A GAME THEORY ANALYSIS OF FIRM REACTION TO EXTERNAL ORGANIZATIONAL DEMANDS: THE CASE OF ANIMAL WELFARE STANDARDS

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Sheril Sherine Tzul

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

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ABSTRACT

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There has been increasing public concern about farm animal welfare regarding transportation, slaughter, and some management practices, especially in systems where animals are confined for most of their existence. Animal welfare organizations (groups) have traditionally focused on forwarding their agendas through legislation, although more recent attempts have focused on convincing large firms that buy agricultural commodities to require particular production process standards to be met.

The strategic interactions of players in the egg industry are modeled using a game theory approach. Two scenarios were explored: a principal-agent contract model between food firms and farmers, and a model where two firms are targeted by animal activists. The former model was empirically analyzed while the latter model was theoretically examined.

Results for the principal-agent contract model indicate that, in general, the decision by the farmer of whether to invest in a free-range production system is dependent on the probability of being caught cheating. Whether contracts will be accepted or rejected by suppliers is dependent on the premium for free-range eggs. Finally, as the amount that can be lost if caught breaching the contract decreases, investment is motivated only with a higher probability of being caught.

Theoretical analysis where competition did not matter and animal welfare was not a determinant of demand shows that animal activists must convince food firms that there will

be a significant change in revenue with compliance as opposed to rejecting the contract or negotiating a compromise in order to attain their objectives of increased animal welfare.

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CHAPTER I. INTRODUCTION

Background

As industries move through their growth cycle, there are many challenges that cannot be escaped. Obstacles encountered fall under various categories, including management; human resources; policies; and, perhaps one of the most important, productivity. Animal agriculture is no different from other industries; it has, is still, and will be undergoing many changes governing its existence. These may include changing demand from consumers due to increasing health awareness and income levels, changing preferences, availability of inputs and other resources, and, of course, technology advances that increase productivity. Changing consumer preferences include those for food product and process attributes including food quality, food safety, environment, social conditions/ethics, and animal welfare (Fulponi, 2005).

Productivity in animal agriculture has increased dramatically since World War II with the use of animal confinement, genetic selection, scientific feed formulation, and productivity-enhancing pharmaceuticals (Farm Foundation, 2006). Modifications that occur in industries are mostly driven by efforts to lower costs while maintaining quality that is capable of generating a profit. Farm Foundation further notes that, in animal agriculture, there has been a shift to larger production units in order to take advantage of economies of scale. Critics contend that these changes have reduced the welfare or well-being of farm animals. At the same time, Curtis (2007) argues that animal productivity or animal performance is still the most reliable indicator of an animal's well-being.

What does animal welfare mean? Animal welfare is a human responsibility that encompasses all aspects of animal well-being, including proper housing; management;

nutrition; disease prevention and treatment; responsible care; humane handling; and, when necessary, humane euthanasia (AVMA, 2007).[1] Albright (2005) mentions that a more recent and widely used definition of animal welfare is where the animal is in a state of complete mental and physical health and hence in harmony with its environment. Animal welfare is a Potemkin attribute, meaning a process oriented quality hidden for third parties as well as customers at the end product level (Jahn, Schramm, and Spiller, 2004). The European Union (EU) has termed the ideal states of animal welfare as the "five freedoms". This includes that animals should be free from: hunger and thirst; discomfort; pain, injury and disease; and fear and distress, and have the freedom to express normal behavior (European Communities, 2007).

Henry Bergh founded the American Society for the Prevention of Cruelty to Animals (ASPCA) in New York City in the 1860s. His motivation came from being disturbed by the cruel treatments to animals he saw in Russia and other parts of Europe while he was serving his term there as a diplomat. He began his work consulting the Earl of Harrowby in London, president of the Royal Society for the Prevention of Cruelty to Animals. He created a Declaration of the Rights of Animals and persuaded many influential people to sign it in 1866 and, a few days later, the legislature passed anticruelty legislation. The ASPCA was to enforce it. The organization now is a nationally influential organization that engages in the direct protection of animals through its shelters and adoption facilities (Encyclopedia Britannica, 2006; Shea, n.d.).

According to animal activists, current farm practices significantly decrease the well being of animals which are raised commercially and slaughtered to produce the many

[1]"The term euthanasia is derived from the Greek word *eu* meaning good and *thanatos* death. A "good death" would be one that occurs with minimal pain and distress" (AVMA, 2007, p. 1).

products with specific attributes that Americans are demanding including poultry, pork, eggs, milk, and beef. Hillman and Huffman (2001) claim that abuses of farm animals are spread quite evenly throughout the meat, dairy and egg industries with the difference being how the abuse is inflicted. For example, pigs are confined in gestation crates, laying hens in cages, and veal calves chained by the neck in a crate built small enough to allow minimum movement.

Furthermore, animal activists also claim that, among the almost 300 million laying hens raised in the U.S. for eggs, more than 95 percent are intensively confined in small wire "battery cages," stacked several tiers high and extending down long warehouses. Among the many practices in modern farming that animal activists claim compromise the welfare of laying hens are beak trimming, forced molting, and lack of dust-bathing and perching opportunities. For hogs and veal calves the criticism is more focused on the restriction of space to perform normal behaviors as well as transporting and management practices (HSUS, 2006). Animal activists' are therefore advocating for less restrictive environments for farm animals. Some groups argue that they are seeking to promote socially responsible production systems in agriculture. People for the Ethical Treatment of Animals (PETA) says it has chosen to shed light on the chicken industry in recent years because large chicken producers and sellers have made little movement toward more humane practices (Warner, 2005). Another reason why confinement is a focus issue is due to the claim from advocates that there is strong scientific evidence that welfare is decreased when animals are confined because there is serious harm done to animals' physical and mental health (Sluizer, 2006).

Animal activists are pressuring food service organizations to compel suppliers to meet new welfare requirements. Restaurants are activists' focus for two major reasons. First, they are at an interface of supply chains with consumers. Second, groups know that food services are seeking to secure market position and advantage through stimulating and satisfying growing consumer demands for appropriate 'quality assurance' (Baines, 2002).

Animal activists are strong in their pursuit to have industries phase out confinement practices and implement free-range production for laying hens and group housing for sows instead of gestation crates. But what exactly constitutes free-range? Free-range involves hens being loose-housed and having daily access to the outdoors. The range of associated housing is wide, but may be similar to that used for barn production (Botheras, Hemsworth, Coleman, and Barnett, 2006). Producers labeling poultry as free-range must demonstrate to the USDA that the poultry has been allowed outdoor access. USDA regulates the label for poultry but not for eggs. No specific amount of time for outside access is required. This label does not require third-party certification (Oberholtzer, Greene, Lopez, 2006). Singer and Mason (2006) explain the way fraud can occur with these labels, "at times these producers will have surplus caged eggs they can't sell," and "Where do you think those eggs are going to be going? In cage-free cartons" (pp. 109-110). Overall animal advocates' quest is for farm animals to have opportunities to be at ease with their environment, meaning no normal behavior is compromised.

Problem Statement

The issue of farm animal welfare is increasing in visibility. During the last few decades there has been increasing public concern about the ways in which food animals are raised, transported, and slaughtered (Mench, 2002; Seng and Laporte, 2005; and Mitchell,

2001). Concerns are expressed about the conditions in which farm animals are kept and some management practices, particularly in systems where animals are kept in confinement for most of their lives (Farm Foundation, 2006).

The number of interest groups engaging in political lobbying has increased dramatically since 1970. It is estimated that the number of interest groups doubled in the United States from 1955 to 1970; doubled again from 1970 to 1990 and reached 20,000 identified interest groups in 1995. This includes groups of all types. Among the many social activist groups, one of them that has an excellent template for success is PETA (Whiting, 2005). Other animal welfare groups include Farm Sanctuary, Humane Society of the United States (HSUS) and ASPCA.

Animal welfare organizations (groups) have traditionally focused on forwarding their agendas through legislation, although more recent attempts have focused on convincing large firms who buy agricultural commodities to require particular production process standards to be met. Most notable is their success in influencing adoption of standards for cage sizes of laying hens by focusing their efforts on a key buyer (McDonald's Corporation), and recent legislative and 'behind the scenes' lobbying (of firms) regarding gestation and farrowing crates in production facilities in the hog industry. In 2000, animal rights organizations began to demand that individual restaurant chain companies force their suppliers to follow specific animal welfare guidelines (Brown and Hollingsworth, 2005).

Animal activists have also been able to persuade several chain restaurant companies to begin developing their own guidelines and programs in an effort to demonstrate to customers their concern for animal welfare (Brown and Hollingsworth, 2005). For

example, PETA and Burger King have been meeting periodically. Burger King Corporation has announced a goal of two percent of its eggs to be "cage-free" and ten percent of its pork to come from farms that allow sows to move around inside pens, rather than be confined to crates. It expects to more than double the two percent of cage-free eggs by the end of 2007 (Martin, 2007; Pork Magazine, 2007). Additionally, Rosenthal (2007) reports that Smithfield Inc., the nation's largest pork producer with 1.2 million breeding sows, has agreed to phase out gestation crates over the next decade. Florida and Arizona voted to ban gestation crates in 2002 and 2006, respectively. Additionally, Pork Magazine (2007) states that CKE restaurants, the California-based parent company of Hardees and Carl's Jr., announced that 15 percent of the pork it uses will come from producers that do not use gestation crates and that, although the time line is not yet clear, they expect this percentage to increase to 25 by 2009. CKE is responding to pressure from PETA.

Sohail, Bryant, and Roland (2004) and Blandford (2006) report an important success story. In 2002 the United Egg Producers announced a new certification program that requires a significant increase in space per hen to produce eggs to improve animal welfare.

Lefebvre (2006) reports on a growing animal welfare campaign that has a wave of colleges and universities, corporate cafeterias, natural food markets, and management companies either eliminating or reducing the use of eggs from confined hens. The Washington D.C. based HSUS has been at the forefront over the last year to aggressively promote cage-free egg use.

It is clear from the many advances that animal advocates are seeing the fruits of their labor and are continuing to work hard in an effort to fulfill their agenda; better

husbandry practices for farm animals that will improve their welfare. There has been a marked increase in the number of animal welfare bills introduced in the U.S. Congress in recent years (Blandford, 2006). Given the recent successes of animal rights groups at the voting booth, future successes seem likely (Lusk, Norwood, Prickett, 2007).

Whether to require meat inputs and other livestock products purchased from suppliers to result from particular production practices is a strategic choice for firms. There are multiple consequences associated with imposing requirements, potentially including reaction of customers, suppliers, and competitors, the impact on profitability, and future demands for changing process standards. The major challenge here for food firms is that changing procurement practices can have a significant effect on their sales, market share, and reputation.

As with any pressure to make changes to already existing practices, industry players must critically analyze what is in it for them especially in terms of sustainability and of course profitability. Before any long term decisions can be made, firms must be convinced that they can: demand a premium for welfare-friendly products or more generally that revenue change will be positive (e.g., also due to increased sales) and that increases in production costs are reasonable. Unless firms note strong economic incentive, animal activists will have a greater challenge.

Objectives

This project evaluates strategic decisions and defines optimal choices that a firm, its competitors and its suppliers will pursue given proposals by animal welfare groups regarding livestock production practices. The focus will be on estimating how progress on standards in animal welfare might influence the procurement demands of food industry

firms. It aims to identify firm choices and to evaluate the role of competitors and their decisions, including estimating payoffs associated with decisions made by firms and the reaction generated from competitors and from animal welfare organizations.

This study identifies a "process standard" of current interest being promoted by animal welfare groups, focusing on housing alternatives for laying hens. Specific objectives are to: evaluate the impact of choice sets (choices) on firm profitability, identify optimal choices for industry participants, and test the sensitivity of choices to key variables using game theory.

Organization

This study is composed of five different chapters. Chapter I was an introduction to the scope of the study, and included a brief history of animal welfare and its increasing importance. The following chapter focuses on reviewing relevant literature on studies that have been conducted as well as information about the targeted industry that will assist readers in understanding the food firm and animal activists' issues. Chapter III deals with data collection and its analysis and presents the model used to arrive at the results. The subsequent chapter explains the empirical and theoretical results obtained from the two games analyzed. Finally Chapter V concludes the thesis discussion with a summary of the scope of study, results, implications as well as potential areas for further exploration.

