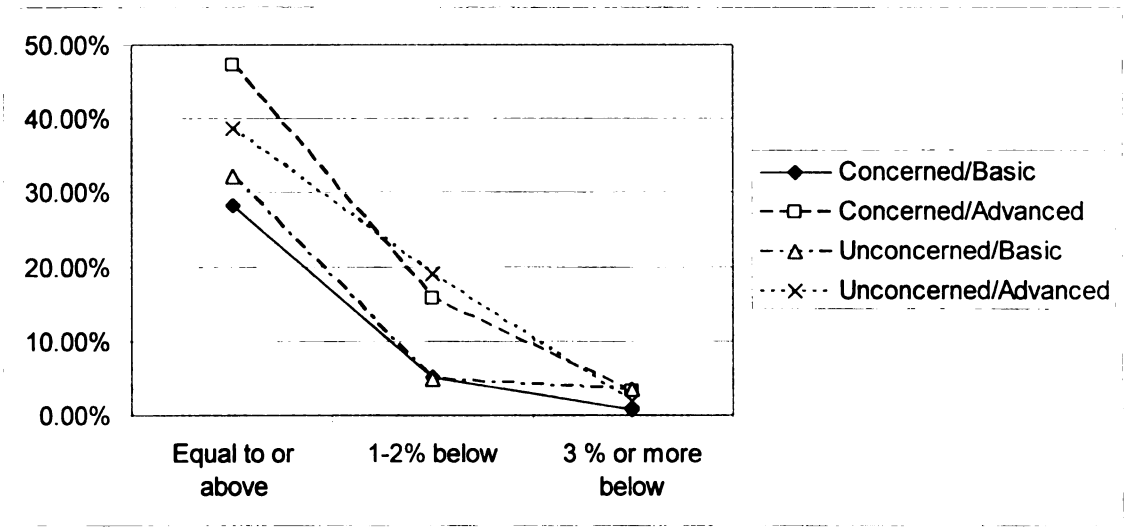


Figure 4.11 graphically depicts market simulation results of the three-way interaction between delivery reliability, incident concern, and security. When a supplier has delivery reliability equal to or above average and advanced security, concerned respondents are more likely to choose this supplier (market preference = 47.18 percent) than unconcerned respondents (market preference = 38.17 percent). However, when a supplier's delivery reliability drops to one to two percent below industry average, unconcerned respondents are more likely to choose a supplier with advanced security (market preference = 18.97 percent) than concerned respondents (market preference = 15.64 percent). At three percent or more below industry average delivery reliability, unconcerned respondents are more likely to choose a supplier with basic security (market preference = 3.38 percent) and concerned respondents are more likely to choose advanced (market preference = 3.23 percent).

These results reflect the finding that concerned respondents derive more utility from delivery reliability than unconcerned respondents, as evidenced by the factor

importance scores in Table 4.13. While concerned respondents also place more value on security than unconcerned respondents, Figure 4.11 illustrates that they do not value security to the extent that they are more likely than unconcerned respondents to choose a supplier with advanced security and one to two percent below average delivery reliability.

FIGURE 4.11 SECURITY BY DELIVERY RELIABILITY BY INCIDENT CONCERN INTERACTION: MARKET PREFERENCE



Market simulations also indicate that both groups of respondents are unlikely to trade-off delivery reliability for security. Tables 4.18 and 4.19 depict these comparisons for concerned and unconcerned respondents respectively.

TABLE 4.18 SECURITY BY DELIVERY RELIABILITY INTERACTION: MARKET PREFERENCE COMPARISON FOR CONCERNED RESPONDENTS

Concerned Respondents						
Security Level	**Delivery Reliability Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Delivery Reliability Level**	**Security Level**
Basic	Equal to or Above	28.31%	>	15.64%	1-2% Below	Advanced
		Implication				
Concerned respondents chose a supplier with basic security/equal to or above delivery reliability more frequently than one with advanced security/1-2% below average delivery reliability.						
Security Level	**Delivery Reliability Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Delivery Reliability Level**	**Security Level**
Basic	Equal to or Above	28.31%	>	3.23%	3% or more Below	Advanced
		Implication				
Concerned respondents chose a supplier with basic security/equal to or above delivery reliability more frequently than one with advanced security/3% or more below average delivery reliability.						
Security Level	**Delivery Reliability Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Delivery Reliability Level**	**Security Level**
Basic	1-2% Below	5.00%	>	3.23%	3% or more Below	Advanced
		Implication				
Concerned respondents chose a supplier with basic security/1-2% below delivery reliability more frequently than one with advanced security/3% below average delivery reliability.						

TABLE 4.19 SECURITY BY DELIVERY RELIABILITY INTERACTION: MARKET PREFERENCE COMPARISON FOR UNCONCERNED RESPONDENTS

Unconcerned Respondents						
Security Level	**Delivery Reliability Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Delivery Reliability Level**	**Security Level**
Basic	Equal to or Above	32.11%	>	18.97%	1-2% Below	Advanced
		Implication				
Unconcerned respondents chose a supplier with basic security/equal to or above delivery reliability more frequently than one with advanced security/1-2% below average delivery reliability.						
Security Level	**Delivery Reliability Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Delivery Reliability Level**	**Security Level**
Basic	Equal to or Above	32.11%	>	1.94%	3% or more Below	Advanced
		Implication				
Unconcerned respondents chose a supplier with basic security/equal to or above delivery reliability more frequently than one with advanced security/3% or more below average delivery reliability.						
Security Level	**Delivery Reliability Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Delivery Reliability Level**	**Security Level**
Basic	1-2% Below	4.90%	>	1.94%	3% or more Below	Advanced
		Implication				
Unconcerned respondents chose a supplier with basic security/1-2% below delivery reliability more frequently than one with advanced security/3% below average delivery reliability.						

Tables 4.18 and 4.19 indicate suppliers with basic security and higher delivery reliability garner more market preference than suppliers with advanced security and lower delivery reliability for both groups. This indicates concerned and unconcerned respondents are more likely to choose a supplier with basic security and higher delivery reliability over a supplier with advanced security and lower delivery reliability.

In summary, H_8 posits that concerned respondents have greater preference for suppliers with lower delivery reliability and higher security. Factor importance scores do not support H_8 and indicate concerned respondents placed *more* importance on delivery reliability than did unconcerned respondents. Utility figures support H_8 and indicate that

concerned respondents prefer a supplier with advanced security and three percent or more below industry average delivery reliability while unconcerned respondents did not (note: Significant differences between concerned and unconcerned respondents utility values cannot be assessed because they were derived from separate logit runs. Only directional preferences can be assessed). Market simulation results do not support H_8 and indicate that concerned respondents are less likely to choose a supplier with lower delivery reliability than unconcerned respondents.

H_8 is not supported. Two out of three evaluation methods do not support the hypothesized relationship. Factor importance scores indicate that concerned respondents place *more* importance on delivery reliability than unconcerned respondents. Utilities indicate concerned respondents prefer a supplier with advanced security and three percent or more below industry average delivery reliability, whereas unconcerned respondents do not. Market simulations indicate that both groups are unwilling to trade-off delivery reliability for security.

H_9 examines the influence of concern on respondents' preference for suppliers with higher prices and higher security.

> **H9: An increase in concern over security incidents experienced by the purchasing firm positively affects preference for suppliers with higher prices and higher security.**

H_9 proposes that concerned respondents are more willing to pay a higher price to utilize suppliers with advanced security than unconcerned respondents. H_9 is evaluated similarly to H_8. Utilities and market simulation results are presented in Table 4.20.

TABLE 4.20 HYPOTHESIS 9 RESULTS: SECURITY BY PRICE BY INCIDENT CONCERN INTERACTION

		Concerned Respondents		Unconcerned Respondents	
Security Level	Price Level	Utilities	Market Preference %	Utilities	Market Preference %
Basic	Equal to or below	0.063	23.29	0.091	31.36
Basic	1-2% higher	(0.061)	7.52	(0.083)	6.54
Basic	3% or more higher	(0.002)	2.38	(0.008)	1.79
Advanced	Equal to or below	(0.063)	37.42	(0.091)	36.70
Advanced	1-2% higher	0.061	24.13	0.083	20.04
Advanced	3% or more higher	0.002	5.27	0.008	3.57

TABLE 4.21 HYPOTHESIS 9 RESULTS: ASSESSMENT OF SIGNIFICANT DIFFERENCES BETWEEN UTILITY VALUES: CONCERNED RESPONDENTS

	Security Level	Basic	Basic	Basic	Adv	Adv	Adv
Security Level	Price Level	Equal to or below	1-2% higher	3% or more higher	Equal to or below	1-2% higher	3% or more higher
Basic	Equal to or below						
Basic	1-2% higher	1.24					
Basic	3% or more higher	0.61	0.56				
Adv	Equal to or below	1.26	0.02	0.58			
Adv	1-2% higher	0.02	1.21	0.59	1.24		
Adv	3% or more higher	0.58	0.59	0.03	0.61	0.56	

TABLE 4.22 HYPOTHESIS 9 RESULTS: ASSESSMENT OF SIGNIFICANT DIFFERENCES BETWEEN UTILITY VALUES: UNCONCERNED RESPONDENTS

	Security Level	Basic	Basic	Basic	Adv	Adv	Adv
Security Level	Price Level	Equal to or below	1-2% higher	3% or more higher	Equal to or below	1-2% higher	3% or more higher
Basic	Equal to or below						
Basic	1-2% higher	1.57					
Basic	3% or more higher	0.81	0.62				
Adv	Equal to or below	1.64	0.07	0.68			
Adv	1-2% higher	0.07	1.49	0.74	1.57		
Adv	3% or more higher	0.68	0.74	0.12	0.81	0.62	

Factor importance scores presented in Table 4.13 reveal that concerned respondents place *less* importance on price (score = 19.73 percent) than do unconcerned respondents (score = 25.15 percent). Utilities indicate that both groups share the same preference patterns. Figures 4.12 and 4.13 graphically depict the utility preference patterns for concerned and unconcerned respondents respectively. Again, the magnitude of utility figures between concerned and unconcerned respondents cannot be compared.

FIGURE 4.12 SECURITY BY PRICE BY INCIDENT CONCERN INTERACTION: UTILITIES FOR CONCERNED RESPONDENTS

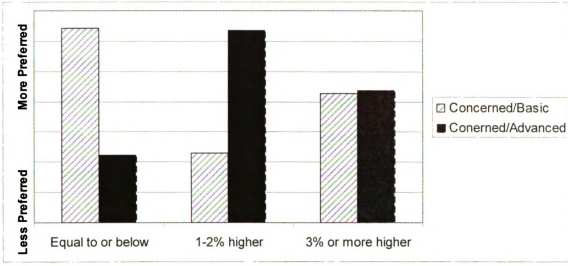


FIGURE 4.13 SECURITY BY PRICE BY INCIDENT CONCERN INTERACTION: UTILITIES FOR UNCONCERNED RESPONDENTS

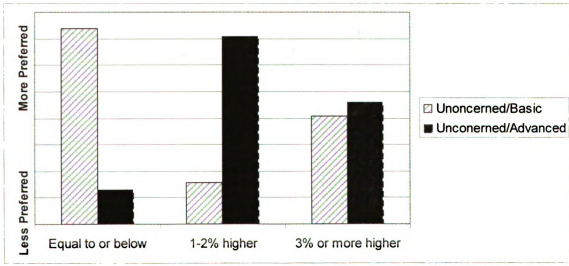
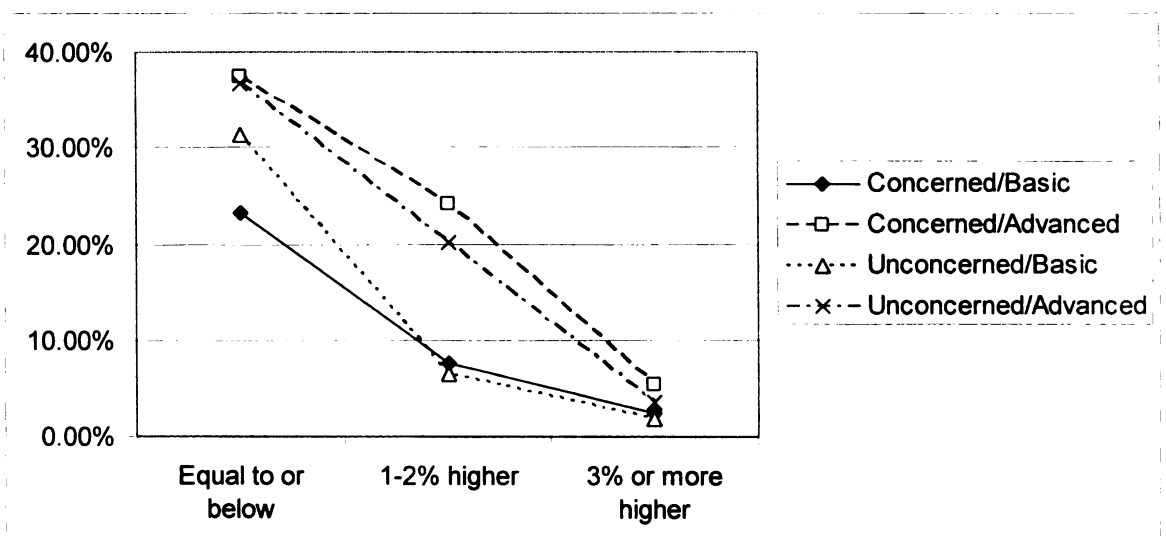


Figure 4.14 graphically depicts market simulation results for the three-way interaction between, security, price, and incident concern. When a supplier possesses advanced security and charges a price equal to or below industry average, they will

garner marginally more market preference from concerned respondents (market preference = 37.42 percent) than unconcerned respondents (market preference = 36.70 percent). Additionally, unconcerned respondents are more likely to choose a supplier with basic security (market preference = 31.36 percent) than concerned respondents (market preference = 23.29 percent). However, when price increases to one to two percent above industry average, the gap between the groups' likelihood of choosing a supplier with advanced security widens. Concerned respondents are more likely to choose a supplier with advanced security and one to two percent higher prices (market preference = 24.13 percent) than are unconcerned respondents (market preference = 20.04 percent). At three percent or more higher price, the gap between the groups' likelihood of choosing advanced security narrows somewhat, but concerned respondents are still more likely to choose a supplier with advanced security (market preference = 5.27 percent) than are unconcerned respondents (market preference = 3.57 percent).

FIGURE 4.14 SECURITY BY PRICE BY INCIDENT CONCERN INTERACTION: MARKET PREFERENCE



Market simulations also reveal that concerned respondents were marginally more willing to choose a supplier with advanced security and one to two percent higher prices over one with basic security and equal to or below prices, which indicates a greater willingness to trade-off price for security. Unconcerned respondents were not as willing to trade-off price for security. Tables 4.23 and 4.24 depict these relationships for concerned and unconcerned respondents respectively.

TABLE 4.23 SECURITY BY PRICE BY INCIDENT CONCERN INTERACTION: MARKET PREFERENCE COMPARISON FOR CONCERNED RESPONDENTS

Concerned Respondents						
Security Level	**Price Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Price Level**	**Security Level**
Basic	Equal to or below	23.29%	<	24.13%	1-2% higher	Advanced
		Implication				
Concerned respondents chose a supplier with basic security/equal to or below prices less frequently than one with advanced security/1-2% higher prices.						
Security Level	**Price Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Price Level**	**Security Level**
Basic	Equal to or below	23.29%	>	5.27%	3% or more higher	Advanced
		Implication				
Concerned respondents chose a supplier with basic security/equal to or below prices more frequently than one with advanced security/3% or more higher prices.						
Security Level	**Price Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Price Level**	**Security Level**
Basic	1-2% higher	7.52%	>	5.27%	3% or more higher	Advanced
		Implication				
Concerned respondents chose a supplier with basic security/1-2% higher prices more frequently than one with advanced security/3% or more higher prices.						