CHAPTER II. LITERATURE REVIEW

Market Structure

New industry structures are emerging in the U.S. under vertical integration or other extension of food industry firms' activities within the supply chain. This trend has become more popular as firms attempt to respond to changes in consumer demand, technology advances, the importance of plant capacity utilization, issues associated with securing inputs, and pressures from various interest groups. Nearly all commercial poultry production in the United States is company-managed, a system known as vertical integration (Leer, 2005). Companies are discovering that vertical integration, which is the process by which entities control many links in the supply chain of a product or service, allows for physical and transaction economies (Postrell, 2003).

The value of all agricultural production under contract has risen dramatically in recent years, roughly tripling over the last three decades (MacDonald et al., 2004). James, Klein, and Svkuta (2007) state that the increase in contract farming and vertically integrated forms of production are undoubtedly two of the most important changes in late twentieth-century U.S. agriculture. Contracts now govern about half of livestock production. And, while vertical integration is common in livestock commodities, it is particularly pronounced in the egg industry.

Our focus will be diverted to the egg industry in an effort to accomplish two objectives. The first is to aid in understanding the relationship between the members of the supply chain. The second is to provide background necessary to evaluate the economic implications that will emerge as a result of strategic actions undertaken by the members of the supply chain as they respond to the many pressures exerted from all angles, especially

those from animal welfare groups. This approach will aid in accomplishing the larger objective of defining optimal choices for the players involved including food firms, their competitors and their suppliers given various proposals by interest groups.

Egg Industry

The egg industry engages in raising hens for egg production either to be sold for human consumption or for hatching chicks. Prior to the 1940's most poultry production in the U.S. consisted of hens kept by families for the production of eggs for their own consumption or for sale locally (Mench, 2002). In the early 1950's through the 1960's, small extensive farms were transformed into large intensive production units (USDA American Egg Board, 2007). Today, the industry is highly vertically integrated; large egg producers deal directly with breeders to obtain parent stocks and then produce their own hatching eggs, chicks, and pullets (Hayenga et al., 2000). Most also maintain their own egg marketing operations; they pack and deliver their own eggs.

The industry has consolidated. In 1987 there were around 2,500 operations. Today there are approximately 260 egg producing companies each with 75,000 hens or more representing about 95 percent of all the U.S. layers. Sixty-four companies have over one million laying hens and eleven companies have five million plus layers. The production of eggs has grown, from 170.5 million cases in 1984 to 213.9 million in 2005. The five largest egg producing states represent approximately 50 percent of all U.S. layers with Iowa being the top state representing more than eighty egg producers and 40 million layers (USDA American Egg Board, 2006).

Egg producers own parent stock that lay the eggs. The eggs are then transported to a company-owned hatchery to produce hatching eggs, chicks, and pullets. Once the bird is

hatched it is transported to another producer/farmer and, at the end of the production period, the company removes the birds from that farm and takes them to a processing facility that they also own. Eggs destined for consumption are either packed or further processed to be sold to large retail stores or chain restaurants for final consumption. Hayenga et al. (2000) state, however, that medium-sized producers contract with others for marketing services; they pack and deliver as directed by a marketing firm who may also be an egg producing firm. This may for example apply to producers who are members of a cooperation. The small producers sell to independent packing stations.

Consumer Demands and Animal Welfare

In Animal Welfare, Economics and Policy, McInerney (2004) argues food is no longer considered from a necessity standpoint but has become a typical consumer good since the focus has shifted from its quantitative availability to its qualitative attributes. Consumers are not searching for the cheapest food; they are in search of food with the highest quality and best value. The attributes that consumers are seeking in their food are many and vary. They include nutritive value, environmental origin and locality of production, taste and flavor, presentation and brand image, and method of production. Welfare of livestock used to produce food is also growing in importance among some and increasing pressure has been placed on livestock producers, especially egg and hog producers, to satisfy the demanding standards of their large buyers. Consumers who are especially sensitive to welfare measures believe that the methods and conditions under which food animals are kept by farmers carries through to become an attribute of the resulting food product.

In a nationwide survey conducted in June and July 2007 to measure consumer preferences for farm animal welfare it was found that 95 percent of respondents believe that the way animals are cared for is important (Lusk, Norwood, and Prickett, 2007). However, only 52 percent thought the average American had the same concern. Furthermore, whereas 76 percent of respondents said animal welfare was more important than low meat prices, only 24 percent thought the average American felt the same. The authors concluded that people respond to survey questions in a manner that creates a favorable impression of themselves, rather than their true preferences. Nevertheless these statistics serve to show that there is a significant percentage of Americans that may be concerned about animal welfare. Of particular note is that 75 percent of respondents said they would vote for laws requiring more humane treatment of farm animals.

Animal rights have progressed rather slowly following the same pattern as children's rights. Both concerns generally address the issue of intentionally putting the well-being of a living thing, be it human or animal, which cannot react or complain over the direct monetary and social needs of the "owner". Life before the 1600s was very difficult therefore the inhabitants of earth had to work tirelessly just so they were able to have their basic needs such as food and shelter met. Diseases claimed children's lives at a very high rate. Therefore, in order to secure labor for farms, parents would bear a lot of children. They took a very realistic view of the world. Physical encouragement was a big issue for both children and working animals. If either failed to perform its duties, they would be punished severely, sometimes even killed. In 1825, the House of Refuge in America was founded which focused on helping children that were abused and abandoned. After focusing on child abuse and helping the population meet their basic needs with more

ease, the industrial revolution then had time to focus on other issues and animal welfare also became an issue (Shea, n.d.).

In the U.S. the American Society for the Prevention of Cruelty to Animals (ASPCA) was founded in 1866 by Henry Bergh, a wealthy philanthropist in New York, to address the issue of the mistreatment of horses. From that point the organization has grown to dealing with almost every issue that involves helping animals and ensuring that they are being treated in a humane manner (Encyclopedia Britannica, 2006 and Shea, n.d.).

Over the years as the concern for the well being of animals has increased, there have been more interest groups evolving including Compassion in World Farming (CIWF), Animal Welfare Institute (AWI), Humane Society of the United States (HSUS), and People for the Ethical Treatment of Animals (PETA). These groups are now targeting various livestock industries and spurring more consumer demand for products from livestock production following certain animal welfare guidelines.

Animal Welfare and the Livestock Industry

Robinson (2006) states that every year there is more public awareness of farm animal welfare and the livestock industry's common production practices; advocates have been working non-stop to pass both state and federal statutes which dictate the care animals must receive and the circumstances under which they must be raised for their welfare not to be compromised. Blandford (2006) mentions that there has been an increase in the number of animal welfare bills introduced in the U.S. Congress in recent years and also much activity at the state level, however only a few bills have been passed. The target of most activism is the confinement industry, not the rancher, feedlot sector or cow/calf producer. Becker (2007), in summary, states that advocates of farm animal welfare are seeking

alterations in animal agriculture practices that have been considered acceptable and necessary for a long time. Practices include but are not limited to, rearing large numbers of hogs and chickens in intensive confinement systems; performing surgical procedures such as castration and tail-docking for hogs, beak trimming; housing layer hens in cages; and isolating veal calves in small crates. This paper will emphasize the animal welfare issues in the egg industry, especially confinement issues.

The Egg Industry (2002), a monthly magazine that reports worldwide news for the egg industry, published a forthright discussion on the welfare of hens. The article included opinions of members of such organizations as the HSUS, Compassion over Killing's, United Poultry Concerns, and PETA. The article states that "No issue poses greater challenges to the egg industry than that of animal welfare." It also mentions that, in the U.S., more than 95 percent of the three million laying hens are confined in battery cages. A battery cage is typically a small enclosure with a sloping floor and equipment for feeding, drinking, and egg collection mounted on the front (European Commission, 1996). Cages have come under increasing criticism, however, largely because of the behavioral restrictions that are imposed on the birds (Mench and Siegel, 2006). Animal activists contend that modern farm practices have reduced the welfare of farm animals (Matheny and Leahy, 2007). The space allowed for hens is so small that it prevents them from performing many of their normal behaviors such as, stretching their wings, turning around without touching other birds, perching, nesting, or dust bathing. Babcock (2002) states that U.S. practices give each hen 53 square inches as compared to the EU regulations which mandate that caged laying hens have at least 111 square inches of space by the year 2012.

According to Sluizer (2006), many veterinary experts say modern confinement practices do serious harm to farm animals' physical and mental health.

Alternatively, McInerney (2004) states that, from a purely economic standpoint, farm animals are viewed as one of the resources in livestock farming, which is in itself an activity producing raw materials for the human food system in order to satisfy consumer demands.

Because of the increasing public awareness for better treatment of farm animals and the threat of losing sales from customers, players in the supply chain of the egg industry are taking action and implementing standards aimed at addressing their support for better farm animal welfare. One of the giant fast food chain restaurants, Burger King, has implemented a set of animal welfare policies which include purchasing two percent of its eggs from producers that do not confine laying hens in battery cages. Burger King expects to more than double this percentage by the end of 2007. It has also implemented preference for purchasing pork from producers that do not confine breeding pigs in gestation crates (Martin, 2007). Additionally, Rosenthal (2007) mentions that the nations' largest hog producer, Smithfield Inc. has agreed to phase out the confinement of pigs in gestation crates over the next decade. The states of Arizona and Florida have also voted to ban gestation crates in their states. These efforts suggest that animal advocates are achieving their objectives with small progress and may soon be seeing larger changes that may affect the egg and pork industries in terms of prices of meat and other livestock products in the long run.

These issues being a concern to the industries have been the major motivation of this study. Through modeling the likely interactions that will ensue due to increasing

demands from animal rights groups, we provide a framework for food firms to consider their strategic options. These insights coupled with economic theory may be the difference between increasing revenue and struggling in the long run for sustenance for food firms.

CHAPTER III. METHODOLOGY

Introduction

This chapter includes the definition of the strategic interactions analyzed, data used, and assumptions made to estimate strategic behavior of industry stakeholders. The strategic interactions of players in the egg industry are modeled using a game theory approach. Game theory stems from neoclassic economic theory which is concerned with two major areas. One is the methods and conditions under which a person or entity seeks to maximize its own utility. Second is cost minimization by participants in markets where their individual actions do not significantly influence others, that is, in a perfectly competitive market structure. However, there are many cases in which economic decisions are strategic under circumstances where conflict is a factor, hence one party's action induces a reaction from others. Game theory is the study of the ways in which strategic interactions among rational players produce outcomes with respect to the utility obtained from an object or event. The mathematical theory of strategic interactions was first noted by John von Neumann and Oskar Morgenstern in 1944 (Stanford Encyclopedia of Philosophy, 2006).

What one player in a specific industry chooses to do can influence how suppliers, competitors, and consumers will react. In the current study, game theory will be used to model the strategic actions that may result given specific assumptions. Although game theory is relevant to parlor games such as poker or bridge, most research in game theory focuses on how groups of people interact (Levine, n.d.). Gambit is the software employed; it is a library of game theory software and tools for the construction and analysis of finite extensive and strategic games (McKelvey, McLennan, and Turocy, 2000). Gambit

analyzes the optimal choices of each player in a game and solves the equilibrium by selecting the most optimal choice for each player based on the end-state payoffs assigned. Payoffs were estimated using Microsoft Excel.

The three major elements that are common in game theory models include players, strategies, and payoffs. Major players for this study include animal welfare groups, large food firms, and their competitors and suppliers. These players decide among different choice sets (strategies).

The general assumptions that apply to all games include: players are rational, each player has two or more possible strategies, the game is either one of perfect information or imperfect information, every possible combination of plays available to the players leads to a well-defined end-state (win, lose, draw) that terminates the game, and a specified payoff is associated with each end-state. Being rational means that a player can assess outcomes, calculate paths to outcomes, and choose actions with the best payoffs given the actions of other players (Stanford Encyclopedia of Philosophy). A game of complete information is characterized by perfect knowledge over every possible outcome and its associated payoff for each player. An incomplete information game is one where players are not knowledgeable as to what a certain outcome is worth to other players. Other assumptions are noted throughout as relevant to specific circumstances.

Although there have been numerous studies focusing on the economic impact of animal welfare demands on various factors, there are a limited number that have utilized a game theory model to study the strategic interactions among players. In fact, "little research has been conducted in to the causes and consequences of activist demands on food companies" as reported Hudson and Lusk (2004, pg. 80). Most studies have emphasized

topics involving the relationship between food prices and animal welfare, animal welfare as related to egg production systems, and the impact of increasing animal welfare standards on global and local trade.

The only study that we are aware of that has examined the strategic interaction between food companies and activists using a game theoretic model in a sequential bargaining context is Hudson and Lusk (2004). The study solves a simple model where competition is not explicitly recognized. The highlight of the game was to find out when food firms would offer some level of compliance based on the uncertainty level of protestors (animal activists) being serious. The study concluded that it is in the best interest of food firms to comply with animal activists' demands. Situations when compliance is not the optimal strategy to pursue depended on the expected effect of protest, the cost of protest to animal activists, and the cost for food firms to defend themselves.

In the current study, various "games" were considered to model important interactions among food firms, animal activists, and suppliers. Games were specifically developed to demonstrate strategic reactions between food firms and farmers. Four frameworks were initially considered. (1) The first depicted the potential effect of a "slippery slope effect" (e.g., animal activists, encouraged by firms accommodating their demands, will subsequently demand more). Three additional frameworks were characterized by contract agreements where a principal and an agent are involved. (2) One models the hold-up problem and considers the role of asset specificity (investment) under unexpected or changing market demand. (3) Another includes the potential for suppliers to agree to, but breach, a contract. (4) The fourth explicitly includes reaction by firm competitors.

From these four possibilities, two models were analyzed[2]. The contract model with uncertainty was empirically analyzed and the more general model depicting interactions between animal activists and two independent firms was theoretically examined. Throughout the thesis, 'firm' refers to food firms and "groups' refers to animal welfare organizations.

Data

Data were obtained from website research and interviews with experts in various fields, including animal activists, food firm personnel, and the poultry industry. Data were collected from three major websites, www.nass.usda.gov, www.ams.usda.com and www.usda.gov, and from various reports prepared by authors who utilized the same websites for their analysis.[3] Data collected included price, production cost, and premiums for both conventional and organic eggs over the period 2004 to 2006. All data are per dozen eggs. Average prices were for the farm level, wholesale level, and retail level. Production costs were for the farm level. Data on price premiums for organic eggs were limited. Thus, the average percentage reported in Oberholtzer, Greene, and Lopez (2006) was used. It included only the years 2004 and 2005.

Farm prices for conventional eggs for the period of interest were collected from USDA. This data was reported monthly on a national level. Wholesale prices for conventional and organic eggs are reported by the USDA Poultry Market News and Analysis branch monthly on a national level. Retail prices for conventional shell eggs were not located, however weekly retail feature prices were available from October 2005 until the present. No government source for cost of production data or farm prices for free-range

[2] Details of the other two models are presented under the future work section in Chapter V.
[3] Authors using the same website to carry out their analysis include Bell (2005) and Oberholtzer, Greene, and Lopez (2006).

eggs was identified. Costs of organically-produced eggs are higher not only due to higher input costs for feed but also as most "free-ranging" birds tend to be brown laying varieties which are larger, hardier birds that eat proportionately more (Michael Sheats, Branch Chief at the USDA Washington Branch, personal communication, November 16, 2007).

Since systematic collection of price data as well as production data for free-range eggs in the U.S. is not available, estimating price premiums between conventional eggs and free-range eggs is complicated. For the purpose of this study, a proxy was used. Because free-range data is not statistically reported, organic egg data was used.[4,5] Data that were not systematically reported were obtained from reports from the Economic Research Service and other government agencies. The numbers used were those that are consistent with the time period being used for this study.

With available data for premiums that organic or cage- free eggs can demand, the payoffs for principal (firm) and agent (farmer) were estimated. Although data was not used for the game that was theoretically solved due to sensitive data requirements for payoff estimates, variables were defined and assumptions made to make our conclusions realistic.

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[4] Although there was data on cage-free eggs, this was limited both in years and factors reported. For example data is available for retail prices only from June 2005 to December 2006, while reported wholesale prices were not found.

[5] Cage-free (barn systems) is where laying hens are raised in large buildings (group housing). Use of the term guarantees that the hens were not caged, but does not guarantee access to the outdoors. Free-range on the other hand is a term used more for meat production and this is where livestock are raised with unrestrained access to the outdoors (allowed to run loose). Organic eggs come from hens fed special diets with access to outdoors. All organic eggs may be termed free-range, however not all free-range can be termed organic. Oberholtzer, Greene and Lopez (2006) define free-range to mean poultry have been allowed access to the outside. The label is regulated by USDA for poultry but not for eggs. No specific amount of time outside or stock density is specified by the regulating agent (USDA).

Scenario 1

Conceptual Model: Empirical Analysis: Principal-Agent Contract
Players: Principal (firm), Agent (farmer), and Nature (Uncertainty)

This game is a sequential game that falls under the category of principal-agent contract. It is specifically an incentive contract where the principal is unable to monitor the agent's action (moral hazard) and hence cannot tell whether the contract is being breached. However agents still run the risk of being caught if they breach the contract since it is open to verification and audit by either the principal or third parties. It is modeled to reflect: welfare standards that are not product testable such as free-range production requiring allowing laying hens to access open spaces to be able to perform their normal behaviors.

The scenario is that groups have proposed to food firms that they buy eggs only from producers that provide free-range produced eggs rather than from producers that confine their hens in battery cages. The pattern of the game is that the firm offers a contract to the farmer through a wholesaler to produce eggs from free-range hens rather than those in already existing cages. If the agent accepts the contract, the agent decides if the investment (free-range) will be made and whether to comply with the terms of the contract or not. Wholesalers act as middleman in the supply chain and hence are factored in to estimate payoffs where applicable. The minimum cost incurred to prepare a production contract for small contractors is assumed to be $2,000, a cost incurred only by the firm. Additionally, there would be a $1,000 cost for negotiating time, which would be incurred by both parties. Of course this amount can vary based on time spent negotiating. Some contracts will require more time while others will take less time before a decision is reached (D., Saxowsky, Department of Agribusiness and Applied Economics, NDSU, personal communication, November 8, 2007). Both costs are fixed costs. The $2,000 is a

fixed cost because, regardless of whether the agent complies or cheats, this cost would be incurred. Furthermore, this cost is incurred at one point in time since once the contract has been drafted; the same contract details will be used for other farmers. The firm need only fill in the appropriate information for the specific farmer. Negotiation cost is a fixed (and sunk) cost also because the decision of whether to offer or not offer the contract comes after time has been spent trying to reach an agreement that is, before "the game" begins. We further assume that preparation of the contract comes after there has been a strong indication (during negotiation) that farmers are willing to invest in free-range production (e.g., that they will accept the contract).

If the contract is breached, the cost that would be incurred for legal action is assumed to be $10,000 per player. This cost is a fixed cost for both players when the farmer breaches the contract and is caught. It is a fixed cost because, whether the case is won or lost in court, the cost will be incurred. It includes the cost for attorney fees. Additionally we must note that there will be additional costs to both players if the contract is breached including loss of goodwill, brand image, and loss of sales. Thus if the contract is breached, and this is demonstrated in court or settlement, there are two additional costs that the farmer may have incurred. They may have to compensate the firm for: 1) the premium paid for fraudulent eggs delivered and 2) punitive damages so as to compensate for future firm losses. These additional costs are difficult to quantify because there are many factors that must be taken into account. For example, these costs will depend on the point of the contract at which it is breached or discovered to be breached. Additionally, quantity covered by the contract is an important factor because a contract of 1,000 dozen eggs will require less compensation than a contract for 50,000 dozen eggs. A civil penalty

of up to $10,000 per violation can be levied on any person who knowingly sells or labels as organic a product that is not produced and handled in accordance with USDA regulations (Oberholtzer, Greene, and Lopez, 2006). For the purpose of this analysis we assume a 25,000 dozen egg contract. The game is characterized by a participation constraint node and an incentive compatibility node as shown in Figure 3.1.

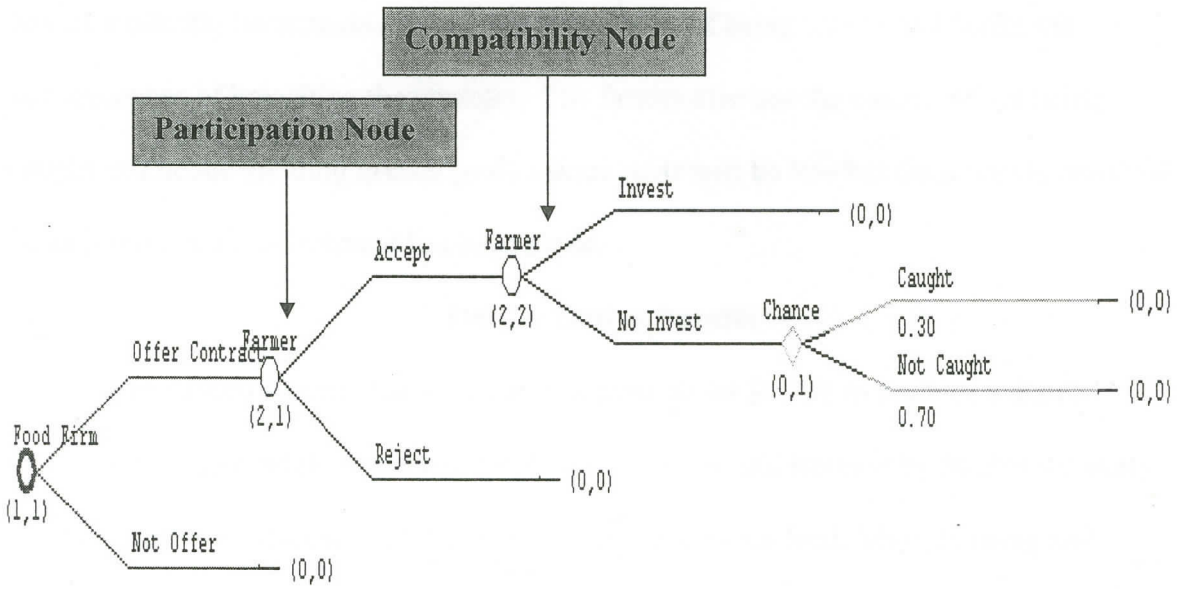

Figure 3.1. Principal-Agent Contract.

The incentive compatibility node is the node in the game tree that makes precise what incentives must be provided to an agent to induce a predetermined effort (invest or not invest) in free-range production and hence comply with the terms of the contract. The participation constraint node is the node that includes the option of accepting or rejecting the contract. It includes the incentives necessary to induce an agent to accept the contract and abandon current confinement practices for laying hens so as to meet the standards imposed by the principal. In order for the egg producer to accept the contract, the net return must be higher than the next best offer that the producer has (which we are assuming to be to maintain current production practices). The payoffs to the principal (firm) in the long

run then depend on the whether the investment is made by the agent. Hence the net return for investing in free-range production must exceed the expected value of not investing and declaring that the investment has been undertaken (cheating the contract). This is because an agent will not invest unless that investment is profitable. A chance node is included to reflect the uncertainty involved where a farmer not making the investment could claim to having made the investment and risk the probability of being caught and suffer the consequences of breaching the contract. The farmer also has the chance of not being caught and hence yielding greater profits since costs will be less but the price charged will be as if though the investment has been made.

Data to Derive Payoffs

Bell (2005) reports that, in general, it costs about $0.431 to produce a dozen conventional eggs, while free-range production costs would increase by $0.284 for every dozen of eggs (66 percent). This cost estimate accounts for feed, labor, housing and equipment depreciation and interest, cost of land, and miscellaneous expenses. Cage-free production costs would increase due to additional medication required (because of higher mortality rates with cage-free production), litter, and additional loss of eggs because of group housing.

The average price of conventional eggs at the farm level for the period 2004 to 2006, according to ERS (2007) was $0.48. Average price for organic eggs at the farm level was $1.15. From 2004 through mid 2006, price premiums for organic shell eggs ranged from 113 percent in 2004 to a high of 414 percent in 2005. The average price premium over the entire period was 278 percent. This price premium however is for the wholesale level. In order to correctly obtain farmer payoffs we must determine the premium that

farmers obtain for investing in free-range production. Since data pertaining to farm level premiums for organic eggs was not readily available in any form, we must make an assumption. It is assumed that farmers receive half the premium received at the wholesale level, or 139 percent.