TABLE 4.24 SECURITY BY PRICE BY INCIDENT CONCERN INTERACTION: MARKET PREFERENCE COMPARISON FOR UNCONCERNED RESPONDENTS

Unconcerned Respondents						
Security Level	**Price Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Price Level**	**Security Level**
Basic	Equal to or below	31.36%	>	20.04%	1-2% higher	Advanced
		Implication				
Unconcerned respondents chose a supplier with basic security/equal to or below prices more frequently than one with advanced security/1-2% higher prices.						
Security Level	**Price Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Price Level**	**Security Level**
Basic	Equal to or below	31.36%	>	3.57%	3% or more higher	Advanced
		Implication				
Unconcerned respondents chose a supplier with basic security/equal to or below prices more frequently than one with advanced security/3% or more higher prices.						
Security Level	**Price Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Price Level**	**Security Level**
Basic	1-2% higher	6.54%	>	3.57%	3% or more higher	Advanced
		Implication				
Unconcerned respondents chose a supplier with basic security/1-2% higher prices more frequently than one with advanced security/3% or more higher prices.						

Table 4.23 indicates that concerned respondents are more likely to choose a supplier with advanced security and one to two percent higher prices over one with basic security and equal to or below prices. Concerned respondents are also more likely to choose a supplier with basic security and equal to or below average prices over a supplier with advanced security and three percent or more higher prices. Further, concerned respondents are more likely to choose a supplier with basic security and one to two percent higher prices over one with advanced security and three percent or more higher prices. Unconcerned respondents are always more likely to choose a supplier with basic security and lower prices over one with advanced security and higher prices. These

results indicate concerned respondents are more willing to trade-off price for security than unconcerned respondents.

In summary, H_9 states that concerned respondents have greater preference for suppliers with higher prices and higher security. Factor importance scores support H_9 and indicate concerned respondents place less importance on price than unconcerned respondents. Utility results do not support H_9 and indicate that preference patterns for both groups were the same, implying that concerned respondents and unconcerned respondents have similar preferences for all levels of security and price. Market simulations support H_9 and indicate that concerned respondents are more likely to choose a supplier with one to two percent higher price and advanced security, whereas unconcerned respondents were not as likely to sacrifice price for security.

H_9 is partially supported. Concerned respondents place less importance on price. Concerned respondents are more likely to trade-off price for security. Utility preferences are the same.

H_{10} through H_{12} examine the influence of international sourcing on respondents' preference for suppliers with advanced security, lower delivery reliability, and higher prices. H_{10} examines the influence of international sourcing as it affects preference for suppliers with advanced security. These results are presented subsequently.

RQ8: Do purchasing firms that source goods internationally place more value on increased supplier security?

H10: International sourcing by the purchasing firm positively affects preference for suppliers with higher security competence.

Returning to the full sample (i.e. not segmenting respondents by concern over security incidents), H_{10} proposes that international sourcing positively affects preference for suppliers with higher security competence. H_{10} is evaluated by examining utilities and market simulation results comparing basic and advanced security across the two supplier locations. For H_{10} to be fully supported, the following must be true: 1) utility results must indicate respondents derive more utility from advanced security, as opposed to basic security, when they source internationally and 2) market simulation results must indicate that respondents are more likely to choose a supplier with advanced security when they source goods internationally than when they source goods domestically. Utility figures were derived from the two-way interaction of security and supplier location. Market simulation results were derived by performing two separate simulations. One simulation examined security and domestic sourcing while holding price, delivery reliability, and quality at their "best" levels. The second simulation examined security and international sourcing while holding price, delivery reliability, and quality at their "best" levels (note: two separate market simulations were run – one for domestic and one for international. This was necessary because respondents' strong preference for domestic sourcing skewed the results and masked the effect of security). Table 4.19 provides utility and market simulation results related to H_{10}.

TABLE 4.25 HYPOTHESIS 10 RESULTS: SECURITY BY SOURCING LOCATION INTERACTION

	Domestic Sourcing		International Sourcing	
Security Level	Utilities	Market Preference %	Utilities	Market Preference %
Advanced	(0.102)	57.75	0.102	67.27
Basic	0.102	42.25	(0.102)	32.73

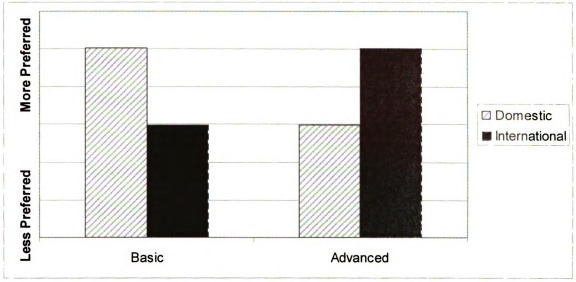
TABLE 4.26 HYPOTHESIS 10 RESULTS: ASSESSMENT OF SIGNIFICANT DIFFERENCES BETWEEN UTILITY VALUES: UNCONCERNED RESPONDENTS

	Security Level	Basic	Basic	Adv	Adv
Security Level	Sourcing Location	Domestic	International	Domestic	International
Basic	Domestic				
Basic	International	3.43*			
Adv	Domestic	3.43*	0.00		
Adv	International	0.00	3.43*	3.43*	

* = Significant difference at $p < 0.05$

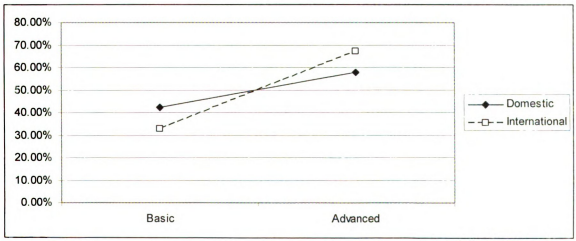
Utilities indicate that when firms source domestically, they significantly prefer suppliers with basic security over advanced security. When firms source internationally, they significantly prefer suppliers with advanced security over basic security. Figure 4.15 depicts these results graphically.

FIGURE 4.15 SECURITY BY SOURCING LOCATION INTERACTION: UTILITIES



Market simulations reveal that respondents are more likely to choose a supplier with advanced security when they source internationally than they are when they source domestically. These results are depicted graphically in Figure 4.16.

FIGURE 4.16 SECURITY BY SOURCING LOCATION INTERACTION: MARKET PREFERENCE



In sum, H_{10} states that international sourcing positively affects preference for suppliers with advanced security. Utility figures support H_{10} and indicate greater preference for advanced security when goods are sourced internationally. Market simulations support H_{10} and indicate that respondents choose a supplier with advanced security when they source goods internationally more often than when they source domestically.

H_{10} is supported. Utilities indicate respondents prefer advanced security when they source internationally and basic when they source domestically. Market simulations indicate respondents are more likely to choose a supplier with advanced security when they source internationally than when they source domestically. The two methods of evaluation are congruent with each other and the hypothesized relationship.

H_{11} examines the influence of international sourcing on respondents' preference for suppliers with lower delivery reliability and higher security.

> **H11: International sourcing by the purchasing firm positively affects preference for suppliers with lower delivery reliability and higher security.**

H_{11} proposes that firms sourcing internationally prefer suppliers with lower delivery reliability and higher security. H_{11} requires the examination of a two-way interaction between delivery reliability and supplier location and a three-way interaction between security, delivery reliability, and supplier location. For H_{11} to be supported, the following must hold true: 1) when comparing utility figures for domestic vs. international supplier locations, respondents must prefer lower delivery reliability for international sourcing and higher delivery reliability for domestic sourcing (note: utilities are not examined for

three-way interactions due to CBC's inability to estimate these results), and 2) market simulations must reveal that suppliers who source goods internationally are more likely to choose a supplier with higher security and lower delivery reliability than their domestic counterparts (note: two separate market simulations were run – one for domestic and one for international. This was necessary because respondents' strong preference for domestic sourcing skewed the results and masked the effect of security). Utility and market simulation results are presented in Tables 4.27 and 4.29 respectively.

TABLE 4.27 HYPOTHESIS 11 RESULTS: DELIVERY RELIABILITY BY SOURCING LOCATION INTERACTION

	Domestic Sourcing	International Sourcing
Delivery Reliability Level	Utilities	Utilities
Equal to or Above	0.049	(0.049)
1-2% Below	(0.128)	0.128
3% or more Below	0.079	(0.079)

TABLE 4.28 HYPOTHESIS 11 RESULTS: ASSESSMENT OF SIGNIFICANT DIFFERENCES BETWEEN UTILITY VALUES

	Delivery Reliability Level	Equal to or above	Equal to or above	1-2% below	1-2% below	3% or more below	3% or more below
Delivery Reliability Level	Sourcing Location	Domestic	International	Domestic	International	Domestic	International
Equal to or above	Domestic						
Equal to or above	International	1.21					
1-2% below	Domestic	2.17*	0.97				
1-2% below	International	0.97	2.17*	3.09*			
3% or more below	Domestic	0.33	1.37	2.19*	0.51		
3% or more below	International	1.37	0.33	0.51	2.19*	1.51	

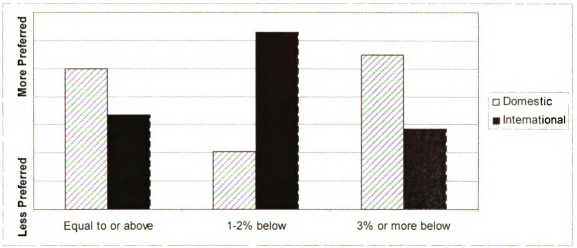
* = Significant difference at $p < 0.05$

TABLE 4.29 HYPOTHESIS 11 RESULTS: SECURITY BY DELIVERY RELIABILITY BY SOURCING LOCATION INTERACTION: MARKET PREFERENCE

		Domestic Sourcing	International Sourcing
Security Level	Delivery Reliability Level	Market Preference %	Market Preference %
Basic	Equal to or Above	30.28	20.52
Basic	1-2% Below	5.11	3.29
Basic	3% or more Below	1.65	1.13
Advanced	Equal to or Above	43.36	52.33
Advanced	1-2% Below	16.90	19.55
Advanced	3% or more Below	2.70	3.19

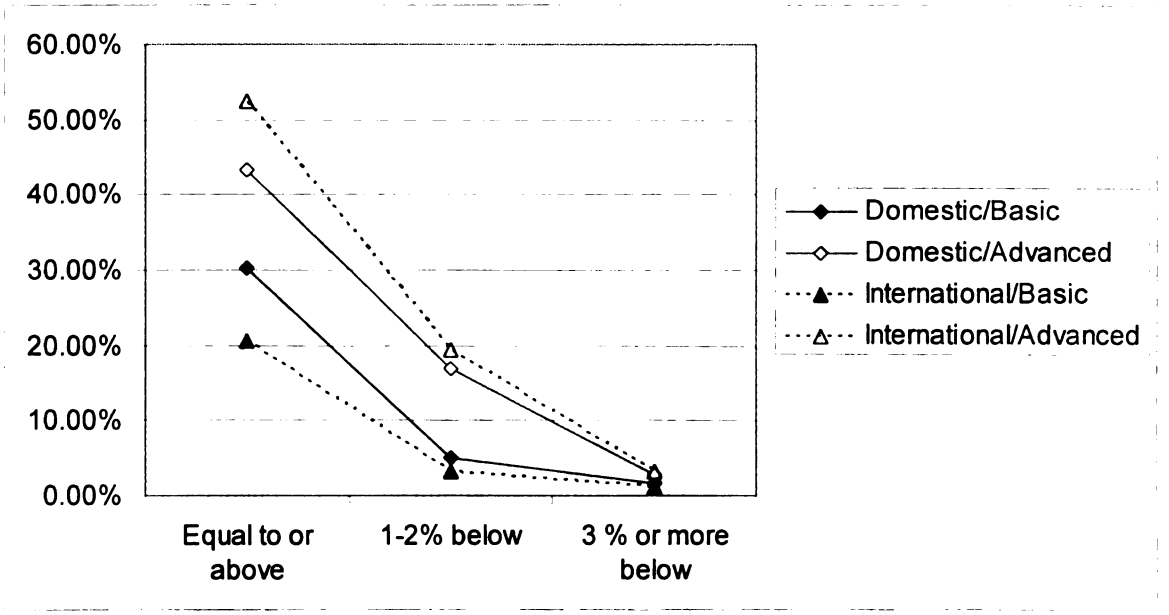
Utilities in Table 4.27 and 4.28 reveal that respondents significantly prefer one to two percent lower delivery reliability when they source goods internationally versus when they source domestically. Respondents derive more utility from the other two levels when they source domestically. These results are depicted graphically in Figure 4.17.

FIGURE 4.17 DELIVERY RELIABILITY BY SOURCING LOCATION INTERACTION: UTILITIES



Market simulation results graphically depicted in Figure 4.18 reveal that when delivery reliability is equal to or above industry average, both international and domestic suppliers with advanced security will garner more market preference than suppliers with basic security. This relationship holds for all three levels of delivery reliability. However, the market preference percentage gap between advanced security and basic security for international suppliers is larger than the gap between advanced security and basic security for domestic suppliers. This indicates that security is more important to respondents when they source internationally. Note again that two separate market simulations were run – one for domestic and one for international – in order to focus on the effects of security on supplier preference. Unfortunately, this prevents one from stating that an international supplier with advanced security will garner more market share than a domestic supplier with advanced security as Figure 4.18 seems to imply. Given respondents' strong preference for domestic suppliers (see utilities in Table 4.5) this is not likely to be realistic.

FIGURE 4.18 SECURITY BY DELIVERY RELIABILITY BY SOURCING LOCATION INTERACTION: MARKET PREFERENCE



Market simulation results also reveal that respondents are more likely to choose an international supplier with basic security and higher delivery reliability over an international supplier with advanced security and lower delivery reliability. These results are depicted in Table 4.30. However, comparing the market preference percentages for domestic and international suppliers with similar attributes reveals that respondents place more importance on security when they source internationally. These results are depicted in Table 4.31.

TABLE 4.30 SECURITY BY DELIVERY RELIABILITY INTERACTION FOR INTERNATIONAL SOURCING: MARKET PREFERENCE COMPARISON I

International Sourcing						
Security Level	**Delivery Reliability Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Delivery Reliability Level**	**Security Level**
Basic	Equal to or Above	20.52%	>	19.55%	1-2% Below	Advanced
		Implication				
Respondents who source goods internationally chose a supplier with basic/equal to or above delivery reliability more frequently than one with advanced/1-2% below average delivery reliability.						
Security Level	**Delivery Reliability Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Delivery Reliability Level**	**Security Level**
Basic	Equal to or Above	20.52%	>	3.19%	3% or more Below	Advanced
		Implication				
Respondents who source goods internationally chose a supplier with basic/equal to or above delivery reliability more frequently than one with advanced/3% or more below average delivery reliability.						
Security Level	**Delivery Reliability Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Delivery Reliability Level**	**Security Level**
Basic	1-2% Below	3.29%	>	3.19%	3% or more Below	Advanced
		Implication				
Respondents who source goods internationally chose a supplier with basic/1-2% below average delivery reliability more frequently than one with advanced/3% or more below average delivery reliability.						

TABLE 4.31 SECURITY BY DELIVERY RELIABILITY BY SOURCING LOCATION INTERACTION: MARKET PREFERENCE COMPARISON II

Domestic Sourcing				International Sourcing		
Security Level	**Delivery Reliability Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Delivery Reliability Level**	**Security Level**
Advanced	Equal to or Above	43.36%	<	52.33%	Equal to or Above	Advanced
		Implication				
Respondents who source internationally chose a supplier with advanced security/equal to or above average delivery reliability more frequently than respondents who source domestically.						
Security Level	**Delivery Reliability Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Delivery Reliability Level**	**Security Level**
Advanced	1-2% Below	16.90%	<	19.55%	1-2% Below	Advanced
		Implication				
Respondents who source internationally chose a supplier with advanced security/1-2% below average delivery reliability more frequently than respondents who source domestically.						
Security Level	**Delivery Reliability Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Delivery Reliability Level**	**Security Level**
Advanced	3% or more Below	2.70%	<	3.19%	3% or more Below	Advanced
		Implication				
Respondents who source internationally chose a supplier with advanced security/3% or more below average delivery reliability more frequently than respondents who source domestically.						

Results in Table 4.30 indicate that firms who source internationally are more likely to choose a supplier with basic security and higher delivery reliability over one with advanced security and lower delivery reliability. However, Table 4.31 indicates that security is more important to firms when they source internationally than it is when they source domestically. If a firm purchases product internationally, they are more likely to utilize a supplier with advanced security than if they source domestically. This indicates that international sourcing has a positive effect on firm's preference for suppliers with greater security.

In sum, H_{11} states that firms who source internationally are willing to accept lower delivery reliability from their suppliers in return for higher security (note: respondents may have no choice but to accept lower delivery reliability when they source internationally. The difference between expectations and actual preferences will be discussed in the limitations section of Chapter Five). Utilities support H_{11} and indicate that respondents are willing to accept one to two percent lower delivery reliability from their international suppliers. Market simulation results partially support H_{11}. On one hand, when sourcing internationally, respondents are more likely to choose a supplier with higher delivery reliability and lower security (see Table 4.30). On the other hand, assuming delivery reliability levels are the same, respondents are more likely to choose a supplier with advanced security when they source internationally than they are when sourcing domestically (see Table 4.31).

H_{11} is partially supported. Utilities indicate preference for one to two percent lower delivery reliability when sourcing internationally. Market simulation indicates that respondents are more likely to choose a supplier with basic security and higher delivery reliability when they source internationally. They are also more likely to choose a supplier with advanced security when they source internationally versus one with advanced security when they source domestically (assuming delivery reliability levels for domestic and international suppliers are equal).

H_{12} examines the influence of international sourcing on respondents' preference for suppliers with higher prices and higher security.

H12: International sourcing by the purchasing firm positively affects preference for suppliers with higher prices and higher security.

H_{12} proposes that firms who source internationally prefer suppliers with higher prices and higher security. H_{12} requires the examination of a two-way interaction between price and supplier location and a three-way interaction between security, price, and supplier location. H_{12} is evaluated in the same way as H_{11}. Utility and market simulation results are presented in Tables 4.32 and 4.34 respectively.

TABLE 4.32 HYPOTHESIS 12 RESULTS: PRICE BY SOURCING LOCATION INTERACTION

	Domestic Sourcing	International Sourcing
Price Level	Utilities	Utilities
Equal to or below	0.029	(0.029)
1-2% higher	(0.031)	0.031
3% or more higher	0.003	(0.003)

TABLE 4.33 HYPOTHESIS 12 RESULTS: ASSESSMENT OF SIGNIFICANT DIFFERENCES BETWEEN UTILITY VALUES

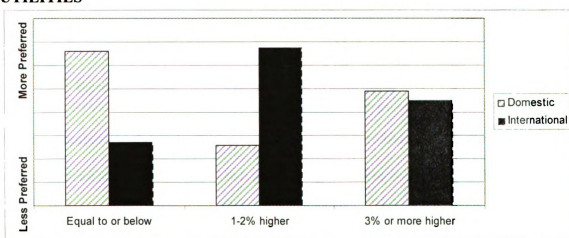
	Price Level	Equal to or below	Equal to or below	1-2% above	1-2% above	3% or more above	3% or more above
Price Level	Sourcing Location	Domestic	International	Domestic	International	Domestic	International
Equal to or below	Domestic						
Equal to or below	International	0.77					
1-2% above	Domestic	0.78	0.04				
1-2% above	International	0.04	0.78	0.80			
3% or more above	Domestic	0.31	0.38	0.40	0.33		
3% or more above	International	0.38	0.31	0.33	0.40	0.06	

TABLE 4.34 HYPOTHESIS 12 RESULTS: SECURITY BY PRICE BY SOURCING LOCATION INTERACTION

		Domestic Sourcing	International Sourcing
		Market Preference	Market Preference
Security Level	Price Level	%	%
Basic	Equal to or below	27.06	18.33
Basic	1-2% higher	6.82	4.39
Basic	3% or more higher	2.03	1.33
Advanced	Equal to or below	37.11	44.74
Advanced	1-2% higher	22.50	25.94
Advanced	3% or more higher	4.48	5.28

Utilities indicate that respondents derive more utility from one to two percent higher prices when they source goods internationally but the difference is not significant. Respondents derive more utility from the other two levels when they source goods domestically but, again, the difference is not significant. These results are presented graphically in Figure 4.19.

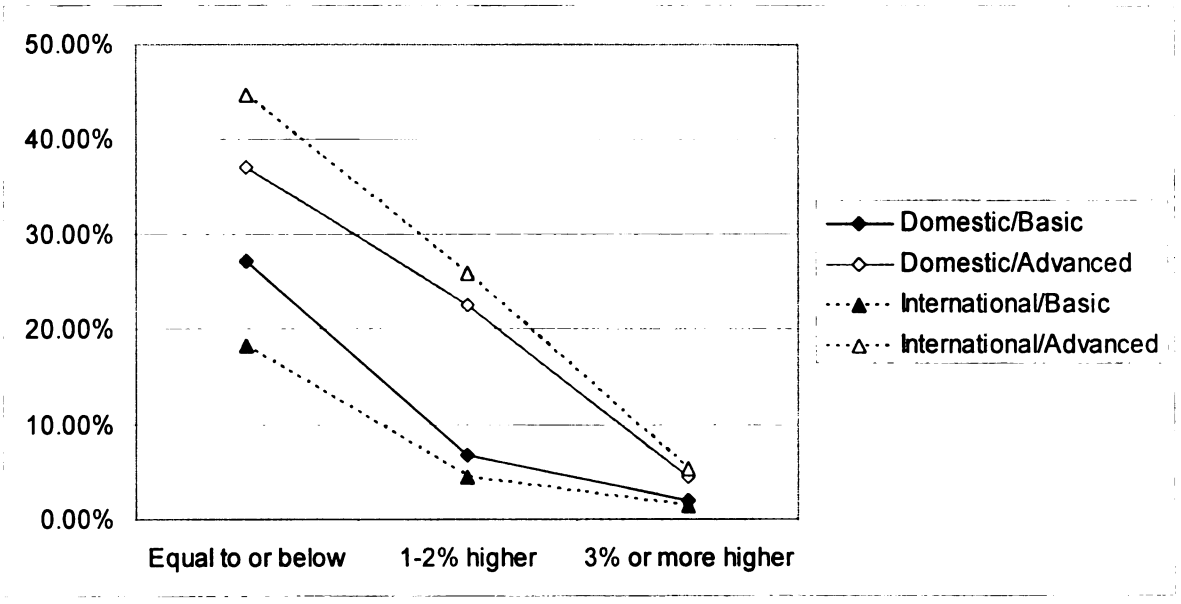
FIGURE 4.19 PRICE BY SOURCING LOCATION INTERACTION: UTILITIES



Market simulation results presented in Figure 4.20 reveal that at prices equal to or below industry average, respondents are more likely to choose advanced security for both

domestic and international suppliers. This relationship holds for all three levels of price. However, the gap between market preferences for international suppliers with advanced security and international suppliers with basic security is larger than the gap between market preferences for domestic suppliers with advanced security and domestic suppliers with basic security. Again, this underscores the importance respondents place on security when they source internationally.

FIGURE 4.20 SECURITY BY PRICE BY SOURCING LOCATION INTERACTION: MARKET PREFERENCE



Market simulations also indicate that respondents are more likely to choose a supplier with advanced security and one to two percent higher prices over one with basic security and equal to or below prices when they source internationally. Further, respondents are more likely to choose a supplier with advanced security and three percent or more higher prices than one with basic security and one to two percent higher prices when they source internationally. These results are presented in Table 4.35.

Comparing market preferences for similar domestic and international suppliers reveals that respondents are more likely to choose advanced security when they source internationally as opposed to when they source domestically. These results are presented in Table 4.36.

TABLE 4.35 SECURITY BY PRICE BY SOURCING LOCATION INTERACTION: MARKET PREFERENCE COMPARISON I

International Sourcing						
Security Level	**Price Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Price Level**	**Security Level**
Basic	Equal to or Below	18.33%	<	25.94%	1-2% Higher	Advanced
		Implication				
Respondents who source goods internationally chose a supplier with advanced/1-2% higher prices more frequently than a supplier with basic/equal to or below.						
Security Level	**Price Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Price Level**	**Security Level**
Basic	Equal to or Below	18.33%	>	5.28%	3% or more Higher	Advanced
		Implication				
Respondents who source goods internationally chose a supplier with basic/equal to or below average prices more frequently than one with advanced/3% or more higher prices.						
Security Level	**Price Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Price Level**	**Security Level**
Basic	1-2% Higher	4.39%	<	5.28%	3% or more Higher	Advanced
		Implication				
Respondents who source goods internationally chose a supplier with advanced/3% higher prices more frequently than a supplier with basic/1-2% higher prices.						

TABLE 4.36 SECURITY BY PRICE BY SOURCING LOCATION INTERACTION: MARKET PREFERENCE COMPARISON II

Domestic Sourcing				International Sourcing		
Security Level	**Price Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Price Level**	**Security Level**
Advanced	Equal to or Below	37.11%	<	44.74%	Equal to or Below	Advanced
		Implication				
Respondents who source internationally are more likely to choose a supplier with advanced security/equal to or below average prices than respondents who source domestically.						
Security Level	**Price Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Price Level**	**Security Level**
Advanced	1-2% Higher	22.50%	<	25.94%	1-2% Higher	Advanced
		Implication				
Respondents who source internationally are more likely to choose a supplier with advanced security/1-2% higher prices than respondents who source domestically.						
Security Level	**Price Level**	**Market Preference**	**Directional Relationship**	**Market Preference**	**Price Level**	**Security Level**
Advanced	3% or more Higher	4.48%	<	5.28%	3% or more Higher	Advanced
		Implication				
Respondents who source internationally are more likely to choose a supplier with advanced security/3% or more higher prices than respondents who source domestically.						

Results in Table 4.35 indicate that when firms choose between international suppliers, they are more likely to choose a supplier with advanced security and one to two percent higher prices over a supplier with basic security and equal to or below prices. Further, Table 4.35 reveals that when firms choose between international suppliers, they are more likely to choose a supplier with advanced security and three percent or more higher prices over one with basic security and one to two percent higher prices.

Table 4.36 compares similar domestic and international suppliers. Results indicate that security is more important to firms when sourcing internationally than it is when they source domestically. For example, an international supplier with advanced security and equal to or below prices is predicted to garner more market share than a

domestic supplier with advanced security and equal to or below prices. This indicates that international sourcing has a positive effect on firm's preference for suppliers with greater security.

In sum, H_{12} states that firms who source internationally are willing to accept higher prices from their suppliers in return for higher security. Utilities do not support H_{12} and indicate that respondents do not derive significantly more utility from international suppliers with higher prices. Market simulations support H_{12} and indicate that when respondents source internationally, they are more likely to 1) choose suppliers with advanced security and one to two percent higher prices over suppliers with basic security and equal to or below average prices, and 2) choose suppliers with advanced and three percent or more higher prices over suppliers with basic security and one to two percent higher prices. Market simulation results also indicate that respondents are always more likely to choose a supplier with advanced security when they source internationally as compared to when they source domestically.

H_{12} is partially supported. Respondents do not derive more utility from suppliers with higher prices when they source internationally. Market simulations indicate respondents are more likely to choose a supplier with advanced security and higher prices over one with basic security and lower prices when they source internationally. Market simulations also indicate respondents are more likely to choose a supplier with advanced security when they source internationally than they are when they source domestically. This concludes the hypothesis evaluation section. The next section of the chapter summarizes the information presented heretofore.

SUMMARY

Chapter Four presented the research results. The Chapter began by detailing the mailing procedures, sample size, and sample characteristics. A review of the sample characteristics found that the respondents were from the targeted population and that no difference exists between the utility patterns of early and late respondents.

The Chapter reviews the hypotheses tests through CBC and presents each research question and corresponding hypotheses in order. Conclusions were drawn from the results to provide support, or lack thereof, for each hypothesis. Table 4.37 summarizes the hypotheses and results presented in the chapter.

Examining the results of H_1 through H_4, respondents prefer "better" levels of each factor over "worse" levels. These results are intuitive, but necessary to set the stage for H_5 through H_{12}.

H_5 and H_6 examine respondent preferences for security as it relates to price and delivery reliability. Generally, respondents preferred suppliers with basic security, lower prices, and higher delivery reliability over suppliers with advanced security, higher prices, and lower delivery reliability. Interestingly, utility figures show that at certain levels of price and delivery reliability respondents preferred higher levels of security indicating that respondents may be willing to trade off these supplier attributes for greater security.

TABLE 4.37 SUMMARY OF RESULTS

Hypotheses	Supported/Not Supported	Rationale (+ = supported; - = not supported; +/- = mixed results)
H_1: Higher product quality is preferred over lower product quality.	Supported	Utilities: +
H_2: Lower product price is preferred over higher product price.	Supported	Utilities: +
H_3: Higher delivery reliability is preferred over lower delivery reliability.	Supported	Utilities: +
H_4: Higher supplier security competence is preferred over lower supplier security competence.	Supported	Utilities: +
H_5: Product price has a greater influence on supplier preference than supplier security competence.	Partially Supported	Factor Importance: + Utilities: - Market Simulation: +
H_6: Delivery reliability has a greater influence on supplier preference than supplier security competence.	Partially Supported	Factor Importance: + Utilities: - Market Simulation: +
H_7: An increase in concern over security incidents experienced by the purchasing firm positively affects preference for suppliers with higher security competence and higher security.	Partially Supported	Factor Importance: + Utilities: - Market Simulation: +
H_8: An increase in concern over security incidents experienced by the purchasing firm positively affects preference for suppliers with lower delivery reliability and higher security.	Not Supported	Factor Importance: - Utilities: -/+ Market Simulation: -
H_9: An increase in concern over security incidents experienced by the purchasing firm positively affects preference for suppliers with higher prices.	Partially Supported	Factor Importance: + Utilities: - Market Simulation: +
H_{10}: International sourcing by the purchasing firm positively affects preference for suppliers with higher security competence.	Supported	Utilities: + Market Simulation: +
H_{11}: International sourcing by the purchasing firm positively affects preference for suppliers with lower delivery reliability and higher security.	Partially Supported	Utilities: + Market Simulation: -/+
H_{12}: International sourcing by the purchasing firm positively affects preference for suppliers with higher prices and higher security.	Partially Supported	Utilities: - Market Simulation: +

H_7 through H_9 examined the role of respondents' concern over security incidents that have occurred at their firm as it relates to preference for suppliers with higher security competence, higher prices, and lower delivery reliability. Findings indicate that concerned respondents 1) prefer suppliers with advanced security, 2) place less importance on price and are more likely to pay a higher price for advanced security, and 3) place more importance on delivery reliability and are not likely to choose a supplier with low delivery reliability and advanced security.