Wholesale average price for conventional eggs was $0.65 from 2004 to 2006 (USDA). Average prices for conventional eggs ranged from $0.43 per dozen to a historical high of $1.14 per dozen during the same period (Oberholtzer, Greene, and Lopez and USDA, 2006). Organic eggs sold for $2.34 a dozen (Oberholtzer, Greene, and Lopez). This wholesale cost for conventional eggs includes $0.18 packaging cost (Sue Trudell, Vice President, Express Market Analytics, personal communication, November 02, 2007). This is the latest industry average cost of packaging. Table 3.1 is a summary of the data used to derive payoffs.

Table 3.1. Assumptions Used to Derive Payoffs.

Data	$/ dozen	$/ 25,000 dozen	Source
Production cost for conventional eggs	0.431	Dollars 10,775	Bell, 2005
Price of conventional eggs at the farm level	0.48	12,000	USDA (2007)
Increase in production cost for free-range	0.284	7,100	Bell
Production cost for free-range (0.431 + 0.284)	0.715	17,875	Bell
Premium: organic (farmers)	139%		Oberholtzer, Greene, and Lopez (2006).
Premium of organic eggs (Price * Premium rate)	0.67	16,750	Calculated
Price at the farm level with premium (wholesaler pays) (Price + Premium)	1.15	28,750	Calculated
Wholesaler cost to package free-range eggs	0.18	4,500	Trudell (2007)

Table 3.1 (continued)

Data	$/ dozen	$/ 25,000 Dozen	Source
Wholesaler total cost (farm price of organic eggs + packaging)	1.33	33,250	Calculated
Wholesale price: conventional eggs with packaging cost	0.65	16,250	USDA (2007)
Wholesaler price: organic eggs To retailer or food firm	2.34	58,500	Oberholtzer, Greene, and Lopez and USDA
Retail price for conventional eggs	1.04	26,000	Brettman (2007)
Retail price for organic eggs	2.85	71,250	USDA (2007)

Note: "Conventional eggs" refer to eggs from hens raised in cages.

Scenario 2

Conceptual Model: Theoretical Analysis

The game theory model shown in Figure 3.2 reflects the strategic interaction between food firms (restaurants) given that animal activists (groups) are targeting them to request that they meet certain animal welfare standards in procurement (e.g., require that their suppliers follow particular current production practices). Unwillingness to comply with activist's demands may result in restaurants being protested through picketing and other means which may cause economic damage in terms of loss of goodwill, brand image, and even sales.

The specific assumptions made in this game are in addition to the general assumptions that apply to a game theory model. Those include that all players are rational and hence each player will assess the outcomes and choose the ones with the best payoffs. Furthermore, this is a perfect information game with no uncertainty involved. Firms have three pure strategies, whereas groups have two. Although empirical analysis of this game is beyond the scope of this thesis as it would require sensitive data to support payoff

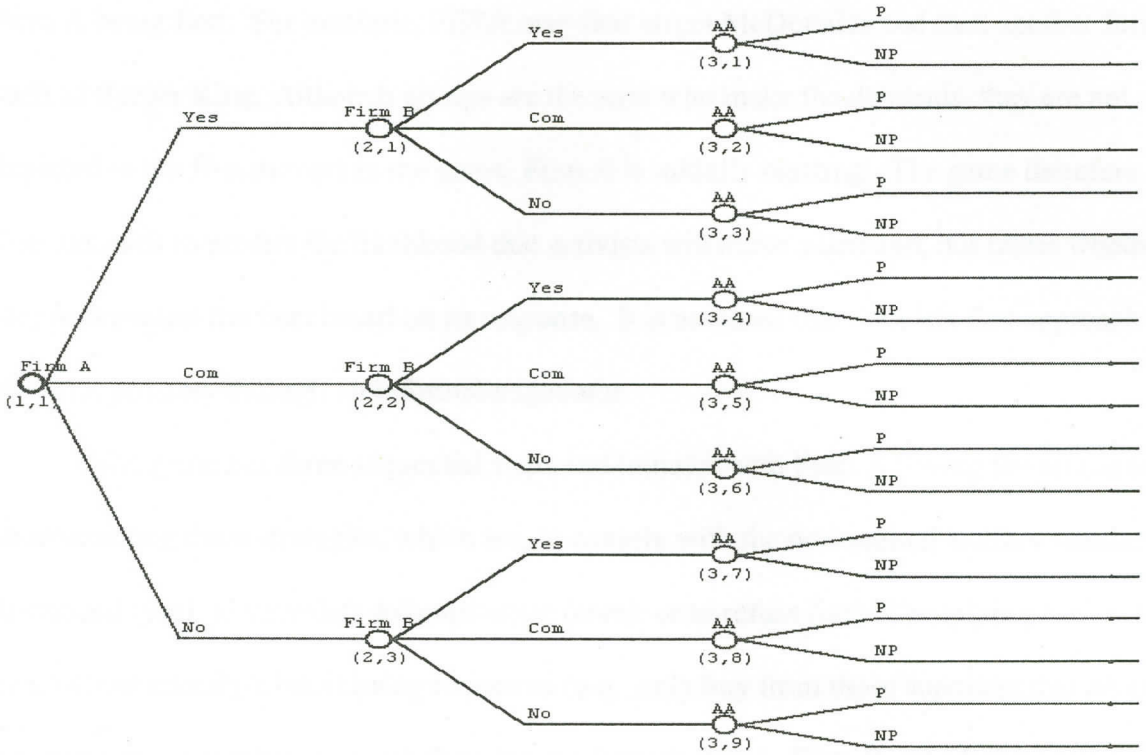

Figure 3.2. Two Firms Sequentially Facing Activists' Demands.

estimates, a theoretical approach is explored. The specific game theory technique utilized to analyze this framework is backward induction. According to Turocy and Stengel (2001) backward induction is used to solve games with perfect information. It first considers the moves that are the last in the game and determines the best action (greater payoff) for a player who moves under alternative choices for two preceding players. Then, taking these as given future actions, it proceeds backwards in time determining the best move for the respective player until the initiating point of the tree is reached.

Perhaps the most important assumption governing the result of the initial analysis is that consumers do not care about the animal welfare practice being proposed. In order to understand the nature of this sequential game with three players we also assume that the food industry is comprised of two firms (players), Firm A and Firm B. The primary reason for a sequential move is due to the assumption that firms are targeted one at a time with

Firm A being first. For example, PETA may first target McDonalds and then another firm such as Burger King. Although groups are the ones who make the demands, they are not depicted as the first movers in the game, Firm A is initially reacting. The game therefore does not seek to predict the likelihood that activists will make a demand, but rather whether they will protest the firm based on its response. It is assumed that activists first approach the firm, possibly through an informal negotiator.

The game has three sequential steps and initiates with Firm A having the option to choose among three strategies, which are, to comply with the new animal welfare standard demanded (yes), to negotiate a compromise (com), or to refuse (no). Complying here will mean doing exactly what is being requested (e.g., only buy from those suppliers that adopt complete free-range practices for their livestock production). Firm B, which is targeted after Firm A, has the same strategies available. Firm B's actions however may be influenced by what its competitor, Firm A decides to do. After both firms have been faced with the new animal welfare standard demands, the third stage in the game is played by activists that choose one of two strategies, either protest (P) the firms or decide to walk away and leave their objectives unaccomplished (NP).

Further assumptions about the groups and their strategic options include mentioning that groups will not protest when there is a "comply, comply" result from food firms, and that the cost to protest either Firm A or Firm B is the same. Further, protesting both firms at the same time would cost twice as much than when only one firm is protested at a time.

Defining Variables

Food firms are facing activists who are pressuring them to require that their suppliers change their production practices, mainly addressing the confinement issue in the egg industry. The change in revenue that a group can inflict on a restaurant is assumed to be represented by E. This variable is a function of price and quantity. If firms decide to comply with the new standards there may be new (or revised) products that, depending on the actions of competitor restaurants and elasticity of demand for animal welfare attributes, may change demand. There will also be changes in costs associated with compliance. The cost to comply is represented by K which includes cost to promote any new products and increased input costs. It is unlikely that any increased cost associated with raising animals under reduced confinement can be fully absorbed by the farmer. Thus, the resulting eggs can be expected to cost more.

Animal activists' goals in general are not to directly cause economic damage. Rather they are more interested in achieving increased animal welfare through eliminating or altering confinement practices. The increased welfare for activists is equal to W. If groups are not satisfied with the choices from Firm A and Firm B, they may protest either firm or both. Cost of protesting is denoted by P. Table 3.2 summarizes the variables.

Table 3.2. Summary of Variables.

Variable	Function of
E	$=f$(p, q). p = price and q = quantity. The change in revenue for firms depending on strategy choice, strategy choice of competitors, and of activists, and response of consumers.
K	$=f$(promotions, increased costs in inputs). Cost to firms to comply with activists' standards.
W	$=f$(change in welfare).
P	$=f$(nature and level of protest). Cost incurred by activists if they protest; p = 0 if they do not protest.

CHAPTER IV. RESULTS

Scenario 1

This chapter shows the results obtained for both scenarios 1 and 2. The results from scenario 1, contracts between food firms and farmers, are shown in Figure 4.1. The numbers in parentheses after every node are payoffs. The first number corresponds to the payoff for the 'firm' and the second corresponds to the payoff for the "farmer." All numbers are in dollars. The numbers in the parentheses below each node represent players and information sets, respectively. For example, (2, 1) means player two (farmer), information set one. The numbers on the branches representing uncertainty are probabilities. In the base case, there is a 70 percent chance of being caught and a 30 percent chance of not being caught if investment is declared when it is not actually done. These probabilities are assumed and later tested with sensitivity analysis. The payoffs for each choice set are defined here, with the payoff to the firm being a change from the pre-game profit realized.

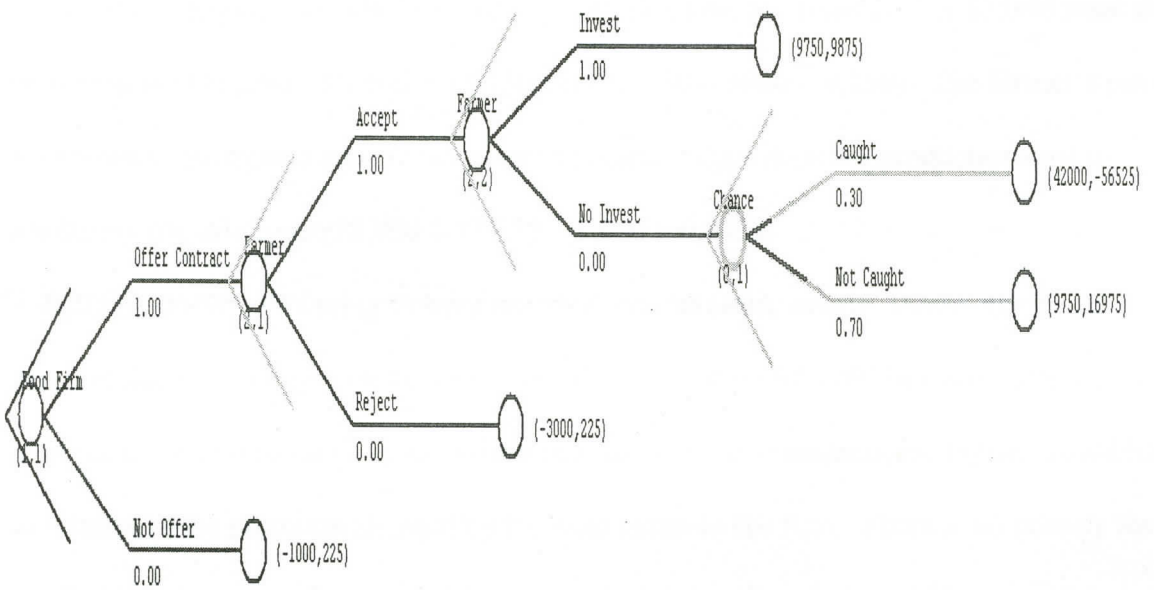

Figure 4.1. Probabilities: 70 Percent Not Caught and 30 Percent Caught.