H_{10} through H_{12} examined the role of international sourcing as it relates to preference for suppliers with advanced security, lower delivery reliability, and higher prices. Findings indicate that international sourcing positively affects preference for suppliers with advanced security and higher prices, but the results for suppliers with lower delivery reliability were not as conclusive.

The data partially or fully support all hypotheses with the exception of H_8. Results indicate that food purchasing managers are not willing to trade-off price and delivery reliability for their suppliers to operate in a secure manner unless they source internationally or are concerned about security incidents at their firm. When sourcing internationally, respondents place more value on supplier security. Respondents who are concerned about security incidents that have occurred at their firm also place more value on supplier security. Results indicate that international sourcing and respondent concern increase the value respondents place on security to the extent that they are willing to pay one to two percent higher prices in return for increased supplier security. However, international sourcing and respondent concern do not increase the value respondents place on security to the extent that they are willing to trade-off delivery reliability for

security. Chapter Five discusses the theoretical and managerial implications of these findings as well as the contributions of this study and directions for future research.

CHAPTER 5: IMPLICATIONS AND FUTURE RESEARCH

INTRODUCTION

Chapter Five presents the implications and limitations of this research as well as directions for future research. First, managerial and public policy implications are discussed. Second, theoretical implications are presented. Next, recommendations are outlined. This research concludes with limitations and directions for future investigations.

IMPLICATIONS

The premise of this research is that suppliers seeking to improve their security capabilities are likely to incur increased cost that will be passed down to their customers if there is a demand for security and suffer a decrease in their ability to deliver products to customers in a reliable manner. Chapter Four detailed the results of this research wherein purchasing managers employed in the food industry were surveyed to assess their willingness to accept price increases, and delivery reliability decreases, from their suppliers in return for security. Chapter Four also detailed the role of concern over security incidents and international sourcing as they affect respondents' willingness to sacrifice price and delivery reliability for supplier security.

Results indicate that food purchasing managers are not willing to trade-off price and delivery reliability for their suppliers to operate in a secure manner unless they source internationally or are concerned about security incidents at their firm. When sourcing internationally, respondents place more value on supplier security. Respondents

who are concerned about previous security incidents that have occurred at their firm also place more value on supplier security. Results indicate that international sourcing and respondent concern increase the value respondents place on security to the extent that they are willing to pay one to two percent higher prices in return for increased supplier security. However, international sourcing and respondent concern do not increase the value respondents place on security to the extent that they are willing to trade-off delivery reliability for security.

Two levels of supplier security competence were evaluated by respondents: basic and advanced. Suppliers with a basic security competence were conceptualized to *only utilize limited measures* to protect their product, processes, and facilities from internal (e.g. disgruntled employee) and external (e.g. terrorist) food contamination threats. A supplier with a basic security competence typically does not employ any, or at least very few, of the following security measures: 1) lock their doors, 2) employ guards, 3) have fences around their facilities, 4) perform background checks on employees, 5) secure inventory, and 6) inspects product for possible contamination before it is shipped. Suppliers with an advanced security competence were conceptualized to *make every effort* to protect their product, processes, and facilities from internal (e.g. disgruntled employee) and external (e.g. terrorist) food contamination threats. A supplier with an advanced security competence typically does employ most, or the majority, of the following actions: 1) lock their doors, 2) has fences and gates protecting their facilities, 3) employ guards protecting entrances, 4) perform thorough background checks on all employees and contractors, 5) constantly tracks inventory in a secure environment to make sure it is not contaminated, and 6) thoroughly inspects product for possible

contamination before it is shipped. In sum, in this research supplier security competence is conceptualized to encompass the extent to which suppliers: 1) lock doors, 2) use fences and gates to protect facilities, 3) employ guards to protect facility entrances, 4) perform background checks on all employees and contractors, 5) track inventory, and 6) inspect product for possible contamination before shipment occurs.

In order to increase the managerial relevance of these results, it is necessary to engage in a final round of qualitative research wherein results were presented to industry representatives. During these interviews, industry representatives were asked to interpret results presented in Chapter Four. The information gathered during these interviews is used to *supplement* the researcher's views in the following discussion. Where information from these interviews is included, the source (i.e. practitioner interviews) is cited. If "practitioner interviews" are not cited in the following discussion, the views expressed are solely those of the researcher.

MANAGERIAL IMPLICATIONS

With regard to price, findings indicate that 1) price plays a greater role in determining supplier preference than security and 2) respondents are not willing to pay a higher price for advanced security unless moderating conditions apply. Interestingly, findings also indicate that security may lead to a competitive advantage in terms of market share if suppliers match the price of their competitors who operate at a lower security level. However, if a supplier is located internationally, or if a supplier's customers are concerned about security incidents that have occurred at their firm, results

indicate that customers are willing to pay one to two percent above industry average to utilize a supplier with advanced security.

These findings uncover several managerial implications. First, an international supplier appears to be more able to derive a competitive advantage from security than a domestic supplier. Firms who source goods internationally face a certain agency dilemma wherein they are less able to monitor suppliers and ensure product is produced in a secure manner. Results indicate that international suppliers employing advanced security measures can capitalize on this information asymmetry and charge one to two percent higher prices for their goods.

Second, suppliers who have invested in security should segment their customer base by those who are concerned about security incidents that have occurred at their firm and those who are not. Previous research has shown that suppliers are not currently passing on the cost of security to their customers. Results indicate that suppliers can charge customers that are concerned about security incidents one to two percent higher prices and gain a competitive advantage over suppliers that do not employ advanced security measures. However, in order for these suppliers to have the ability to charge a higher price for their security capabilities they must educate their customers on the importance of security and the measures taken to secure their operations. When customers are accepting bids from suppliers, these suppliers should highlight the importance of security in their bid package and further highlight their efforts to ensure physical security (e.g. use of locked doors, fences, gates, and guards to protect facility entrances), perform background checks on all personnel who have access to facilities,

track inventory to ensure it does not deviate from a pre-specified route, and thoroughly inspect product for possible contamination before shipment occurs.

With regard to delivery reliability, results indicate there is a positive relationship between delivery reliability and security. In no case were respondents willing to sacrifice delivery reliability for supplier security. International sourcing decreases the amount of delivery reliability respondents were willing to accept for advanced security, but concerned respondents were actually less willing to sacrifice delivery reliability than unconcerned respondents. This indicates that domestic and international suppliers must find ways to hold their delivery reliability constant while simultaneously increasing security if they hope to gain a competitive advantage. This can be accomplished by holding excess inventory, but with excess inventory comes increased cost and risk of obsolescence, especially in the food industry where product often has a short shelf life. These results may also indicate a causal factor on the part of respondents (e.g. use of JIT).

It is recommended that suppliers employ tracking technologies, such as Radio Frequency Identification (RFID) and Global Positioning Systems (GPS), to substitute information for inventory. While this is likely to increase short-term costs, it is also likely to synergistically improve delivery reliability and security. Firms that employ tracking technologies will have greater knowledge of inventory availability. This knowledge allows firms to more accurately match supply and demand without holding excess inventory. Further, tracking technologies allow firms to uncover if product has deviated from a preset route during manufacturing or transport. This deviation may indicate a security incident has occurred.

Practitioner interviews indicate that delivery reliability may have a halo effect with respect to security. Purchasing managers feel that suppliers who focus on delivery reliability are likely to employ advanced security measures (i.e. if a supplier does one thing well, they probably do all things well). This may explain the positive relationship between these two factors. Interviews further indicated that price does not have a halo effect with respect to security. High prices do not cue purchasing managers to believe that suppliers employ advanced security and low prices certainly do not indicate advanced supplier security. This implies that suppliers may be able to "sell" security to their customers by providing high levels of delivery reliability and simultaneously avoid the liability of promising customers that their operations are secure.

Findings with respect to price, delivery reliability, and concern over security incidents merit further investigation from a customer segmentation standpoint. It appears that concerned respondents are not only less price sensitive, but they value other supplier attributes (e.g. quality, security, and delivery reliability) more than their unconcerned counterparts. Previous research has shown that security is currently viewed as more of a strategic concern (Voss et al., 2006) in as much as security is primarily perceived to be a method of brand protection. Practitioner interviews revealed that there are two general classes of customers in the food industry: those that are "deal prone" (i.e. focus on price) and those that are "service mavens" (i.e. focus on service/more strategic issues). Customers who are deal prone are likely to place less value on security as it impedes their efforts to purchase product at the lowest cost. Customers who are service mavens appear to be more likely to sacrifice price for outcomes such as security, quality, and delivery

reliability. Given the results presented in Chapter Four, it appears that concerned respondents are part of the service maven category.

As evidence, factor importance scores indicate that security and delivery reliability contribute more to supplier preference for concerned respondents than unconcerned respondents. Interestingly, quality is more important to unconcerned respondents, but concerned respondents preferred the highest level of product quality while unconcerned respondents actually preferred the lowest level of product quality. Managers are advised to segment their customers according to their emphasis on price or service with the knowledge that those customers who place more value on service are more likely to also place more value on security.

This can be somewhat challenging. Suppliers who primarily handle commodity goods are likely to sell product to customers who focus more on price. These suppliers are likely to derive little, if any, competitive advantage from increasing security. Suppliers who add significant value to a product, or sell "name brand" goods, are more likely to sell these products to customers who are more service oriented. In order to protect their brand, these service oriented customers are more likely to be willing to sacrifice price for security. However, if commodity suppliers sell goods to customers who are conscious of the effect of product quality on manufacturing performance, these suppliers may be able to charge a higher price for their goods if they can use security processes to deliver a higher quality product. Suppliers of all product types are cautioned that neither price nor service oriented customers are likely to be willing to sacrifice delivery reliability.

Focusing on this interaction between product characteristics (commodity v. value added) and customer focus, Figure 5.1 illustrates recommendations of when security should be implemented, should not be implemented, and when customers should be educated on the importance of security. Figure 5.1 is presented below:

FIGURE 5.1 SECURITY IMPLEMENTATION MATRIX

Customer Focus

Product Characteristics	Price	Service
Commodity	**Do not Implement** **UNLESS** Do not implement security unless risk is a concern	**Educate Customer** Implement if customer perceives that the product is crucial to their process or if risk is a concern
Branded	**Educate Customer** Implement if customer perceives brand equity to be important or if risk is a concern	**Implement** A customer that is focused on service and purchases a value added product is likely to value supplier security

Figure 5.1 contains four quadrants delineated by various combinations of customer focus and product characteristics. When products are characterized as commodity goods, and a supplier's customer focuses on price, the supplier will gain little competitive advantage (perhaps will even be placed at a competitive disadvantage) from security implementation. However, this does not mean that a supplier should not implement security. If the supplier wishes to mitigate the demand and supply risk posed by terrorists, and this risk is perceived to be significant, the supplier should implement

security in order to avoid the potential costs of an incident. When a supplier sells branded (i.e. brand name) products to service oriented customers, they should implement security in order to protect this brand name and also are likely to have the ability to derive a competitive advantage from security because their customers are more likely to pay a higher price to a secure supplier.

If a supplier sells a commodity product to a service oriented customer, or a branded product to a price oriented customer, then it would behoove the supplier to educate their customers on value of security and implement security under certain circumstances. First, for both quadrants, suppliers should implement security if they have a strong desire to mitigate risk. Commodity suppliers selling product to service oriented customers should educate their customers on the value of security and emphasize that/assess if their commodity good is crucial to the customer's process. Provided that the good is crucial to the customer's process, and the customer recognizes this situation, the supplier may have the ability to charge a higher price for their commodity. In other words, security may serve as a way to differentiate one supplier's commodity good from another supplier's. Suppliers selling branded products to price oriented customers should implement security in order to protect their own brand, but should also educate their customers on the value of security and attempt to convince them that security will help protect their own assets. In this situation, the supplier has more incentive to implement security, as a way to protect brand equity, regardless of whether a competitive advantage can be garnered from security implementation.

PUBLIC POLICY IMPLICATIONS

The results of this research also have public policy implications. Results indicate that international suppliers are able to charge prices one to two percent above industry average if advanced security capabilities are employed, but results also indicate that respondents strongly prefer domestic suppliers (see Table 4.5) and were not willing to pay higher prices for their domestic suppliers to operate in a secure manner. Results indicate that concerned respondents were willing to pay one to two percent higher prices for their suppliers to operate in a secure manner, but roughly one-half of the sample is composed of unconcerned respondents. Respondents were not willing to sacrifice delivery reliability for security regardless of any mitigating circumstances.

Therefore, *domestic* suppliers will only be able to charge a higher price for security if their customers are concerned about security incidents that have occurred at their firm. However, even concerned respondents will not accept lower delivery reliability for higher security. If service levels suffer as a result of security implementation, concerned respondents are likely to drop a supplier with higher security in favor of one with higher delivery reliability. Further, it has not been established if a one to two percent price increase will cover the cost of security. If a one to two percent price increase does not cover the cost of security, suppliers could only be incented to increase security if they are able to gain enough market share (i.e. volume) by increasing security to overcome its cost in the long-term. In the absence of this market share increase, suppliers who increase security are placed at a competitive disadvantage in terms of cost.

Given this information, and the current state of industry security implementation (i.e. most firms have only implemented physical security measures that would have little positive effect on delivery reliability) it appears that in order to achieve a critical mass of supply chain security in the domestic food industry, the U.S. Government is going to have to regulate its implementation. For widespread, voluntary security implementation to occur without regulation: 1) a one to two percent price increase would have to cover security expenses, 2) suppliers will have to find a way to hold delivery reliability constant while simultaneously increasing security, 3) the number of firms concerned about security incidents that have occurred at their firm will likely have to increase, and/or 4) a major security event will have to occur in the food industry, which would increase the number of firms concerned about security. In as much as 1) it is unknown whether a one to two percent price increase will cover security expenses, 2) security has been shown to negatively affect delivery reliability, 3) only one half of the sample was concerned about security, and 4) a major security incident has not occurred in the food industry, in the short-term it is likely that regulation will be necessary to ensure the food industry implements security measures.

THEORETICAL IMPLICATIONS

This research represents one of the few empirical works to examine supply chain security. Further, the results of this research are the first to examine the value managers place on security. Perhaps the primary theoretical contribution of this work is that it lays the foundation for future research. Future research opportunities are discussed in the next section.

This work delineated the importance of security in relation to other supplier selection criteria. Examination of factor importance scores presented in Table 4.5 reveals that security plays less of a role in determining supplier preference than product quality, delivery reliability, and price. However, results also indicate that security is more important to firms under certain circumstances (e.g. international sourcing and concern over security incidents). While the study of supply chain security is still in its infancy, it is likely to grow more important in the future given the likelihood that security will have to be regulated. Future supplier selection criteria research should include security as a control variable, if not a primary factor of investigation.

This work uncovered that service oriented firms are likely to place more value on security and to consider it part of their suppliers' service offering. Future investigations into the value of suppliers' product quality and delivery reliability should control for supplier security competence.

RECOMMENDATIONS

The results of this research have important change management implications. Perhaps one of the overriding questions facing food industry executives is whether or not they should implement security measures. Managers faced with this dilemma should first research security best practices in order to uncover the steps needed to secure operations. Second, managers should determine the extent to which they wish to implement these best practices, assess the cost of doing so, and the effect these security measures will have on delivery reliability, quality, and price. Third, managers should either formally or informally "survey" their customers. These surveys should question customers' quality,

delivery reliability, and price preferences as well as the value they place on security and the extent to which they are concerned about security incidents that have occurred at their firm. International suppliers should specifically survey customers on the extent to which they are willing to sacrifice price and delivery reliability for security or simply *expect* to pay a higher price and receive lower delivery reliability when they source internationally. Given that respondents strongly prefer domestic suppliers to international suppliers (see Table 4.5), it is possible they simply *expect* to pay a higher price if they source their goods internationally. For example, if a commodity is available domestically and internationally, respondents would source this product domestically all else being equal. However, if the commodity were not available domestically, respondents would have no choice but to source internationally. This situation is quite common in the food industry given the year round demand for products with seasonal availability of inputs. International suppliers of seasonal products are likely aware their customers have few supplier choices, enabling them to charge a higher price.

Armed with this knowledge, suppliers will have a better grasp of customer preferences. Customers who are service oriented (i.e. they place a high priority on security, quality, and delivery reliability over price), or are concerned about security incidents at their firm, are more likely to accept higher prices if they have been educated as to suppliers' advanced security capabilities. Suppliers should then assess whether this price increase allows them to recoup the long-term costs of security. If the price increase covers security expense, and the supplier can use tracking technology (or other means) to hold delivery reliability constant, then it is recommended that this supplier undertake a security initiative.

If price increases do not cover security expenses, or survey results reveal that customers are price oriented (i.e. value low price above other supplier attributes), then suppliers must weigh the benefits of security as a long term-cost avoidance mechanism versus the short-term cost of security implementation. The cost of security measures in the short-term may pale in comparison to the long-term costs of litigation, loss of customer goodwill, sales, brand equity, and subsequent sale of equity investments that are likely to occur as a result of a major security/contamination incident. However, the supplier must also recognize that the likelihood of a major security incident is quite low. It is recommended that suppliers whose security expenses are not covered by price increases, or who service price oriented customers, secure their operations to the extent that they are not placed at a severe competitive disadvantage.

Another, perhaps more likely, scenario is that some customers will value security to the extent they are willing to pay more for it and others will not. In this case, suppliers might consider the possibility of implementing security at select facilities, and servicing customers who value security out of these facilities, while leaving other facilities relatively unsecured. In this case, facilities with high levels of security should strive to be "world class" in every respect. These world class facilities should offer the highest levels of product quality, delivery reliability, and security and educate customers that product from this facility comes at a price premium and why this premium is necessary. Other facilities should focus solely on efficiency - producing product at the lowest total cost. This would allow the firm to offer "menu pricing" to customers. Under a menu pricing strategy, customers have the option of receiving product from the world class facility that delivers high quality product, on time (perhaps utilizing the previously

mentioned tracking technologies to control delivery reliability), and in a secure manner. Conversely, customers have the option of purchasing low cost product from the unsecured facility. This strategy may also serve as a stop-gap measure for suppliers who wish to test the security waters without fully committing to the expense of company wide implementation.

However, this stop-gap measure is likely to be just that. Suppliers who secure only certain facilities are more vulnerable at unsecured locations. While a security incident may be avoided at a secure location, a security incident at an unsecured location will have a negative halo effect on the firm as a whole. This is likely to raise doubts in customers who were serviced from the world class facility and cause them to source elsewhere, thus negating any positive benefits that may have been gained from the menu pricing strategy. This strategy is only recommended in situations where a firm cannot afford to simultaneously implement security measures at all facilities.

It should also be noted that suppliers increase their liability when they secure their operations, educate their customers regarding security capabilities, and promise that secure product will be delivered. If a security incident occurs, despite best efforts, this security breach is likely to bring about greater liability because the supplier failed to live up to its promises. If this is a significant concern, suppliers may wish to forego promises of security in lieu of simply delivering high levels of delivery reliability, which practitioner interviews revealed may have a halo effect on security.

To the extent that it does not compromise business viability, firms are encouraged to 1) implement security measures, 2) sacrifice reasonable amounts of price and delivery reliability from their suppliers in return for security, 3) encourage customers to

implement security, and 4) work with industry groups to form a critical mass of supply chain security while simultaneously collaborating with supply chain partners on ways to gain synergies from security measures such that price and delivery reliability are not adversely affected in the long-term. These actions will be difficult but, in their absence, the food industry is likely to be faced with heavy handed, one size fits all security regulation leading to long-term, negative consequences for the industry as a whole.

LIMITATIONS

The findings of this research contribute significantly to the current body of supply chain security knowledge, but certain limitations do exist. First, as is common with most research, results may not be generalizable to other industries. The food industry is likely to place more emphasis on security than other industries due to the vulnerability of the food supply chain to terrorist intrusion as well as the serious repercussions of distributing contaminated food to consumers. While only half of the respondents in this study indicated they were concerned about security incidents at their firm, it would be logical to assume that less than half of respondents from other industries would be concerned about security. Therefore, significant industry differences could exist.

Further, CBC results do not allow one to differentiate between expectations and actual preferences. Results indicate that respondents are willing to pay one to two percent higher price to international suppliers employing advanced security measures. However, these results may simply reflect respondent expectations. Respondents may legitimately place more value on security when they source internationally, but their

willingness to pay a higher price for security (as indicated in the managerial implications above) may simply be an artifact of their expectations. Therefore, security may simply be an order qualifier for international suppliers. While the results indicate that respondents are willing to pay more for security from these suppliers, this result may simply be an indication that they expect to pay more to their international suppliers.

Another limitation present in this work is the inability to reliably determine if significant differences exist between market preference percentages due to the small number of observations. Thus, the researcher is left to rely on "directional" differences (i.e. the market preference of one factor level is greater than the market preference of another). For this reason, significant differences between market preference percentages were not thoroughly discussed in this research but undoubtedly the results would be more robust if one were able to reliably determine if significant differences exist. Due to the use of multiple evaluation methods, this is not perceived to severely devalue the research results, but perhaps future research should consider use of "bootstrapping" to simulate a larger number of observations and test for significant differences.

Decisions made while designing this research also pose certain limitations. The definitions of basic and advanced security presented to respondents are rather simplistic in as much as they are firm centric. This research did not seek to expand security beyond that employed by the supplier. A true security program encompasses more than a single firm and a supplier who truly employs advanced security measures would do more than the firm centric measures provided to respondents. Further, there is a significant "security gap" between the conceptualization of basic security and the conceptualization of advanced security. While this was necessary to illustrate a difference between the two,

one could posit that basic security is so basic as to be unrealistic and advanced security may be so advanced as to be unrealistic.

FUTURE RESEARCH

These results present opportunities for future research. First, concluding interviews with managers revealed that security adoption may follow an S-curve similar to new product adoption wherein there are a small number of early adopters, a larger number of early followers, and a small number of firms who are resistant to change with respect to security adoption. It is likely that concerned respondents comprise the early adopter group and possibly part of the early follower group, while unconcerned respondents are likely to compose the bulk of the early follower group and the resistant to change group. Future research should establish if this relationship holds with respect to security adoption. Future research should also seek to uncover the characteristics of these groups. It is likely that larger firms, or firms who produce "name brand" goods, are more willing to sacrifice for security as they have more of a stake in brand protection. Smaller firms who have not invested in creating mass brand awareness, or firms who primarily trade in commodity goods, are likely to have less concern over security.

Second, future research should seek to determine the optimal service offering for each of these groups. The possibility exists that early adopters have different supplier preferences than the early follower and resistant to change groups. Future research should seek to uncover the optimal levels of quality, price, delivery reliability, and security preferred by each of these groups.

Third, future research should seek to validate the relationship of security to quality and delivery reliability. It appears respondents who are concerned about security incidents may be more service oriented, and demand for supplier security may be correlated with demand for other, more strategic, supplier offerings (e.g. quality and delivery reliability). Future research should seek to provide empirical evidence supporting this relationship between security and these more strategic factors.

Fourth, future research should seek to determine if a one to two percent price increase covers the cost of security increases. This research is likely to be very industry and product specific. For example, food is a relatively cheap commodity and a one to two percent increase in price may not cover the cost of security implementation. If a one to two percent price increase does not cover the cost of security, does the increase in market share derived from increasing security pay for security increases? However, researchers investigating the relationship of price to security should seek to go beyond price as defined by initial monetary outlay and explore the total cost of ownership of utilizing secure suppliers. It is possible that, while utilizing secure suppliers may cost more initially, this cost may be offset over time by synergies between security and other operational criteria. In other words, the cost of security may be offset by other factors with the possibility of recouping this cost over time.

Fifth, practitioner interviews indicated that firms may not actually be willing to pay a higher price for security when they source internationally. Respondents may simply *expect* to pay more for goods when they source internationally because these goods may not be available domestically. Future research should seek to determine if

willingness to pay more for internationally sourced goods is a function of increased security or simply a function of expectations.

Sixth, practitioner interviews revealed that the high amount of vertical integration in the food industry may play a role in the willingness of firms to sacrifice for supplier security. If a firm sources goods internally, even if the sourcing location is overseas, this firm may perceive that they have a lower risk of security incident because their suppliers are under their control, thus lowering the purchasing agent's uncertainty with respect to the supplier's level of security. Future research should explore the role of vertical integration as it determines demand for security.

Finally, future research may seek to extend the present research and determine if consumers, as opposed to firms, are willing to pay a higher price for security. A correlation may be drawn between the value of certified organic food products and certified secure food products. Manufacturers and retailers have found that some consumers value organically produced food to the extent that they are willing to pay a price premium for these goods. If retailers are able to certify that food product is secure, consumers may be willing to pay a price premium for that product.

APPENDICES

APPENDIX A

COMPLETE SCENARIO LIST

Scenario List

1…108	1…3	1…3	1…3	1…2	1…2
Scenario	Product Quality	Product Price	Delivery Reliability	Security Competency	Supplier Location
1	1	1	1	1	1
2	1	1	1	1	2
3	1	1	1	2	1
4	1	1	1	2	2
5	1	1	2	1	1
6	1	1	2	1	2
7	1	1	2	2	1
8	1	1	2	2	2
9	1	1	3	1	1
10	1	1	3	1	2
11	1	1	3	2	1
12	1	1	3	2	2
13	1	2	1	1	1
14	1	2	1	1	2
15	1	2	1	2	1
16	1	2	1	2	2
17	1	2	2	1	1
18	1	2	2	1	2
19	1	2	2	2	1
20	1	2	2	2	2
21	1	2	3	1	1
22	1	2	3	1	2
23	1	2	3	2	1
24	1	2	3	2	2
25	1	3	1	1	1
26	1	3	1	1	2
27	1	3	1	2	1
28	1	3	1	2	2
29	1	3	2	1	1
30	1	3	2	1	2
31	1	3	2	2	1
32	1	3	2	2	2
33	1	3	3	1	1
34	1	3	3	1	2
35	1	3	3	2	1

36	1	3	3	2	2
37	2	1	1	1	1
38	2	1	1	1	2
39	2	1	1	2	1
40	2	1	1	2	2
41	2	1	2	1	1
42	2	1	2	1	2
43	2	1	2	2	1
44	2	1	2	2	2
45	2	1	3	1	1
46	2	1	3	1	2
47	2	1	3	2	1
48	2	1	3	2	2
49	2	2	1	1	1
50	2	2	1	1	2
51	2	2	1	2	1
52	2	2	1	2	2
53	2	2	2	1	1
54	2	2	2	1	2
55	2	2	2	2	1
56	2	2	2	2	2
57	2	2	3	1	1
58	2	2	3	1	2
59	2	2	3	2	1
60	2	2	3	2	2
61	2	3	1	1	1
62	2	3	1	1	2
63	2	3	1	2	1
64	2	3	1	2	2
65	2	3	2	1	1
66	2	3	2	1	2
67	2	3	2	2	1
68	2	3	2	2	2
69	2	3	3	1	1
70	2	3	3	1	2
71	2	3	3	2	1
72	2	3	3	2	2
73	3	1	1	1	1
74	3	1	1	1	2
75	3	1	1	2	1
76	3	1	1	2	2
77	3	1	2	1	1
78	3	1	2	1	2
79	3	1	2	2	1
80	3	1	2	2	2
81	3	1	3	1	1
82	3	1	3	1	2
83	3	1	3	2	1
84	3	1	3	2	2
85	3	2	1	1	1

86	3	2	1	1	2
87	3	2	1	2	1
88	3	2	1	2	2
89	3	2	2	1	1
90	3	2	2	1	2
91	3	2	2	2	1
92	3	2	2	2	2
93	3	2	3	1	1
94	3	2	3	1	2
95	3	2	3	2	1
96	3	2	3	2	2
97	3	3	1	1	1
98	3	3	1	1	2
99	3	3	1	2	1
100	3	3	1	2	2
101	3	3	2	1	1
102	3	3	2	1	2
103	3	3	2	2	1
104	3	3	2	2	2
105	3	3	3	1	1
106	3	3	3	1	2
107	3	3	3	2	1
108	3	3	3	2	2

APPENDIX B

SURVEY INSTRUMENT

Page 1

Page 1 asks the respondent to enter the password provided to them in order to access the survey.

Page 2

Instructions

Thank you for your willingness to participate in this survey. To receive your executive summary of the results of this research, please provide your e-mail address at the end of the survey. Your answers will not be tracked by your e-mail address nor will your e-mail address be shared with any outside parties.

This survey asks you to trade-off characteristics of a hypothetical food manufacturer that supplies your firm with an important food product. A food manufacturer is defined as a firm whose primary value added activity is to change the form of a food product. This includes grain millers, protein processors, or any other supplier that receives food product in one form, changes the physical form of the product in some way, and then ships the product to your firm.

Supplier characteristics are defined in terms of five factors: product price, delivery reliability, security competence, location, and product quality. Please only focus on these five factors. You will be asked to compare four sets of supplier characteristics at a time and then **choose which one of the four you prefer MOST**.

Brief definitions are presented in Section 1. In Section 2 you will be asked to choose the most attractive set of supplier characteristics. If you need a more detailed defintion of a supplier characteristic, click on the button containing the name of the characteristic and a separate screen will appear with the definition. Following Section 2 are a few demographic questions.

Each page of questions/evaluations has a "Next" button at the bottom of the page. Please answer each question carefully before you hit the "Next" button to go to the next page.

This survey should take 15 minutes to complete. If you are interrupted during the survey, log off the website and log back on later with your password. The purpose of using passwords is to keep others out and to allow you to return. Your individual responses are completely confidential and are not tracked by your password nor will they be shared

with anyone. I am the only person who will have access to the data that is gathered through this research. Only the aggregate value all respondents place on the supplier characteristics will be published.

Thank you for your time!

Doug Voss
Logistics Ph.D. Student
Michigan State University

(Click the Next button to continue)

Page 3

Section 1
Concept Definitions

Instructions:

Please read the following definitions and keep them in mind when you proceed to Section 2.

Product Price: Product price is defined as the monetary amount a supplier charges your firm for their product. There are 3 levels of product price: Equal to or Below Industry Average, Above Industry Average (1-2% above industry averge), and Significantly Above Industry Average (3% or more above industry average).

Delivery Reliability: Delivery reliability is defined as the percentage of time that a supplier delivers product at the promised delivery time. There are 3 levels of delivery reliability: Equal to or Above Industry Average, Below Industry Average (1-2% below industry average), and Significantly Below Industry Average (3% or more below industry average).