1. (-1000, 225) Contract not offered. The payoff for the firm is $-1,000 because it experiences a negotiation cost of $1,000. An agreement is not reached and activist group pressure is ignored. We assume that the firm will not offer the contract. The farmer under this case will continue producing conventional eggs, hence 1,225 is total revenue minus the production cost of conventional eggs; (12,000 – 10,775 = 1,225). The farmer will also incur $1,000 for negotiation, therefore his final payoff is: 1,225 – 1,000 = 225.

2. ($-3000, 225) Contract rejected. Although the farmer will not accept the contract it still continues producing the 25, 000 dozen conventional eggs for the open market. Three thousand dollars accounts for costs incurred including negotiation and preparing the contract. It is a negative payoff to the firm. The farmer rejecting the contract will have incurred negotiation cost as well which is $1,000. It will continue producing conventional eggs for other buyers.

3. (9750, 9875) Contract accepted and the investment made. The firm's payoff with the investment made and no breach from the agent will be the total revenue (from retail price) of free-range eggs minus wholesale price; from this total the fixed cost of $3,000 must also be subtracted (71,250 – 58,500 = 12,750, and 12,750 – 3000 = 9,750). The farmer's payoff for investing in organic eggs is the price of organic eggs minus the production cost of producing organic eggs (28,750 – 17,875 – 1,000 = 9,875).

4. (42000, -56525) Claiming to have invested, not invested, caught. Recall that firms contract farmers through wholesalers. The firm's return is $42,000 because, although it paid the price of free-range eggs to the wholesaler, we are assuming the farmer would have to reimburse the premium charged by the wholesaler to the firm. There is no penalty fee applied here because when a contract is breached the settlement is usually to pay the

difference between the value of what was promised and what was delivered. Although this is the case, settlement depends on the parties involved and what they agree to. Although the firm overpays the wholesaler $42,250 it did sell the misrepresented eggs at a free-range price and does not necessarily later need to compensate customers. Essentially, the firm does not lose the money it claims in the settlement, thus, negotiation sometimes can be reached where the amount paid to the firm is less than the actual premium that was paid (D. Saxowsky, Department of Agribusiness and Applied Economics, NDSU, personal communication, November 8, 2007). This total amount of $42,250 is later varied to test the sensitivity of different settlement agreements.

Sales (25,000 dozen at 2.85/dozen)	71,250
Less Expenses	
Legal fees	10,000
Fixed costs	3,000
Cost of eggs (25,000 dozen at 2.34)	58,500
Total Expenses	71,500
Reimbursement	-250
Net Income	42,250
	42,000

The farmer has a negative payoff since, if caught, legal action may be taken by the principal, reputation will be lost and the current contract may be terminated. The farmer will also incur $10,000 for attorney fees and $1,000 for negotiation. The egg industry is highly vertically related (Hayenga et.al, 2000). Because of vertical integration, wholesalers have agreements with farmers to raise their laying hens and then pay farmers for the eggs produced. Farmers may be caught by firms (rates from the wholesaler) through auditing parties that the firm will hire. Therefore, when caught cheating, the contract firm is

assumed to go after the farmer. Wholesalers are assumed not to be knowledgeable of the breach. Even if the firm goes after compensation from the wholesaler for the extra amount of money paid for organic eggs that were actually conventional eggs, it is likely the wholesaler will pressure the farmer to compensate the firm. It was the farmer that breached the agreement. The wholesaler will also demand the farmer to reimburse the difference that he/she paid to the farmer for the misrepresented eggs. The farmer thus is exposed to two costs: compensate the firm, and legal fees. Although the farmer must compensate the wholesaler, this money is not a "cost" to the farmer because the farmer received that premium and essentially is just returning the unearned money. We test the sensitivity of the results to this scenario where the farmer must compensate both the firm and the wholesaler to situations where no wholesaler existed. The payoff calculation associated with reimbursing the wholesaler is shown below.

Wholesaler paid farmer free-range price for 25,000 dozens (1.15 * 25,000)	28,750
If wholesaler paid conventional price (0.48 * 25,000)	12,000
Reimburse	16,750
Farmer owes wholesaler cost for packaging (25,000 *0.18)	4,500
Total Cost	21,250

The farmer payoff therefore, includes the following:

Sales (25,000 * 1.15) premium included		28,750
Expenses:		
Attorney fee	10,000	
Negotiation fee	1,000	
Reimbursing wholesaler (less premium)	16,750	
Wholesaler packaging cost	4,500	
Production cost (25,000 * 0.43)	10,775	
Reimburse the firm on behalf of the wholesaler	42,250	
Total Expense:		85,275
Net Income		-56,525

5. (9750, 16975) Claiming to have invested, not caught. If the firm does not discover that the investment has not been made then it will be paying the price of free-range eggs and selling the eggs at free-range egg price (71,250 – 58,500 – 3,000 = 9,750); the farmer will be earning profits at the firm's expense. Subtracting the $3,000 fixed cost from profits yields $9,750. The farmer will incur production cost for conventional eggs but charge the price of free-range eggs to the wholesaler (28,750 - 10,775 – 1000 = 16,975).

One Sequential Equilibrium

We assume a 30 percent probability that the farmer is caught breaching the contract. Figure 4.1 demonstrates the sequential equilibrium to the game, which is, the contract will be offered and the farmer will accept the contract and make the investment. We note that although the payoff to cheating is significantly more than the amount from investing (16,975 versus 9,875), the farmer prefers to refrain from breach of contract. This result is due to the possibility of being caught and the relatively large negative payoff if caught.

These returns are however assuming absolute certainty; therefore expected payoffs are calculated by factoring in the probabilities assigned to the chance node. Let P represent probability. Thus the farmer's expected payoff with no investment made is:

P (caught | no investment) = 0.30 and P (not caught | no investment) = 0.70.

-56,525 * P (NI|C) + 16,975 * P (NI|NC) = -56,525 *0.3 + 16,975 * 0.70 = -5,075.

Hence because the expected payoff to the farmer is -$5,075 versus $9,875 when the investment is made, the farmer will choose to comply with the terms of the contract.

On the other hand, the expected payoff to the firm when the farmer fails to invest is:

42,000 * P (NI|C) + 9,750 * P (NI|NC) = 42,000 * 0.30 + 9,750 * 0.70 = 19,425.

Sensitivity 1: Probabilities

The probabilities were changed to reflect a nine percent probability that the farmer will be caught if he does not invest and declares that he does (implying a 91 percent probability of not being caught) (Figure 4.2). The first observation here is that as the probability of being caught decreases there is more incentive to breach the contract. Similarly in this game the decision of whether to invest or not is dependent on the farmer's expected payoffs.

P (caught | no investment) = 0.09 and P (not caught | no investment) = 0.91.

-56,525 * P (NI|C) + 16,975 * P (NI|NC) = -56,525 *0.09 + 16,975 * 0.91 = 10,360.

Therefore, since the expected payoff of not investing is 10,360 versus 9,875 when the investment is made, the farmer will choose not to invest.

Although trial and error using Gambit was utilized to select these probabilities, there exist alternative ways to calculate these probabilities. Following is an example:

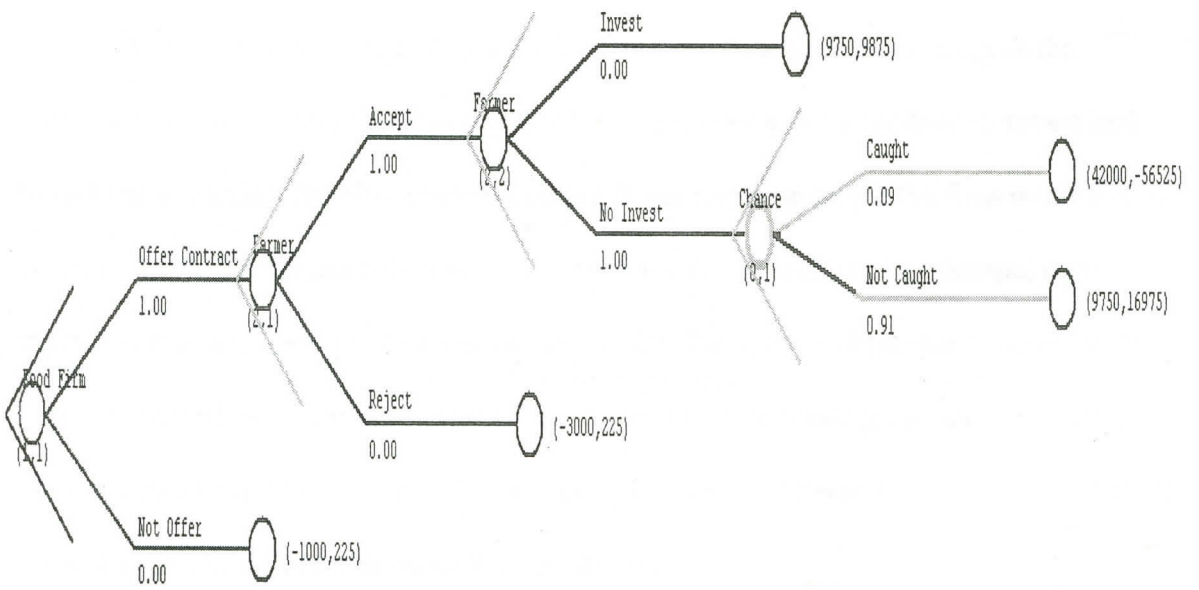

Figure 4.2. Probabilities: 91 Percent Not Caught and 9 Percent Caught.

Farmer's payoff with the investment made is 9,875 as calculated earlier.

The farmer will be indifferent between making the investment and breaching the contract if the expected payoff was the same when the contract is breached. Similarly, the farmer will not invest if the expected payoff for not investing was greater than that when the investment is made, 9,875. Therefore, calculating the probability at which the farmer will be caught for the investment to be made is noted as the expected payoff with no investment.

Expected payoff, no investment = -56,525 * P(C) + 16,975 * [1 – P(C)]

-56,525 * P(C) + 16,975 * [1 – P(C)] = investment payoff

-56,525 * P(C) + 16,975 * [1 – P(C)] = 9,875

P(C) = -56,525 + 16,975 – 16,975P = 9,875

– 73,500P = – 7,100

P = 0.0965

At P(C) = 9.65 percent, the farmer is indifferent between investing and not investing. As long as the probability of being caught is 9.65 percent or less, the contract will be breached.

In the third game, we observe that, at 10 percent probability that the farmer will be caught, the investment is made (Figure 4.3). Thus, we conclude that as long as the probability of being caught is 9 percent or less the farmer will be inclined to invest and breach the contract. We also observe that the dominant strategy for the firm is to offer the contract, while the farmer will always accept. Thus the payoffs of the principal depend on the action that the agent pursues and the action that the agent will pursue depends on the expected payoff, which in turn depends on the probability of being caught. The farmer's expected payoff in this case is 9,625 as opposed to 9,875. Therefore at this probability of being caught the farmer will make the investment.

P (caught | no investment) = 0.10 and P (not caught | no investment) = 0.90.

-56,525 * P (NI|C) + 16,975 * P (NI|NC) = -56,525 *0.10 + 16,975 * 0.90 = 9,625.

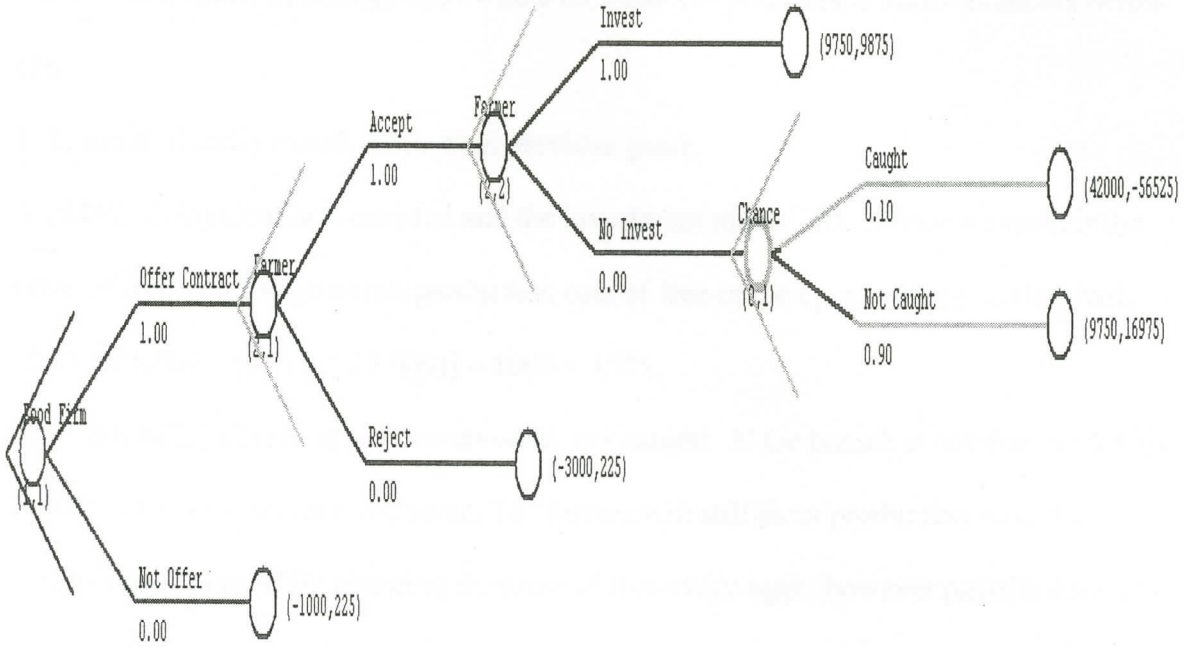

Figure 4.3. Probabilities: 90 Percent Not Caught and 10 Percent Caught.

Sensitivity 2: Premium

In order to account for premium effects in the equilibrium, we next assume different values for the premium percentage that farmers can obtain for free-range eggs. We examined the output if farmers were able to demand half of the 139 percent premium (69.5 percent). Recall that the base amount was obtained by dividing the total average premium at the wholesale level by two. To test for sensitivity to this premium, we first assumed a quarter of the total wholesale level premium.

When the contract is not offered and when the contract is offered and rejected as well as, when the contract is breached and not discovered, the payoffs stay the same as in the base case for all other sensitivity tests regarding premium. However, when the contract is accepted and the investment made, although the payoff of the firm remains the same as

in the base case, the farmer's payoff changes. This is due to a different price for free-range eggs. The price of free-range eggs with a 69.5 percent premium is $0.81 as shown below (3).

1, 2, and 4. Exactly match those from previous game.

3. (9750, 1375) Contract accepted and the investment made. The farmer's payoff is the price of free-range eggs minus production cost of free-range eggs and negotiation cost. [0.81 * 25,000 – (0.715 * 25,000)] – 1000 = 1375.

5. (9750, 8475) Claiming to have invested; not caught. If the breach is not discovered, the payoff of the firm remains the same. The farmer will still incur production costs for conventional eggs while charging the price of free-range eggs; however payoffs decrease because the premium is less.

Farmer payoff = (price + premium) * quantity – conventional production cost – negotiation cost
= (0.48) + (0.33) * 25,000 – 10,775 - 1000
= 8,475

From Figure 4.4 it is clear that even at a premium of 69.5 percent the dominant strategy for firms remains to offer contract. Firms would offer the contract and farmers would accept the contract and invest. The strategy that would be undertaken by the farmer is dependent on the probability of being caught breaching the contract and the expected payoff to the farmer. The farmer invests with a 69.5 percent premium because its expected payoff when no investment is made is -$11,025 as compared to positive $1,375 when the investment is made.

P (caught | no investment) = 0.30 and P (not caught | no investment) = 0.70.

-56,525 * P (NI|C) + 8,475 * P (NI|NC) = -56,525 *0.30 + 8,475 * 0.70 = -11,025.

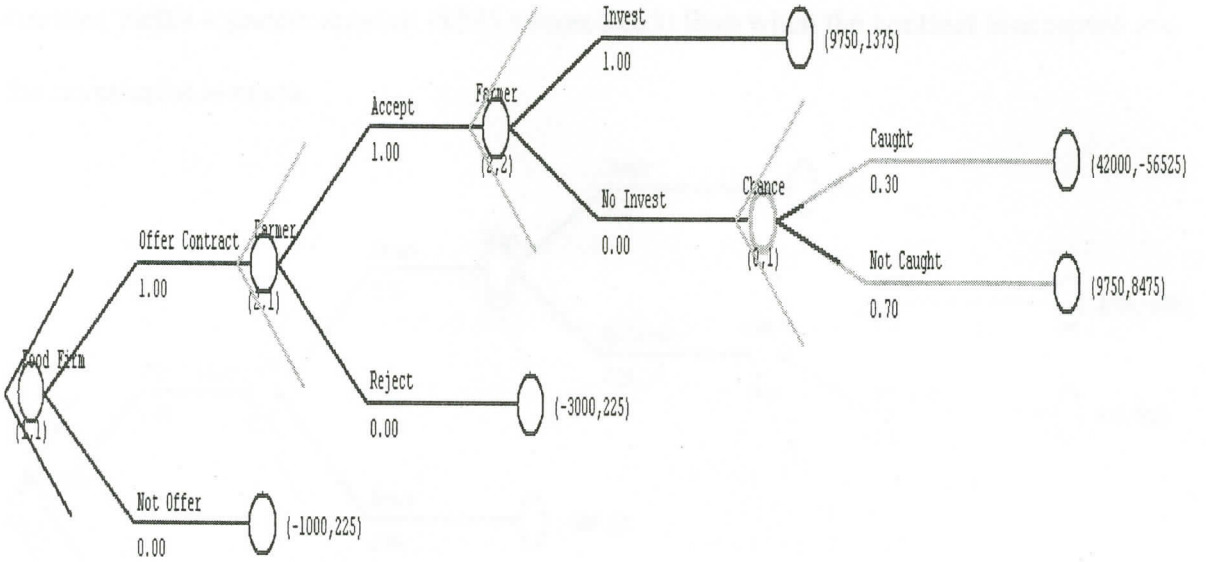

Figure 4.4. Farmer Premium 69.5 Percent.

Further sensitivity tests were done to identify the premium level that farmers would have to be paid in order for firms to have an incentive to offer the contract and for farmers to participate (accept contract).

In Figure 4.5, with a 58 percent premium firms will not offer the contract (the game ends here). This is the case because the firm prefers to lose $-1,000 for negotiation time rather than $-3,000 for negotiating and preparing the contract when the farmer has given a strong indication that it will not participate in the game. At this premium the farmer is better off producing conventional eggs because its payoff (based on a 25,000 dozen contract) will be $225, while, if it accepts the contract and makes the investment, it will only be able to earn $85.

In Figure 4.6 at 59 percent premium, the result is quite different. The firm is fully convinced that it would be profitable to give in to the initial demands of animal activists. The farmer however, has some skepticism. Although the firm will offer the contract, the farmer will reject it. This result is due to the estimated payoffs showing that rejecting the

contract yields a greater amount ($225 versus $205) than when the contract is accepted and the investment is made.

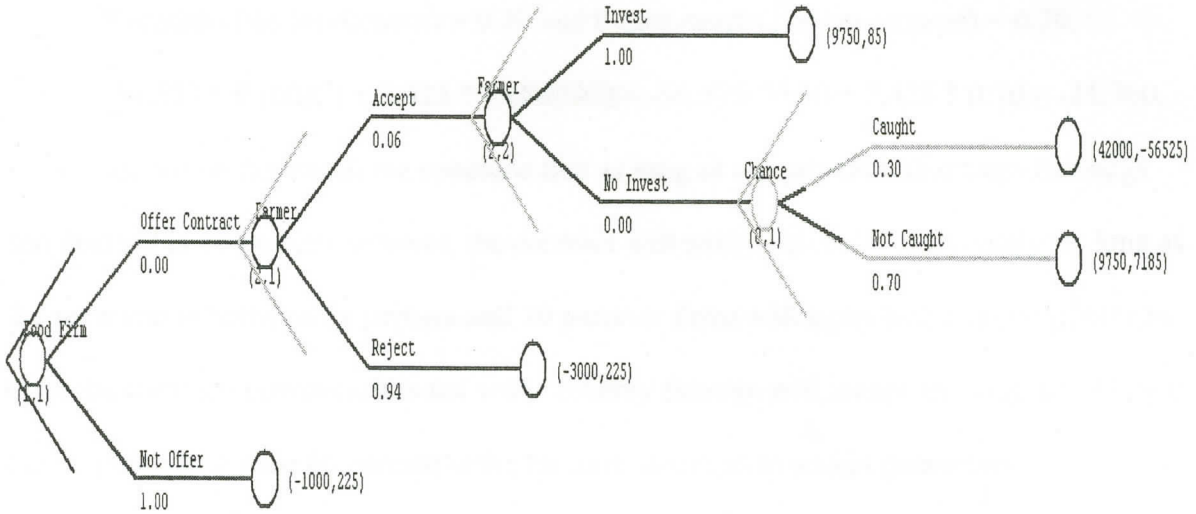

Figure 4.5. Farmer Premium 58 Percent.

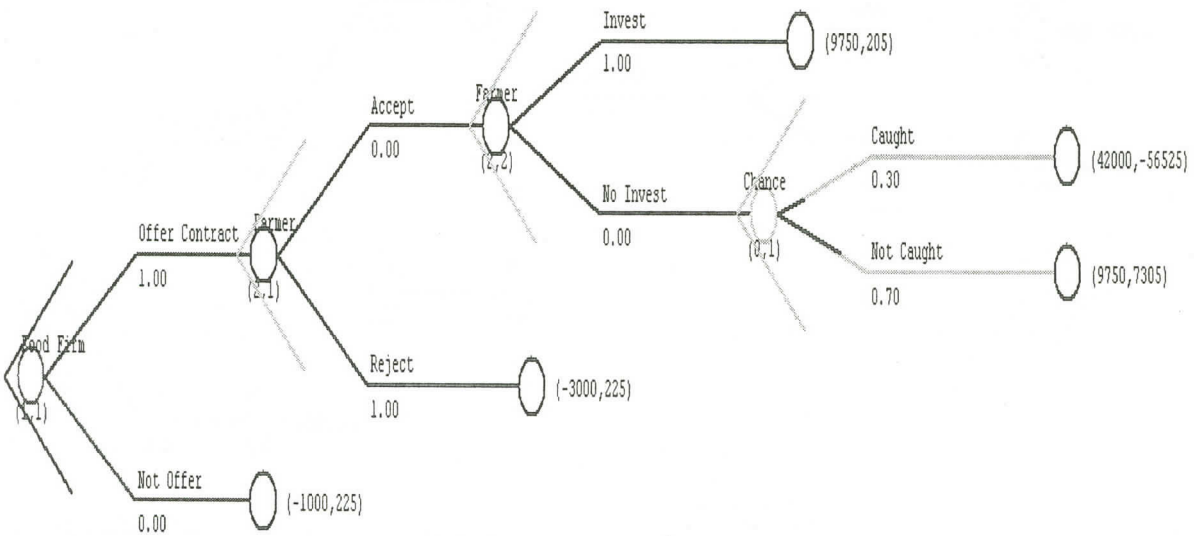

Figure 4.6. Farmer Premium 59 Percent.

From Figure 4.7 we observe that with a premium of 60 percent farmers are no longer in doubt of the profitability of producing free-range eggs. The contract will be offered, accepted, and the investment made. This action is motivated by the fact that, with

investment, the expected payoff to the farmer is $325, while if the contract is breached the expected payoff is negative, $-11,760.

P (caught | no investment) = 0.30 and P (not caught | no investment) = 0.70.

-56,525 * P (NI|C) + 7,425 * P (NI|NC) = -56,525 *0.30 + 7,425 * 0.70 = -11,760.

Based on this result we conclude that as long as the premium that cage-free eggs can demand is 58 percent or lower, the contract will not be offered. Additionally, as long as the premium is between 58 percent and 59 percent, firms will agree that it is compatible to offer the contract; however, it is not with certainty farmers will accept the contract. Only if the premium is at least 60 percent is the farmers' decision to accept guaranteed.