Product Quality:
Product quality is defined as how well a supplier's product conforms to your firm's pre-set specifications. There are 3 levels of product quality: Equal to or Below to Industry Average, Moderately Higher than Industry Average, and Significantly Higher than Industry Average.

Location of Supplier:
Supplier location is defined as the location where the supplier manufactures the food

product that is then shipped to your firm via the most appropriate mode of transportation. There are 2 supplier locations: United States (located in *Iowa* and employs only U.S. residents), and Middle East (located in *Saudi Arabia* and employs only Saudi residents).

Supplier Security Competence:
Security is defined as the application of policies, procedures, and technology to protect food supply chain assets from theft, damage, or terrorism, and to prevent the introduction of unauthorized contraband, people, or weapons of mass destruction into the food supply chain.

There are 2 levels of supplier security: basic and advanced:

Basic Supplier Security Competence:
Suppliers with a basic security competence *only utilize limited measures* to protect their product, processes, and facilities from internal (e.g. disgruntled employee) and external (e.g. terrorist) food contamination threats.

Advanced Supplier Security Competence:
Suppliers with an advanced security competence *make every effort* to protect their product, processes, and facilities from internal (e.g. disgruntled employee) and external (e.g. terrorist) food contamination threats.

This concludes Section 1. Please proceed to Section 2

(Click the Next button to continue)

Page 4

Section 2
Choosing a Supplier

This section will present you with fifteen different scenarios. Each scenario contains four sets of characteristics describing a hypothetical food manufacturer that supplies product to your firm. Please carefully look over each of the four sets of characteristics in each scenario then indicate which one of the four you would **most prefer** by clicking the circle below the set of characteristics. If you need clarification on the defintion of a term, (e.g. Security, Price, etc...) click on the button containing the name of that term.

Please begin with the scenario below:

Pages 5 – 20

Pages five through twenty present the conjoint scenarios in which respondents are asked to choose between fifteen hypothetical suppliers. Due to the fact that the CBC software randomly mixes the factor levels presented for each supplier in each scenario for each respondent no examples are provided.

Pop-up windows

Each factor label in the above scenario is contained within a java script "button". When respondents click this button a pop-up window appears displaying the following factor/factor level definitions.

Supplier Security Competence: Consider two different levels of security that a supplier could employ.

Security is defined as the application of policies, procedures, and technology to protect food supply chain assets from theft, damage, or terrorism, and to prevent the introduction of unauthorized contraband, people, or weapons of mass destruction into the food supply chain.

The two levels of security, basic and advanced, are provided subsequently:

Basic Supplier Security Competence:
Suppliers with a basic security competence *only utilize limited measures* to protect their product, processes, and facilities from internal (e.g. disgruntled employee) and external (e.g. terrorist) food contamination threats. A supplier with a basic security competence typically **does not** employ any, or at least very few, of the following security measures: lock their doors, employ guards, have fences around their facilities, perform background checks on employees, secure inventory, and inspects product for possible contamination before it is shipped to your firm.

Advanced Supplier Security Competence:
Suppliers with an advanced security competence *make every effort* to protect their product, processes, and facilities from internal (e.g. disgruntled employee) and external (e.g. terrorist) food contamination threats. A supplier with an advanced security competence typically **does** employ most, or the majority, of the following actions: lock their doors, has fences and gates protecting their facilities, employ guards protecting entrances, perform thorough background checks on all employees and contractors, constantly tracks inventory in a secure environment to make sure it is not contaminated, and thoroughly inspects product for possible contamination before it is shipped to your firm.

Product Price:

Product price is defined as the monetary amount a supplier charges your firm for their product. These price levels are presented below:

Equal to or Below Industry Average - The supplier's price is equal to or below the industry average.

Above Industry Average - The supplier's price is moderately higher than the industry average (1-2% above industry average).

Significantly Above than Industry Average - The supplier's price is significantly higher than the industry average (3% or more above industry average).

Delivery Reliability:

Delivery reliability is defined as the percentage of time that a supplier delivers product at the promised delivery time. These delivery reliability levels are presented below.

Equal to or Above Industry Average: The supplier's delivery reliability is equal to or above the industry average.

Below Industry Average: The supplier's delivery reliability is moderately worse than the industry average (1-2% below industry average).

Significantly Below than Industry Average: The supplier's delivery reliability is significantly worse than the industry average (3% or more below industry average).

Location of Supplier:

Supplier location is defined as the location where the supplier manufactures the food product that is then shipped to you via the most appropriate mode of transportation. The two supplier locations are given below:

United States: This supplier is located in *Iowa* and employs only U.S. residents.

Middle East: This supplier is located in *Saudi Arabia* and employs only Saudi residents

Product Quality:

Product quality is defined as how well a supplier's product conforms to your firm's pre-set specifications. Consider there to be three different levels of product quality a supplier may attain:

Equal to or Below Industry Average - The supplier's product quality is equal to or below the industry average.

Moderately Higher than Industry Average - The supplier's product quality is moderately better than the industry average.

Significantly Higher than Industry Average - The supplier's product quality is significantly higher than the industry average.

Page 21

This concludes Section 2.

Section 3 begins on the next page and asks you a few general questions about you and your firm.

Section 3 is the final section of the survey and should take you no more than 5 minutes.

Please be sure to answer each question carefully before hitting the "Next" button.

Demographic questions

Beginning on Page 22, and concluding with the end of the survey, respondents were asked to complete the series of demographic questions presented below.

1. What is your title?

- ○ President (owner)
- ○ Vice-President
- ○ Director
- ○ Manager
- ○ Other (please specify) _____

2. Please circle the category that best describes your current position (circle only one):

- ○ Purchasing
- ○ Supply Chain/Logistics
- ○ Quality Assurance
- ○ Security
- ○ Other (please specify) _____

3. How long have you worked in this industry (in years)?

- ○ 0-1 years
- ○ 2-4 years
- ○ 5-9 years
- ○ 10-14 years
- ○ 15-19 years
- ○ 20 or more years

4. How long have you worked in your current position (in years)?

- ○ 0-1 years
- ○ 2-4 years
- ○ 5-9 years
- ○ 10-14 years
- ○ 15-19 years
- ○ 20 or more years

5. How long have you worked for your current employer (in years)?

- ○ 0-1 years
- ○ 2-4 years
- ○ 5-9 years
- ○ 10-14 years
- ○ 15-19 years
- ○ 20 or more years

6. How many employees are in your division?

- ○ Less than 50
- ○ 50 - 250
- ○ 250 - 1,000
- ○ 1,000 - 5,000
- ○ More than 5,000

7. How many total employees work for your company in the U.S.

- ○ Less than 50
- ○ 50 - 250
- ○ 250 - 1,000
- ○ 1,000 - 5,000
- ○ More than 5,000

8. Which best describes your firm's market area (check only one)?

- ○ Local
- ○ Regional
- ○ National
- ○ Global

9. Which best describes your firm's supply scope (check only one)?

- ○ Local
- ○ Regional
- ○ National
- ○ Global

10. Which best describes your firm's scope of activities (check only one)?

- ○ Manufacturing
- ○ Merchandiser/Retailer
- ○ Carrier
- ○ Warehouse/Distributor
- ○ Logistics Service Provider
- ○ Farm

11. Which best describes your firm's profit orientation?

- For-Profit
- Not-For-Profit

12. How would you assess your firm's level of vulnerability to intentional contamination/security incidents?

- Minimal
- Moderate
- Average
- Above Average
- Significantly Above Average

13. How concerned are you about intentional contamination/security incidents that have occurred at your firm?

- Very Unconcerned
- Unconcerned
- Neutral
- Concerned
- Very Concerned
- Not Applicable

14. How do you assess the vulnerability of your suppliers to intentional contamination/security incidents?

- Limited Vulnerability
- Somewhat Vulnerable
- Moderately Vulnerable
- Significantly Vulnerable

15. What role do the intentional contamination/security incidents experienced by your firm play in selecting a supplier?

- ○ Very Limited Role
- ○ Limited Role
- ○ Moderate Role
- ○ Major Role
- ○ Very Major Role
- ○ Not Applicable

16. How likely would you be to pay a higher price for a supplier's product if they were more secure than other potential suppliers of the same product?

- ○ Very Unlikely
- ○ Somewhat Unlikely
- ○ Neither Likely nor Unlikely
- ○ Somewhat Likely
- ○ Very Likely

17. How likely would you be to accept a lower level of delivery reliability from a supplier if they were more secure than other potential suppliers of the same product?

- ○ Very Unlikely
- ○ Somewhat Unlikely
- ○ Neither Likely nor Unlikely
- ○ Somewhat Likely
- ○ Very Likely

Please provide your e-mail address if you wish to receive an executive summary of the results of this research.

(Click the Next button to continue)

APPENDIX C

WILCOXON RANK SUM TEST RESULTS

Description of Wilcoxon Rank Sum Test (Lehmann 1975)

The Wilcoxon Rank Sum test is a nonparametric method of determining statistical differences between two independent sets of observations, whose properties violate the assumptions of the Student's t-test, by determining significant differences between the sum of their ranks, which approximates a normal distribution as $N \rightarrow \infty$. The procedure for calculating the Wilcoxon Rank Sum test statistics and determining their significance, or lack thereof, is as follows:

1. Determine if one wishes to assess if the means of two groups are equal (two-tailed test) or if it is hypothesized that one group is greater than another (one-tailed test).
2. Divide data into two groups that are to be compared for significant differences.
3. Order the data from highest value to lowest value.
4. Rank the data from 1....n.
5. Calculate sum and average of the ranks for each group.
6. Sum the sums of each group.
7. Average the averages of each group.
8. Ta = sum of Group A ranks where Na = number of observations in Group A
9. Tb = sum of Group B ranks where Nb = number of observations in Group B
10. Calculate Ta max and Tb max where Ta max = (Na*Nb)+[Na(Na+1)]/2 and Tb max = (Na*Nb)+[Nb(Nb+1)]/2.
11. Calcuate Ua and Ub (test statistics) where Ua = Ta max – Ta and Ub = Tb max – Tb.
12. Look up critical values for the test in a Wilcoxon Rank Sum table such as is found in Lehmann (1975).
13. If both Ua and Ub fall outside of the critical values, the difference is significant. If either fail to fall outside of the critical values, the difference is not significant.
14. For the following tests, the critical values are as follows:

Critical values for two tailed test @ .05 (6x6; .025 on each tail) = 5;30
Critical values for two tailed test @ .10 (6x6; .05 on each tail) = 7;28
Critical values for one tailed test @ .05 (3x3) = 0;8
Critical values for one tailed test @ .10 (3x3) = 1;7

The critical values above illustrate that it is almost impossible to find a significant difference at the .05 level for a one-tailed test. It is difficult to find a significant difference for a one or two-tailed test given the number of observations available. Therefore, caution should be taken in interpreting the following results.

TABLE C.1 HYPOTHESIS 5 RESULTS: SECURITY BY PRICE INTERACTION

Security Level	Price Level	Utilities	Market Preference %
Basic	Equal to or below	0.083	27.06
Basic	1-2% higher	(0.076)	6.82
Basic	3% or more higher	(0.007)	2.03
Advanced	Equal to or below	(0.083)	37.11
Advanced	1-2% higher	0.076	22.50
Advanced	3% or more higher	0.007	4.48

TABLE C.2 TEST FOR SIGNIFICNT DIFFERENCE IN MARKET PREFERENCE FOR BASIC AND ADVANCED SECURITY FOR ALL LEVELS OF PRICE

Advanced	Basic		
Group A	Group B		
37.11%	27.06%		
22.50%	6.82%		
4.48%	2.03%		
Ordered Data	Group	Rank	
37.11%	a	1	
27.06%	b	2	
22.50%	b	3	
6.82%	a	4	
4.48%	a	5	
2.03%	b	6	
	Group A Ranks	Group B Ranks	
	1	2	
	3	4	
	5	6	Total
Sum	9	12	21
Average	3	4	3.5
Ta = 9	Tb = 12		
Ta and Tb Max for N = 3 = 15			
Ua = 6			
Ub = 3		Not Significant (p > .10)	

TABLE C. 3 HYPOTHESIS 6 RESULTS: SECURITY BY DELIVERY RELIABILITY INTERACTION

Security Level	Delivery Reliability Level	Utilities	Market Preference %
Basic	Equal to or Above	0.054	30.28
Basic	1-2% Below	(0.098)	5.11
Basic	3% or more Below	0.044	1.65
Advanced	Equal to or Above	(0.054)	43.36
Advanced	1-2% Below	0.098	16.90
Advanced	3% or more Below	(0.044)	2.70

TABLE C.4 TEST FOR SIGNIFICANT DIFFERENCE IN MARKET PREFERENCE FOR BASIC AND ADVANCED SECURITY FOR ALL LEVELS OF DELIVERY RELIABILITY

Advanced	Basic		
Group A	Group B		
43.36%	30.28%		
16.90%	5.11%		
2.70%	1.65%		
Ordered Data	Group	Rank	
43.36%	a	1	
30.28%	b	2	
16.90%	a	3	
5.11%	b	4	
2.70%	a	5	
1.65%	b	6	
	Group A Ranks	Group B Ranks	
	1	2	
	3	4	
	5	6	Total
Sum	9	12	21
Average	3	4	3.5
Ta = 9	Tb = 12		
Ta and Tb Max for N = 3 = 15			
Ua = 6			
Ub = 3		Not Significant (p > .10)	

TABLE C. 5 HYPOTHESIS 8 RESULTS: SECURITY BY DELIVERY RELIABILITY BY INCIDENT CONCERN INTERACTION

		Concerned Respondents		Unconcerned Respondents	
Security Level	Delivery Reliability Level	Utilities	Market Preference %	Utilities	Market Preference %
Basic	Equal to or Above	0.098	28.31	0.023	32.11
Basic	1-2% Below	(0.017)	5.00	(0.195)	4.90
Basic	3% or more Below	(0.082)	0.65	0.172	3.38
Advanced	Equal to or Above	(0.098)	47.18	(0.023)	38.71
Advanced	1-2% Below	0.017	15.64	0.195	18.97
Advanced	3% or more Below	0.082	3.23	(0.172)	1.94

TABLE C.6 TEST FOR SIGNIFICANT DIFFERENCE IN MARKET PREFERENCE FOR SECURITY AND DELIVERY RELIABILITY BETWEEN CONCERNED AND UNCONCERNED RESPONDENTS

Concerned	Unconcerned		
Group A	Group B		
28.31%	32.11%		
5%	4.90%		
0.65%	3.38%		
47.18%	38.71%		
15.64%	18.97%		
3.23%	1.94%		
Ordered Data	Group	Rank	
47.18%	a	1	
38.71%	b	2	
32.11%	b	3	
28.31%	a	4	
18.97%	b	5	
15.64%	a	6	
5%	a	7	
4.90%	b	8	
3.38%	b	9	
3.23%	a	10	
1.94%	b	11	
0.65%	a	12	
	Group A Ranks	Group B Ranks	
	1	2	
	4	3	
	6	5	
	7	8	
	10	9	
	12	11	Total
Sum	40	38	78
Average	6.67	6.33	6.5
Ta = 40	Tb = 38		
Ta and Tb Max for N = 6 = 57			
Ua = 17			
Ub = 19		Not Significant (p > .10)	

TABLE C.7 TEST FOR SIGNIFICANT DIFFERENCE BETWEEN MARKET PREFERENCE OF SUPPLIERS WITH ADVANCED SECURITY V. MARKET PREFERENCE OF SUPPLIERS WITH BASIC SECURITY FOR CONCERNED RESPONDENTS