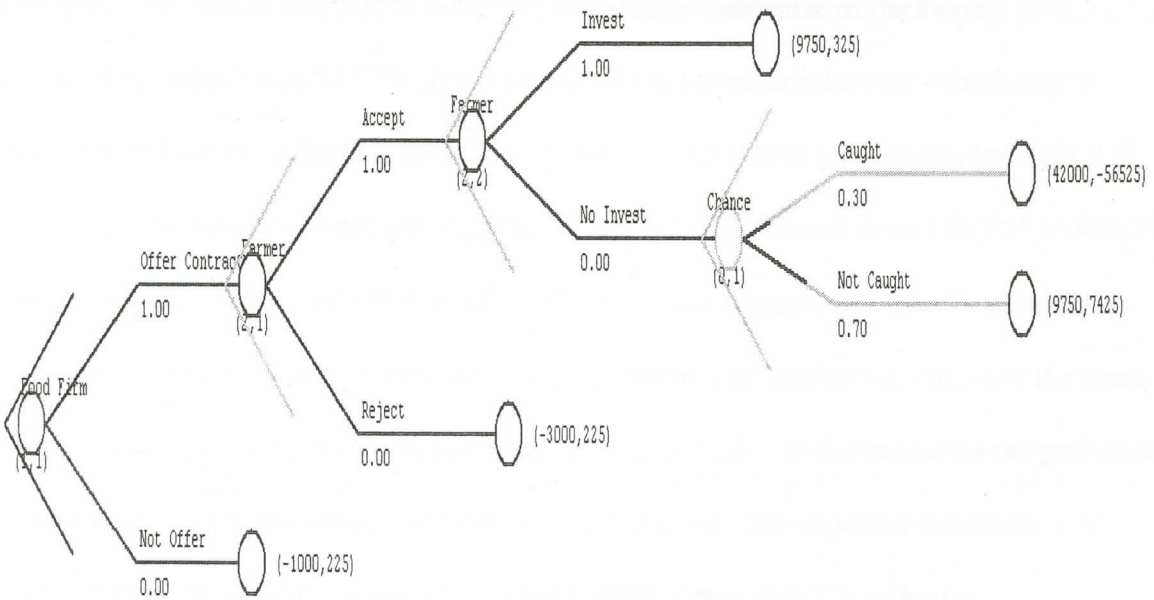

Figure 4.7. Farmer Premium 60 Percent

Sensitivity 3: Reimbursing the Firm and Not the Wholesaler.

Sensitivity of the results to the amount that the farmer would have to pay when caught cheating was tested. In the base case, payoffs were calculated assuming the farmer

would have to reimburse the wholesaler for the premium charged. Additionally, we also included payment to the wholesaler for extra packaging and processing cost incurred. The farmer's payoff was a total of $-56,525 in a situation where the contract was breached and it was discovered. However, if the farmer reimbursed both the wholesaler and the firm, it means that the only party that ends up losing when breach occurs is the farmer. In the following game we assume that the farmer would reimburse the premium charged by the wholesaler to the firm and that the wholesaler would settle with this agreement. This is because the wholesaler would not lose in a breach since it would be the farmer reimbursing the firm. In the base case, the farmer reimburses the wholesaler $16,750 for the premium charged. The farmer also had to cover the wholesaler's expense of packaging, processing, and grading, which was $4,500. If the farmer did not have to return the wholesaler's premium and cover packaging costs, its negative payoff would be decreased to $-35,275.

Figure 4.8 shows that although the farmer's loss decreases from $56,525 to $35,275 when the wholesaler is not reimbursed for the premium charged and the extra costs it incurred packaging the misrepresented eggs, the sequential equilibrium remains the same. The contract is offered, accepted, and the investment made. In the base case the probability of being discovered breaching the contract is 30 percent. We expected the result to be highly dependent on this probability. Indeed, when the probability of being caught is 13 percent or less the farmer would more than likely breach the contract. In the base case where the farmer would have a loss of $56,525, breach can occur when the probability of being caught is 9 percent or less. Restated, the decision of whether to breach or not depends on the probability of being caught. Furthermore, as the amount lost when caught breaching the contract decreases, there would have to be a higher probability of being

caught to make the investment. That is, there is a tradeoff between probability of being caught and penalty imposed if caught.

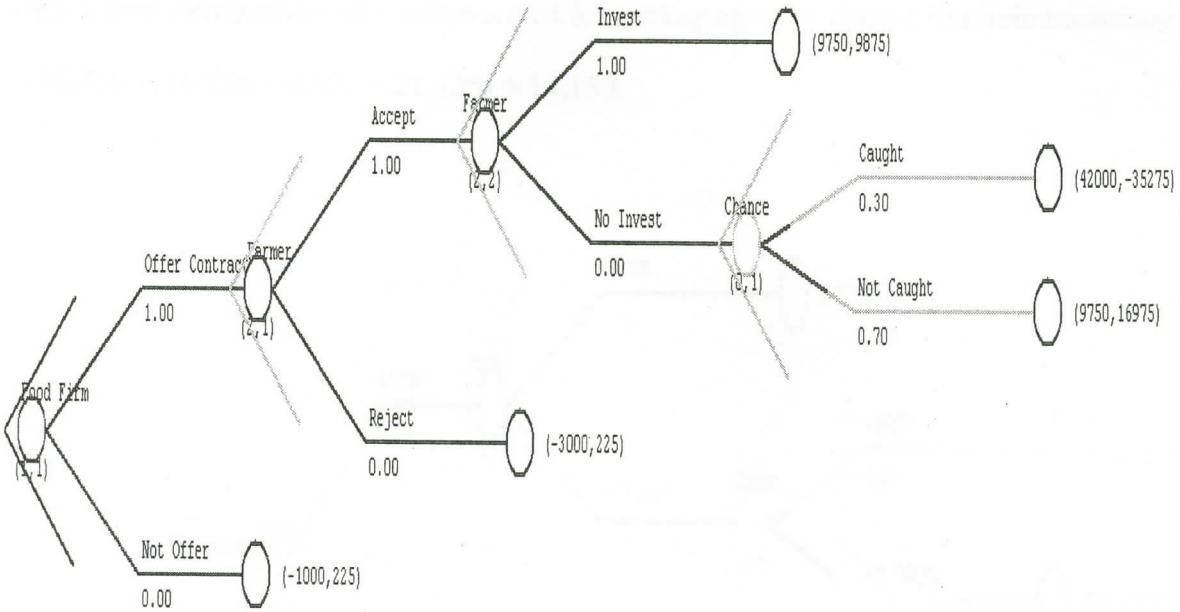

Figure 4.8. Wholesaler Not Reimbursed.

Sensitivity 4: Reimbursing the Firm 50 Percent of the Premium Charged.

In another case we assume that, since the firm may not explicitly lose money, it will sell the eggs at free-range price and may not thereafter explicitly compensate consumers for the premium charged. In this case, the firm and the farmer may be able to negotiate a settlement less than the amount of the premium charged. In the base case scenario the firm's operating return was $42,000. If both parties were to negotiate a 50 percent reimbursement of the premium charged, the firm would only receive $21,125 for the premium charged on the faulty eggs. Therefore instead of $42,000 the firm would have a return of $20,875 (42,000 – 21,125).

The farmer in this case would only lose $14,150 if it were to breach the contract. This is also excluding the wholesaler in the final settlement. Thus, original loss – (wholesaler reimbursement + cost covered for packaging + 50 percent firm reimbursement) = 56,525 - (16,750 + 4,500 + 21,125) = 14,150.

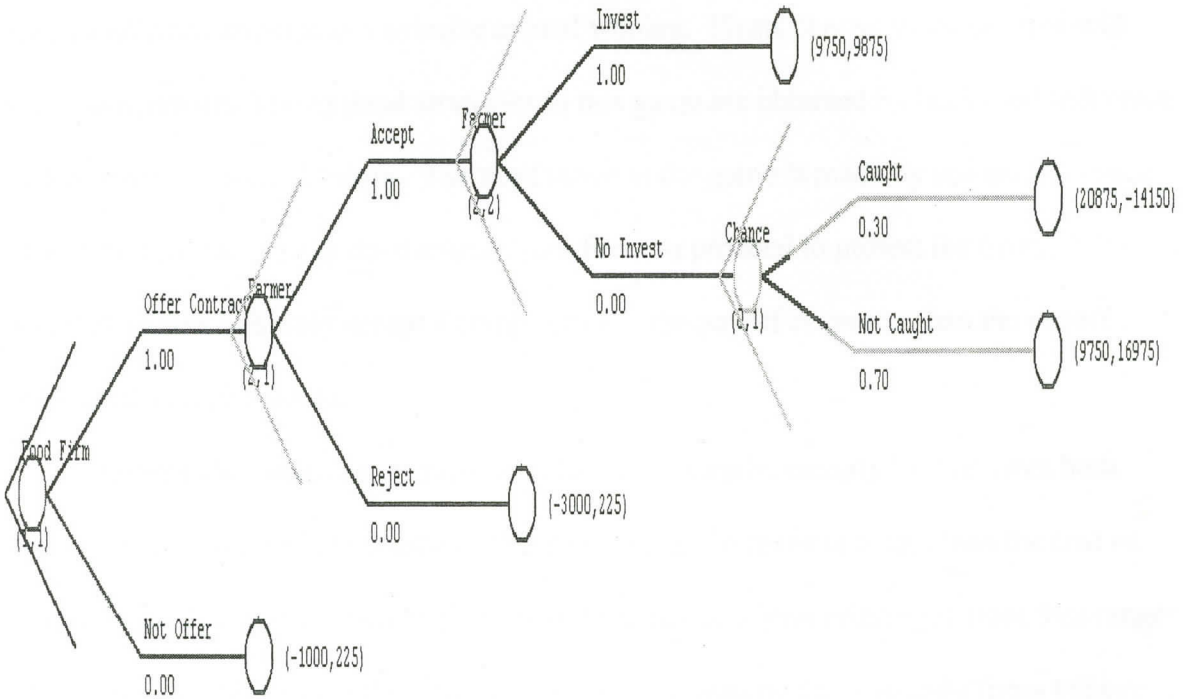

Figure 4.9. 50 Percent Settlement.

Figure 4.9 shows that even when only 50 percent of the total premium charged to the firm must be reimbursed, the one sequential equilibrium remains the same. The contract is offered, accepted, and the investment made. This result is also dependent on the probability of being caught. We again changed the probabilities given these payoffs and found that, as long as the probability of being caught is 22 percent or less, farmers would

more than likely breach the contract. As the amount that can be lost if caught breaching the contract decreases, investment is motivated only by a higher probability of being caught.

Scenario 2

Third Node Analysis

As in all games, players will choose the strategy that maximizes their payoff. Animal activists attempt to maximize animal welfare. Firms choose strategies that will maximize payoffs. The optimal strategies to this game are obtained by backward induction to derive the Nash equilibrium. The third move in the game is made by groups who must choose between accepting the decision from firms or proceed to protest the firms. We must note that groups will only accept a compromise if the payoff is greater than the payoff associated with protesting.

Ultimately groups are striving to achieve a "comply, comply" action from both firms, hence their goal is to convince firms the change in revenue is less than the cost of compliance. That is, to convince firms that the benefits of procuring eggs from free-range production are greater than the costs; $E - K > 0$. We assume that currently firms believe that $E - K < 0$. If it was perceived as positive then rational firms would have already implemented the animal welfare friendly procurement practices.

Second Node Analysis

In the second stage, firm B has three choices; comply with the standards, negotiate a compromise, or refuse. It is reasonable to assume the cost of complying, K, is greater than the cost of compromising which is greater than the cost of refusing ($K_{byy} > K_{byc} >$

K_{byn})[6]. In order to achieve a "comply, comply" strategy, animal activists must therefore convince the firms that the demand for the firm will change once free-range products are introduced (or alternatively that demand will negatively change if they are not implemented). To achieve full compliance, firms must be convinced that their change in revenue will be greater if they complied fully than if they negotiated a compromise (E_{byy} - $K_{byy} > E_{byc}$ - $K_{byc} > E_{bynpB}$ - K_{bynpB})[7]. For example, Firm B would negotiate a compromise rather than fully comply if it cost less but did not affect revenue. The caveat is that a compromise may not fully satisfy the activists but rather only reduce the likelihood or extent of protest. Thus although the firm negotiated a compromise, the chance of protest remains.[8]

First Node Analysis

As mentioned earlier, animal activists are in the game with the goal of achieving full compliance from both firms since this would mean that they would achieve their maximum payoff ($W_{yy} - 0$). Therefore, just as they have to convince Firm B that the benefits of free-range production practices are greater than the costs that will be incurred, in the same manner they must be able to convince Firm A that the same holds. Therefore Firm A must be convinced that a positive change in revenue if it complies will outweigh any increased cost as compared to negotiating a compromise (E_{ayy} - $K_{ayy} > E_{ayc}$ - $K_{ayc} > E_{ann}$ - K_{ann}). To obtain their objective of "comply, comply," animal activists must convince both

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[6] The first subscript represents which firm to which the variable applies. The second subscript represents Firm A's choice of action while the third subscript represents the strategy undertaken by the Firm B. Y for yes, c for compromise, and n for no.