Concerned	Unconcerned		
Group A	Group B		
47.18%	28.31%		
15.64%	5%		
3.23%	0.65%		
Ordered Data	Group	Rank	
47.18%	a	1	
28.31%	b	2	
15.64%	a	3	
5%	b	4	
3.23%	a	5	
0.65%	b	6	
	Group A Ranks	Group B Ranks	
	1	2	
	3	4	
	5	6	Total
Sum	9	12	21
Average	3	4	3.5
Ta = 9	Tb = 12		
Ta and Tb Max for N = 3 = 15			
Ua = 6			
Ub = 3		Not Significant (p > .10)	

TABLE C.8 TEST FOR SIGNIFICANT DIFFERENCE BETWEEN MARKET PREFERENCE OF SUPPLIRES WITH ADVANCED SECURITY V. MARKET PREFERENCE OF SUPPLIERS WITH BASIC SECURITY FOR UNCONCERNED RESPONDENTS

Concerned	Unconcerned		
Group A	Group B		
38.71%	32.11%		
18.97%	4.90%		
1.94%	3.38%		
Ordered Data	Group	Rank	
38.71%	a	1	
32.11%	b	2	
18.97%	b	3	
4.90%	a	4	
3.38%	b	5	
1.94%	a	6	
	Group A Ranks	Group B Ranks	
	1	2	
	4	3	
	6	5	Total
Sum	11	10	21
Average	3.67	3.33	3.5
Ta = 11	Tb = 10		
Ta and Tb Max for N = 3 = 15			
Ua = 4			
Ub = 5		Not Significant (p > .10)	

TABLE C.9 HYPOTHESIS 9 RESULTS: SECURITY BY PRICE BY INCIDENT CONCERN INTERACTION

		Concerned Respondents		Unconcerned Respondents	
Security Level	Price Level	Utilities	Market Preference %	Utilities	Market Preference %
Basic	Equal to or below	0.063	23.29	0.091	31.36
Basic	1-2% higher	(0.061)	7.52	(0.083)	6.54
Basic	3% or more higher	(0.002)	2.38	(0.008)	1.79
Advanced	Equal to or below	(0.063)	37.42	(0.091)	36.70
Advanced	1-2% higher	0.061	24.13	0.083	20.04
Advanced	3% or more higher	0.002	5.27	0.008	3.57

TABLE C.10 TEST FOR SIGNIFICANT DIFFERENCE IN MARKET PREFERENCE FOR SECURITY AND PRICE FOR CONCERNED AND UNCONCERNED RESPONDENTS

Concerned	Unconcerned		
Group A	Group B		
23.29%	31.36%		
7.52%	6.54%		
2.38%	1.79%		
37.42%	36.70%		
24.13%	20.04%		
5.27%	3.57%		
Ordered Data	Group	Rank	
37.42%	a	1	
36.70%	b	2	
31.36%	b	3	
24.13%	a	4	
23.29%	a	5	
20.04%	b	6	
7.52%	a	7	
6.54%	b	8	
5.27%	a	9	
3.57%	b	10	
2.38%	a	11	
1.79%	b	12	
	Group A Ranks	Group B Ranks	
	1	2	
	4	3	
	5	6	
	7	8	
	9	10	
	11	12	Total
Sum	37	41	78
Average	6.166667	6.833333	6.5
Ta = 37	Tb = 41		
Ta and Tb Max for N = 6 = 57			
Ua = 20			
Ub = 16		Not Significant (p > .10)	

TABLE C.11 TEST FOR SIGNIFICANT DIFFERENCE BETWEEN MARKET PREFERENCE OF SUPPLIERS WITH ADVANCED SECURITY V. MARKET PREFERENCE OF SUPPLIERS WITH BASIC SECURITY FOR CONCERNED RESPONDENTS

Concerned	Unconcerned		
Group A	Group B		
37.42%	23.29%		
24.13%	7.52%		
5.27%	2.38%		
Ordered Data	Group	Rank	
37.42%	a	1	
24.13%	a	2	
23.29%	b	3	
7.52%	b	4	
5.27%	a	5	
2.38%	b	6	
	Group A Ranks	Group B Ranks	
	1	3	
	2	4	
	5	6	Total
Sum	8	13	21
Average	2.666667	4.333333	3.5
Ta = 8	Tb = 13		
Ta and Tb Max for N = 3 = 15			
Ua = 7			
Ub = 2		Not Significant (p > .10)	

TABLE C.12 TEST FOR SIGNIFICANT DIFFERENCE BETWEEN MARKET PREFERENCE OF SUPPLIERS WITH ADVANCED SECURITY V. MARKET PREFERENCE OF SUPPLIERS WITH BASIC SECURITY FOR UNCONCERNED RESPONDENTS

Concerned	Unconcerned		
Group A	Group B		
36.70%	31.36%		
20.04%	6.54%		
3.57%	1.79%		
Ordered Data	Group	Rank	
36.70%	a	1	
31.36%	b	2	
20.04%	a	3	
6.54%	b	4	
3.57%	a	5	
1.79%	b	6	
	Group A Ranks	Group B Ranks	
	1	2	
	3	4	
	5	6	Total
Sum	9	12	21
Average	3	4	3.5
Ta = 9	Tb = 12		
Ta and Tb Max for N = 3 = 15			
Ua = 6			
Ub = 3		Not Significant (p > .10)	

TABLE C. 13 HYPOTHESIS 11 RESULTS: SECURITY BY DELIVERY RELIABILITY BY SOURCING LOCATION INTERACTION: MARKET PREFERENCE

		Domestic Sourcing	International Sourcing
Security Level	Delivery Reliability Level	Market Preference %	Market Preference %
Basic	Equal to or Above	30.28	20.52
Basic	1-2% Below	5.11	3.29
Basic	3% or more Below	1.65	1.13
Advanced	Equal to or Above	43.36	52.33
Advanced	1-2% Below	16.90	19.55
Advanced	3% or more Below	2.70	3.19

TABLE C. 14 TEST FOR SIGNIFICANT DIFFERENCE IN MARKET PREFERENCE FOR SECURITY AND DELIVERY RELIABILITY FOR DOMESTIC AND INTERNATIONAL SOURCING

Domestic	International		
Group A	Group B		
30.28%	20.52%		
5.11%	3.29%		
1.65%	1.13%		
43.36%	52.33%		
16.90%	19.55%		
2.70%	3.19%		
Ordered Data	Group	Rank	
52.33%	b	1	
43.36%	a	2	
30.28%	a	3	
20.52%	b	4	
19.55%	b	5	
16.90%	a	6	
5.11%	a	7	
3.29%	b	8	
3.19%	b	9	
2.70%	a	10	
1.65%	a	11	
1.13%	b	12	
	Group A Ranks	Group B Ranks	
	2	1	
	3	4	
	6	5	
	7	8	
	10	9	
	11	12	Total
Sum	39	39	78
Average	6.5	6.5	6.5
Ta = 39	Tb = 39		
Ta and Tb Max for N = 6 = 57			
Ua = 18			
Ub = 18		Not Significant (p > .10)	

TABLE C. 15 TEST FOR SIGNIFICANT DIFFERENCE BETWEEN MARKET PREFERENCE OF SUPPLIERS WITH ADVANCED SECURITY WHEN SOURCING DOMESTICALLY V. SOURCING INTERNATIONALLY

Domestic	International		
Group A	Group B		
43.36%	52.33%		
16.90%	19.55%		
2.70%	3.19%		
Ordered Data	Group	Rank	
52.33%	b	1	
43.36%	a	2	
19.55%	b	3	
16.90%	a	4	
3.19%	b	5	
2.70%	a	6	
	Group A Ranks	Group B Ranks	
	2	1	
	4	3	
	6	5	Total
Sum	12	9	21
Average	4	3	3.5
Ta = 12	Tb = 9		
Ta and Tb Max for N = 3 = 15			
Ua = 3			
Ub = 6		Not Significant (p > .10)	

TABLE C.16 TEST FOR SIGNIFICANT DIFFERENCE BETWEEN MARKET PREFERENCE OF SUPPLIERS WITH BASIC SECURITY WHEN SOURCING INTERNATIONALLY V. SUPPLIERS WITH ADVANCED SECURITY WHEN SOURCING INTERNATIONALLY

International	International		
Group A	Group B		
52.33%	20.52%		
19.55%	3.29%		
3.19%	1.13%		
Ordered Data	Group	Rank	
52.33%	a	1	
20.52%	b	2	
19.55%	a	3	
3.29%	b	4	
3.19%	a	5	
1.13%	b	6	
	Group A Ranks	Group B Ranks	
	1	2	
	3	4	
	5	6	Total
Sum	9	12	21
Average	3	4	3.5
Ta = 9	Tb = 12		
Ta and Tb Max for N = 3 = 15			
Ua = 6			
Ub = 3		Not Significant (p > .10)	

TABLE C. 17 HYPOTHESIS 12 RESULTS: SECURITY BY PRICE BY SOURCING LOCATION INTERACTION

		Domestic Sourcing	International Sourcing
Security Level	Price Level	Market Preference %	Market Preference %
Basic	Equal to or below	27.06	18.33
Basic	1-2% higher	6.82	4.39
Basic	3% or more higher	2.03	1.33
Advanced	Equal to or below	37.11	44.74
Advanced	1-2% higher	22.50	25.94
Advanced	3% or more higher	4.48	5.28

TABLE C. 18 TEST FOR SIGNIFICANT DIFFERENCE BETWEEN MARKET PREFERENCE FOR DOMESTIC AND INTERNATIONAL SOURCING AT ALL LEVELS OF SECURITY AND PRICE

Domestic	International		
Group A	Group B		
27.06%	18.33%		
6.82%	4.39%		
2.03%	1.33%		
37.11%	44.74%		
22.50%	25.94%		
4.48%	5.28%		
Ordered Data	Group	Rank	
44.74%	b	1	
37.11%	a	2	
27.06%	a	3	
25.94%	b	4	
22.50%	a	5	
18.33%	b	6	
6.82%	a	7	
5.28%	b	8	
4.48%	a	9	
4.39%	b	10	
2.03%	a	11	
1.33%	b	12	
	Group A Ranks	Group B Ranks	
	2	1	
	3	4	
	5	6	
	7	8	
	9	10	
	11	12	Total
Sum	37	41	78
Average	6.17	6.83	6.5
Ta = 37	Tb = 41		
Ta and Tb Max for N = 6 = 57			
Ua = 20			
Ub = 16		Not Significant (p > .10)	

TABLE C.19 TEST FOR SIGNIFICANT DIFFERENCE BETWEEN MARKET PREFERENCE OF SUPPLIERS WITH ADVANCED SECURITY WHEN SOURCING DOMESTICALLY V. SOURCING INTERNATIONALLY

Domestic	International		
Group A	Group B		
37.11%	44.74%		
22.50%	25.94%		
4.48%	5.28%		
Ordered Data	Group	Rank	
44.74%	b	1	
37.11%	a	2	
25.94%	b	3	
22.50%	a	4	
5.28%	b	5	
4.48%	a	6	
	Group A Ranks	Group B Ranks	
	2	1	
	4	3	
	6	5	Total
Sum	12	9	21
Average	4	3	3.5
Ta = 12	Tb = 9		
Ta and Tb Max for N = 3 = 15			
Ua = 3			
Ub = 6		Not Significant (p > .10)	

TABLE C. 20 TEST FOR SIGNIFICANT DIFFERENCE BETWEEN MARKET PREFERENCE OF SUPPLIERS WITH BASIC SECURITY WHEN SOURCING INTERNATIONALLY V. SUPPLIERS WITH ADVANCED SECURITY WHEN SOURCING INTERNATIONALLY

International	International		
Group A	Group B		
18.33%	44.74%		
4.39%	25.94%		
1.33%	5.28%		
Ordered Data	Group	Rank	
44.74%	b	1	
25.94%	b	2	
18.33%	a	3	
5.28%	b	4	
4.39%	a	5	
1.33%	a	6	
	Group A Ranks	Group B Ranks	
	3	1	
	5	2	
	6	4	Total
Sum	14	7	21
Average	4.67	2.33	3.5
Ta = 14	Tb = 7		
Ta and Tb Max for N = 3 = 15			
Ua = 1			
Ub = 8		Significant Difference (p < .10)	

APPENDIX D

PRE-NOTIFICATION LETTER

Dear _____,

My name is Doug Voss and I am currently working to complete my Ph.D. in logistics at Michigan State University. In order to complete my degree I am required to collect data and produce a dissertation from this data. You have been randomly selected to participate in this study. Your participation in this research is purely voluntary. Your responses, should you choose to participate, will be stored separately from your name. This will prevent the matching of your responses to your name. Should you choose to participate, you will be provided an executive summary of the results.

The purpose of my research is to determine how important supplier security is to purchasing managers employed by food manufacturers. This research will consist of a web-based survey which presents profiles of four hypothetical suppliers, as well as placing you in a hypothetical situation, and asks you to pick one of the two suppliers given their hypothetical profile and your hypothetical situation. From the combined responses I receive from all of the respondents to this survey I will be able to determine how much importance purchasing managers place on security, product quality, delivery reliability, and product price. I will also discover if certain conditions make security more valuable to purchasing managers.

Again, your participation in this research is purely voluntary. There are no adverse consequences for choosing to not participating. Your responses, should you choose to participate, will be stored separately from your name. This will prevent the matching of your responses to your name. You will be provided an executive summary of the results upon completion of this research. The expected date of completion is June, 2006.

You will receive a letter in the next seven days that contains a link to a web page. This web page contains the survey. Please do not hesitate to contact me with any questions or concerns you may have. Thank you for your time.

Best regards,

Doug Voss
Ph.D. Candidate in logistics
The Eli Broad College of Business
Michigan State University
vossmic1@msu.edu
(517) 353-6381

David J. Closs, Ph.D.

APPENDIX E

NOTIFICATION LETTER

Dear _____,

You have been sent a postcard requesting your participation in Doug Voss' dissertation research pertaining to food supply chain security. To protect respondent anonymity, I am not tracking who has completed the survey. If you have completed it, I would like to extend my sincere "Thanks". If you have not completed the survey, **YOUR HELP IS GREATLY NEEDED**, and will allow you to receive an executive summary of the results.

As someone who has worked in the private sector, I fully realize the value of your time and know you receive numerous surveys. I cannot stress enough that this survey is only for academic use, nobody will profit from your participation, and you are only asked to provide anonymous preferences about a hypothetical supplier.

If you have a spare **15 minutes** to complete the survey, please direct your web browser to www.purchasingsurvey.com with your password: **PW**

Thank you very much for your time! **Your help means a great deal to me personally and professionally.** Please do not hesitate to e-mail or call if you have any questions.

Best regards,

Doug Voss
Ph.D. Candidate in logistics
N370 Business College Complex
The Eli Broad College of Business
Michigan State University
voss@bus.msu.edu
(517) 432-5535 ext. 258

David J. Closs, Ph.D.

APPENDIX F

FINAL NOTIFICATION LETTER

Dear _____,

You have been sent a postcard and letter requesting your participation in Doug Voss' dissertation research pertaining to food supply chain security. To protect respondent anonymity, I am not tracking who has completed the survey. If you have completed it, I would like to extend my sincere "Thanks". If you have not completed the survey, **YOUR HELP IS GREATLY NEEDED**, and will allow you to receive an executive summary of the results.

As someone who has worked in the private sector, I fully realize the value of your time and know you receive numerous surveys. I cannot stress enough that this survey is only for academic use, nobody will profit from your participation, and you are only asked to provide anonymous preferences about a hypothetical supplier.

If you have a spare **15 minutes** to complete the survey, please direct your web browser to www.purchasingsurvey.com with your password: _____

Thank you very much for your time! **Your help means a great deal to me personally and professionally.** Please do not hesitate to e-mail or call if you have any questions.

Warmest regards,

Doug Voss
Ph.D. Candidate in logistics
N370 Business College Complex
The Eli Broad College of Business
Michigan State University
voss@bus.msu.edu
(517) 432-5535 ext. 258

David J. Closs, Ph.D.

APPENDIX G

UCHRIS ASSURANCE OF EXCEMPT RESEARCH PROTOCOL

Principal Investigator Assurance of An Exempt Protocol

Name of Principal Investigator: Cheri Speier

Title of Project: "How Much Security is Enough? The Importance of Security in the Supplier Selection Decision"

IRB #: X05-862

The University Committee on Research Involving Human Subjects has deemed this project as exempt, in accord in federal regulations of projects exempt from IRB review. As an exempt protocol, the IRB will not be further involved with the review or continued review of the projects, as long as the project maintains the properties that make it exempt.

- Since the IRB is no longer involved in the review and continued review of this project, it is the Principal Investigator who assumes the responsibilities of the protection of human subjects in this project and ensures that the project is performed with integrity and within accepted ethical standards, particularly as outlined by the Belmont Report (see exempt educational materials).

- The Principal Investigator assumes responsibility for ensuring that the research subjects be informed of the research through a documented or undocumented consent process, if appropriate.

- The Principal Investigator assumes the responsibility to maintain confidentiality of the subjects and the data, and maintain the privacy of the subjects and the protection of the data through appropriate means. If data is anonymous, the investigators will make no attempt to identify any individuals.

- The Principal Investigator assumes the responsibility that co-investigators and other members of the research team adhere to the appropriate policies to protect human subjects, maintain confidentiality and privacy, and adhere to accepted ethical standards.

- If the Principal Investigator adds additional investigators to an exempt protocol, he/she may inform UCRIHS of the additions. This may be of particular importance to graduate students if the Graduate School requires proof of IRB approval.

- Any complaints from participants regarding the risk and benefits of the project must be reported to the UCRIHS.

- Since the Principal Investigator and co-investigators are charged with human subject protection and adhering to ethical principles in exempt research, it is appropriate that investigators be trained in human subject principles. The Principal Investigator and all members of the research team are required to complete MSU IRB educational requirements or equivalent.

- Any change in the protocol which may raise the project from exempt to an expedited or full review category, must be presented to UCRIHS. If there is any question about a change in protocol the Principal Investigator should consult the Chair of UCRIHS. Failure to submit changes which raise the protocol out of the exempt category will be considered non-compliance and will be subject to investigation and action by UCRIHS.

By signing below, the Principal Investigator assures that he/she will abide by the terms of this assurance and the UCRIHS exempt policy.

_____ _____

Signature of Principal Investigator Date

BIBLIOGRAPHY

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Aberdeen Group (2004), "How Supply Chain Leaders Protect Their Brands: A Benchmark Report on Regulatory Compliance and Product Safety Mandates for Food, Pharmaceuticals, Consumer Products, and Medical Devices," September

Armstrong, J. Scott and Terry S. Overton (1977), "Estimating Nonresponse Bias in Mail Surveys," *Journal of Marketing Research*, 14 (August), 396-402.

Blalock, Cecelia (2003), "Tackling Transportation Security," *Advantage*, October, available at www.fmi.org/advantage.

Bledsoe, Gleyn E. and Barbara A. Rasco (2002), "Addressing the Risk of Bioterrorism in Food Production," *Food Technology*, 56(2), February, p. 43-47.

Bowersox, Donald J., David J. Closs, M. Bixby Cooper (2002), "Supply Chain Logistics Management," New York, NY: McGraw Hill.

--------, --------, and Theodore P. Stank (1999), "21st Century Logistics: Making Supply Chain Integration a Reality," Oak Brook, IL: Council of Logistics Management.

Braglia, Marcello and Alberto Petroni (2000), "A Quality Assurance-Oriented Methodology for Handling Tradeoffs in Supplier Selection," *International Journal of Physical Distribution and Logistics Management*, 30 (2), p. 96-111.

Bremmer, Paul (2001). New risks in international business. Retrieved on October 10, 2003, from: http://www.mmc.com/views/autumn_01_bremer.shtml.

Bruemmer, Barbara (2003), "Food Biosecurity," *Journal of the American Dietetic Association*, June, 103 (6), p. 687 – 691.

Cattin, Phillipe and Dick R. Wittink (1982), "Commercial Use of Conjoint Analysis," *Journal of Marketing*, 46 (3), pg. 44-53.

Chalk, Peter (2001), "Terrorism, Infrastructure Protection, and the U.S. Food and Agricultural Sector," Rand Corporation, Senate Testimony given October 10, 2001.

Choi, Thomas Y. and Janet L. Hartley (1996), "An Exploration of Supplier Selection Practices Across the Supply Chain," *Journal of Operations Management*, 14 (?), p. 333-343.

Churchill, Jr., Gilbert A. (1979), "A Paradigm for Developing Better Measures of Marketing Constucts," *Journal of Marketing Research*, 16 (February), p. 64-74.

-------- and Dawn Iacobucci (2002), Marketing Research: Methodological Foundations, eighth edition, Harcourt College Publishers, Ft. Worth, pgs. 1006.

Closs, David J. and Edmund F. McGarrell (2004), "Enhancing Security Throughout the Supply Chain," IBM Center for the Business of Government, available at www.businessofgovernment.org, pgs. 52.

Cremin, Brian (2001), Extortion by product contamination: A recipe for disaster within the food and drink industry, *The American Behavioral Scientist*, February, 44(6), p. 1042-1052.

Cullen, David and Sean Kilcarr (2004), "Lockdown 2: Security and Borders," *Fleet Owner*, June, 99(6), p. 20-26.

Cupp, O. Shawn, David E. Walker II, and John Hillison (2004), Agro terrorism in the U.S.: Key security challenge for the 21st Century, *Biosecurity and Bioterrorism*, 2(2), p. 97-105.

Department of Transportation Bureau of Transportation Statistics (2005), "Pocket Guide to Transportation," available at http://www.bts.gov/publications/pocket_guide_to_transportation/2005/pdf/entire.pdf, accessed 1-23-05.

Dillman, Don A. (2000), Mail and Internet Surveys: The Tailored Design Method, Second Edition, John Wiley and Sons, Inc., New York, pgs. 464.

Dobie, Kathryn, L. Milton Glisson, and James Grant (2000), "Terrorism and the Global Supply Chain: Where Are Your Weak Links?," *Journal of Transportation Management*, 12(1), Spring, p. 57-66.

Dunn, Steven C., Robert F. Seaker, and Matthew A. Waller (1994), "Latent Variables in Business Logistics Research: Scale Development and Validation," *Journal of Business Logistics*, 15 (2), p. 145-172.

Evans, Richard H (1982), "Product Involvement and Industrial Buying," *Journal of Purchasing and Materials Management*, 18 (Summer), p. 23 – 28.

EyeforTransport Global Research (2004), North American supply chain security – An analysis of eyefortransport's recent survey, July 2004.

EyeforTransport (2005), "Cargo and Supply Chain Security Trends 2005," available at http://www.eyefortransport.com, accessed 9/21/05.

Fransella, Fay, Richard Bell, and Don Bannister (2004), A Manual for Repertory Grid Technique, Second Edition, John Wiley and Sons, Ltd., West Sussex, pgs. 266.

Gips, Michael A. (2003), The first link in the food chain, *Security Management*, February 2003, Available at http://www.securitymanagement.com/library/001379.html, accessed August 26th, 2004.

Goffin, Keith, Marek Sywejczewski, and Colin New (1997), "Managing Suppliers: When Fewer Can Mean More," *International Journal of Physical Distribution and Logistics Management*, 27 (7), p. 422-436.

Green, Paul E. and V. Srinivasan (1978), "Conjoint Analysis in Consumer Research: Issues and Outlook," *Journal of Consumer Research*, 5 (2), p. 103-123.

Hannon, David (2004), Securing the supply chain: What you need to know today, *Purchasing*, January 15, 133(1), p. 50-52.

Hair, Joseph F. Jr., Rolph E. Anderson, Ronald L. Tatham, and William C. Black (1998), Multivariate Data Analysis, fifth edition, Upper Saddle River, NJ: Prentice Hall, pgs. 730.

Harl, Neil E. (2002), U.S. agriculture, food production is threatened by bioterrorism attacks, *Ag Lender* April, 2002:1.

Helferich, Omar Keith and Robert L. Cook (2003), "Securing the Supply Chain," Council of Logistics Management, Oak Brook, IL.

Hulme, George V. (2005), "Food Chain's Fear Factor," *Information Week*, May, p. 39-42.

Johnson, M. Eric (2001), "Learning from Toys: Lessons in Managing Supply Chain Risk from the Toy Industry," *California Management Review*, 43 (3), p. 106-124.

Jorgensen, Barbara (2003), Remedies for an insecure supply chain, *Electronic Business*, November, 29(14), p. 37-38.

Kahaner, Larry (2003), "Lock 'em Up," *Fleet Owner*, 98(2), p. 8.

Kent, John L. and Daniel J. Flint (1997), "Perspectives on the Evolution of Logistics Thought," *Journal of Business Logistics*, 18(2), p. 15-29.

Lehmann, Donald R. and John O'Shaughnessy (1974), "Difference in Attribute Importance for Different Industrial Products," *Journal of Marketing*, 38 (April), p. 36-42.

-------- and -------- (1982), "Decision Criteria Used in Buying Different Categories of Products," *Journal of Purchasing and Materials Management*, 18(1), p. 9-15.

Lehmann, Erich L. (1975), Nonparametrics: Statistical Methods Based on Ranks,

McGraww-Hill, New York, p. 457.

Louviere, Jordan J. and George Woodworth (1983), "Design and Analysis of Simulated Consumer Choice or Allocation Experiments: An Approach Based on Aggregate Data," *Journal of Marketing Research*, 20 (November), p. 350 – 367.

-------- (1988), Analyzing Decision Making: Metric Conjoint Analysis, Sage Publications, London, pgs. 95.

Meriwether, Gordon and Rita Goodell (2004a), "A Food Security Primer: Risk to Recovery Part 1: Overview," available at http://www.idmagonline.com, accessed 1-3-05.

Michigan State University Food Supply Chain Security Research Team (in progress).

Min, Hokey (1994), "International Supplier Selection: A Multi-Attribute Utility Approach," *International Journal of Physical Distribution and Logistics Management*, 24 (5), p. 24-33.

National Academy of Sciences (2004), Countering agricultural bioterrorism, available at http://books.nap.edu/catalog/10505.html, accessed August 26th, 2004.

Nganje, William, William W. Wilson, and James Nolan (2003), "Terrorism and the Grain Handling System," CAES Annual Meeting, July 26-30, 2003, Montreal, Canada.

Nunnally, Jum (1978), Psychometric Theory, Second Edition, McGraw Hill, New York, pgs. 701.

Orme, Bryan K. (2006), "Getting Started with Conjoint Analysis: Strategies for Product Design and Pricing Research," Madison, WI; Research Publishers, LLC.

Phillips, Lawrence T. (2001), "A Crisis of Security and Economics," *Regulation*, 24(4), p. 53-56.

Porter, Michael E. (1985), Competitive Advantage: Creating and Sustaining Superior Performance, Collier McMillan, New York, pgs. 557,

Radjou, Navi (2003), Securing the supply chain: Constructive paranoia, *Network Computing*, September 25, 14(19), p. 2.

Rand Corporation (2003), "Agro terrorism: What is the Threat and What Can Be Done About It?," *Rand Corporation Research Brief Series*, available at www.rand.org.

Rice, James B. and Federico Caniato (2003), "Building a Secure and Resilient Supply Network," *Supply Chain Management Review*, 7(5), September-October, p. 22-30.

-------- and Philip W. Spayad (2005), "Investing in Supply Chain Security: Collateral Benefits," IBM Center for the Business of Government, available at www.businessofgovernment.org, pgs. 28.

Rogers, David, David Lockman, Gregg Schwerdt, Brian O'Donnell, and Roger Huff (2004), Supply chain security, *Material Handling Management*, February, 59(2), p. 15-17.

Russell, Dawn M. & John P. Saldanha, (2003), "Five Tenets of Security-Aware Logistics and Supply Chain Operation," *Transportation Journal*. 42(4), p. 44-54.

Segal, Madhav N. (1982), "Reliability of Conjoint Analysis: Contrasting Data Collection Procedures," *Journal of Marketing Research*, 19 (February), p. 139–143.

Sheffi, Yossi (2001). "Supply chain management under the threat of international terrorism," *International Journal of Logistics Management*. 12(2), p. 1-11.

Spekman, Robert E. and Edward W. Davis (2004), "Risky Business: Expanding the Discussion on Risk and the Extended Enterprise," *International Journal of Physical Distribution and Logistics Management*, 34 (5), p. 414 – 433.

Strozniak, Peter (2004), "If the Fight Comes to Food," *Industry Week*, October, 253(10), p. 15.

Transportation Security Administration (2003), Report to Congress on transportation security, March 31, 2003.

U.S. Customs and Border Protection (2004), "CSI in Brief", available at http://www.cbp.gov/xp/cgov/border_security/international_activities/csi/csi_in_brief.xml, accessed 1-25-04.

U.S. Food and Drug Administration (2004), "Fact Sheet on FDA's New Food Bioterrorism Regulation: Establishment and Maintenance of Records," December 6, available at http://www.cfsan.fda.gov/~dms/fsbtac23.html, accessed 1-2-05.

-------- (2003), Risk Assessment for food terrorism and other food safety concerns, October 7, 2003. Available at http://www.cfsan.fda.gov/~dms/rabtact.html. Accessed August 26th, 2004.

Vonderembse, Mark, Michael Tracey, Chong Leng Tan, and Edward J. Bardi (1995), "Current Purchasing Practices and JIT: Some of the Effects on Inbound Logistics," *International Journal of Physical Distribution and Logistics Management*, 25 (3), p. 33-48.

Warehousing Education and Research Council (2004), "The Cost of Security,"

Warehousing Education and Research Council Newsletter, September, p. 1-3.

Wheelis, Mark, Rocco Casagrande, and Lawrence V. Madden (2002), Biological attack on agriculture: Low tech, high impact bioterrorism, *Bioscience*, July, 52(7), p. 569 – 576.

Wilson, Elizabeth J (1994), "The Relative Importance of Supplier Selection Criteria: A Review and Update," *International Journal of Purchasing and Materials Management*, 30 (3; Summer), p. 35-41.

Wolfe, Michael. (2001), Fifth EU/US Forum on Intermodal Freight Transport, Retrieved on September 2, 2003, from: http://ops.fhwa.dot.gov/freight/documents/frt_sec_ex_sum4_4_02.doc.

-------- (2004), "The Dynamics of Supply Chain Security," *The Monitor*, 10 (2), available at http://www.maritimeexpo.com, accessed 9/21/05.

World Health Organization (2002), "Terrorist Threats to Food: Guidance for Establishing and Strengthening Prevention and Response Systems," Geneva.

Zsidisin, George A. (2003), "A Grounded Definition of Supply Risk," *Journal of Purchasing and Supply Management*, 9, p. 217 – 224.