[7] The fourth (and fifth) subscript denote the action taken by animal activists against firm A and B, respectively, p for protest and np for no protest. The last subscript (capitalized) represents which firm is either being protested or not.

[8] This reflects a situation of only an informal compromise with one activist group (e.g., the agreement did not have the requisite strength to negate a protest, or was not accepted by another activist group who did not accept the compromise).

firms that the price they can charge will increase or that they will sell more, or both (or alternatively that they would otherwise lose an amount greater than the cost of complying). Assuming firms A and B compose the industry, activists would need to convince the firms that industry demand for animal welfare is inelastic (e.g., industry revenue will increase if more stringent animal welfare standards are adopted).

Nash Equilibrium Given Two Assumptions

It was previously noted that the preferred strategy for animal activists is "comply, comply". If competition on animal welfare standards does not influence firm-level demand within the industry, i.e., customers are indifferent towards free-range products and products coming from confined livestock or $\Delta E = 0$, it becomes of greater concern for firms to minimize costs (refuse demands). Obtaining this Nash equilibrium implies that even when animal activists protest, the expected effects will be negligible. Thus, activists tend to focus on convincing firms that their decision to not comply will negatively affect their revenues.

CHAPTER V. CONCLUSIONS AND IMPLICATIONS

This final chapter is composed of four sections. Section one provides a brief summary of the thesis. Sections two and three are summaries of the main findings from the scenarios analyzed, and conclusions and implications. Section four outlines suggestions on future work that may be explored.

Summary

The motivation for this study was a combination of factors. There has been very little study geared towards understanding the strategic actions that emerge among food firms, their competitors, and their suppliers in the egg industry in the face of increasing pressure from animal activists. Furthermore, from the limited work that exists, we found only one study that utilizes a game theory model to analyze the strategic action between food firms and animal welfare activists.

The purpose of this study was to evaluate the strategic decisions that food firms would pursue given proposals from animal activists. Optimal choices are defined for firms and their suppliers in a situation where decisions regarding contracts for new production standards are evaluated. Also included is consideration of how progress on standards in animal welfare might influence the procurement demands of food industry firms. The impact of choice sets on firm profitability was evaluated. Optimal choices for industry participants were selected and the sensitivity of key choices tested.

Two scenarios were explored; a principal-agent contract model between food firms and farmers and a model including more than one firm targeted by animal activist organizations. The former model was empirically analyzed while the latter model was theoretically examined.

Conclusions and Implications

Scenario 1: Principal-Agent Contract

The principal-agent game was employed to determine the strategic actions that will ensue between food firms and farmers when faced with proposed changes in animal welfare standards in the production process. Although systematic data for free-range production was not available, using data for organically produced eggs aided in providing reasonable results. These results offer substantial base for conclusions to be drawn and to make recommendations to food firms and farmers when considering the pressure exerted by animal activists. The framework itself provides a means for participants to consider their situation (i.e., through use of their own estimated values).

We initiated this empirical analysis with a base case assuming specific costs for negotiation and preparation of a 25,000 dozen egg contract, a 139 percent premium to farmers for free-range egg production, and a 30 percent probability that a farmer would be caught breaching the contract.

The one sequential equilibrium in the base case is that firms will always offer the contract, farmers will always accept. The issue of greatest interest is therefore whether farmers will invest in free-range production or breach the contract. From changing the probabilities that farmers will be caught breaching the contract we are able to obtain results that indicate the level at which auditing systems must be performed in order to entice farmers to honor the contract. Findings indicate that as long as the probability of being caught is at least 10 percent farmers will make the investment. Otherwise, they will fail to make the investment and declare that they did (i.e., accept but breach the contract).

The next step was to test how sensitive these results were to the level of premium that farmers receive for free-range eggs. In estimating payoffs with varying premiums we noted that when the contract is not offered, when it is rejected, and when the farmer is caught breaching the contract, the returns remain the same as they were in the base case.

This analysis led us to conclude the following: as long as farmers are able to demand at least a 60 percent premium, there is no doubt about accepting the contract, and likewise about making the investment. Furthermore, as the premium rate drops to 58 percent and below, firms will not consider complying with demands from animal activists. Farmers would offer strong indication that they will not participate in such a contract because it would be perceived as less profitable (assuming negotiation takes place before preparation of contract). With a slight increase in premium that is, at 59 percent premium, although firms will offer the contract, farmers will not always accept.

In the base case, the farmer was assumed to be required to reimburse both the wholesaler and the firm for the misrepresented eggs provided when caught breaching the contract. However, given that both the wholesaler and the firm sold the product at its respected premium (e.g., as free-range eggs), in actuality they did not explicitly lose money. Therefore, we tested a scenario where the farmer was only responsible for the firm's (but not the wholesalers') reimbursement. This considerably decreased the amount a farmer would lose if caught breaching the contract. With the base case probability of being caught breaching the contract (30 percent), the results indicate that the one sequential equilibrium remains the same. The contract would be offered, accepted, and the investment made. We proceeded to test the sensitivity of the probabilities in these scenarios and found out that as long as the probability of being caught breaching the contract was 13 percent or

less, farmers would cheat. When the farmer had to reimburse both the wholesaler and the firm, breach is possible when the probability of being caught was 9 percent or less.

To verify that as loss decreases the probability of being caught must increase in order for farmers to comply with the terms of the contract, we examined the scenario where the farmer, in addition to not reimbursing the wholesaler, only had to reimburse the firm half of the premium charged for the misrepresented eggs. This negotiated settlement is possible because firms sold the eggs at free-range prices and face uncertain future losses (e.g., as due to reputation effects). In this situation the farmer's loss decreases considerably. Findings show that, in order to ensure against a breach of contract, there has to be at least 22 percent probability that the farmer will be discovered cheating.

From the scenarios explored and the sensitivity tests, we conclude that: 1. The decision of whether to invest or not is highly dependent on the probability of being caught cheating. 2. The strategy that will be undertaken at the participation node is dependent on the premium that farmers can demand for free-range eggs. 3. As the amount that can be lost if caught breaching the contract decreases, investment is motivated only with a higher probability of being caught. This suggests that firms must be willing to spend more money on auditing systems or fight for larger settlements when a farmer is caught breaching the contract in order to ensure profit-motivated farmers comply with the terms of the agreement.

Scenario 2

The sequential game presented was dedicated to explaining what would be the most likely outcomes where groups are pressuring food firms to require that their suppliers change their current production practices from intensive confinement to free-range. This

theoretical analysis assumes that with a "comply, comply" strategy or a negotiated compromise it is possible for animal activists to see an increase in animal welfare. The model also shows that, if animal welfare is not a determinant of demand faced by food firms, then firms will not comply or compromise.

In both cases the challenge for animal activists is to convince food firms that the benefits of changing current production practices to free-range are greater than its costs. In other words, their change in revenue if they fully comply will be positive and greater than if they decided to negotiate a compromise or refuse. If they want to see animal welfare standards improved industry-wide they need to make the claim that the demand for the entire industry will increase. In an attempt to reach their objectives, animal activist must therefore have the capability to convince consumers that the conditions under which their food was produced, specifically animal welfare considerations, are important factors. That is, produce an effect for firms when they make a strategic choice about procurement of the welfare attribute. It is recognized that people vary in their attitude to welfare, emphasizing physical aspects, naturalness, or a combination of these (Appleby, 2005). A major push for organizations is to create awareness of and demand for a free-range attribute and to emphasize to food firms that demand for this attribute is inelastic, especially among specialty or niche markets.

Costs are also an important consideration. Cost estimates associated with free-range production vary. HSUS (2006) reports a range from 26 to 59 percent, while Bell (2005) reports 66 percent. Because farmers cannot likely absorb the additional cost to a great extent, and therefore it will need to be passed to consumers or will lessen firm profits, there is incentive to reduce this cost. Animal activists should work to convince firms that

costs associated with less confined production will more than compensate for increased input costs through increased income. Egg consumption has low price elasticity. The own price elasticity of demand for shell eggs in the United States is -0.057. Economically this implies that food firms are able to pass on additional costs to consumers without considerably affecting their market share. However, elasticity of demand faced by industry firms is much higher and therefore industry-wide initiatives are likely to be more successful.

Animal activists, in the long run, may be able to achieve the "comply, comply" strategy they are seeking through providing the right data and evidence that less confinement is economically profitable and sustainable for food firms to adopt. Consumer behavior is not the main driving force behind on-farm efficiency since there is data that demonstrates that little of consumers' money actually reaches farmers. It is estimated that of each dollar consumers spend on food only 19 cents goes to the farmer, the rest is absorbed by others in the production line including those who package, transport, and market the products. Additionally, when consumers purchase meals at restaurants the cost of animal products in the meal only account for approximately 5 percent of its purchase price. Therefore an increase in production costs only add about 0.5 percent to the price of an average restaurant meal (Appleby, 2005).

Food firms must be able to clearly see the outcome of their actions to avoid negatively affecting their market share, sales, and of course brand image. This is because assuming that all food firms adopt free-range production (e.g., free-range eggs dominated), supply of egos would decrease as they are more expensive to produce. This would imply an increase in the price of egg-products as well as a decrease in the quantity and consumer

surplus. This would have a greater positive impact at the farm level since producer surplus would be increased (Babcock, Miranowski, and Carbone, 2002). At the firm level we also note that, if one firm complies and the other does not, the change in revenue for the complying firm is expected to be positive; $E > 0$. This result is attributed to an increase in price and/or quantity, depending on the degree to which competition matters (elasticity of demand for the firm) and on elasticity of demand for the industry. Food firms must be cautious, however, in that the market for welfare-friendly products may be a niche and the premium may decline rapidly once the consumer base for which this is an important attribute is satisfied.

When it comes to animal welfare and its associated impacts on the food product market there are limited studies that have been conducted in this area. Existing literature in general focuses on only partial analysis of animal agriculture and not the entire U.S. industry that deals with animal welfare issues. Attempts to empirically analyze the relationship of food firms and animal activists using a game theory model appear to be limited to Hudson and Lusk (2004). This thesis sets up a theoretical framework to consider firm strategy in a situation where competitor strategies and consumer demand are not influenced by firm choice and introduces these influences. It allows for consideration of actions that animal activists will pursue to convince food firms that free-range production is a promising aspect to consider investing in.

Future Work

Scenarios for Consideration

This study focused on two specific games; an empirical analysis for a contract type game and a theoretical analysis for a situation where competition among food firms is explicitly included. Two additional frameworks are offered that reflect other potential

interactions that can be modeled to evaluate the issue with new animal welfare standard options facing large food firms. These scenarios can be the basis for additional work in light of current industry conditions. The numbers in parentheses represent the player and the information set. For example, (1, 2) means player one, information set two.

Slippery Slope

The first framework is structured to model a 'slippery slope'[9] result when groups and firms "play" in a sequential game that will continue indefinitely. There exists incomplete information such that the firm is unable to verify the level of seriousness that the group has in threats to protest against the firm. The firm may be inclined to comply or not based on the level of seriousness that it anticipates from animal activists. Assume standard 'A' has been set by the group which, for example, could be for firms to request that their egg producers invest in free-range production. The groups are targeting food firms who buy eggs from producers who in their view do not offer sufficiently large pens for proper animal movement (along with issues regarding handling practices) (Hudson and Lusk, 2004). The firm has three choices which are to agree and request that farmers (their suppliers) invest in free-range production for laying hens (Adopt A), to say no, or to compromise with animal activists and perhaps require investment in only a portion/percentage of what is been requested (Adopt B) (Figure 5.1).

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[9] The Slippery Slope argument states that one action will initiate a chain of events that will lead to a (generally unwanted) event later (Thompson, 2005). In this case it would be argued that giving into animal activist demands at one point would increase the likelihood of future demands.

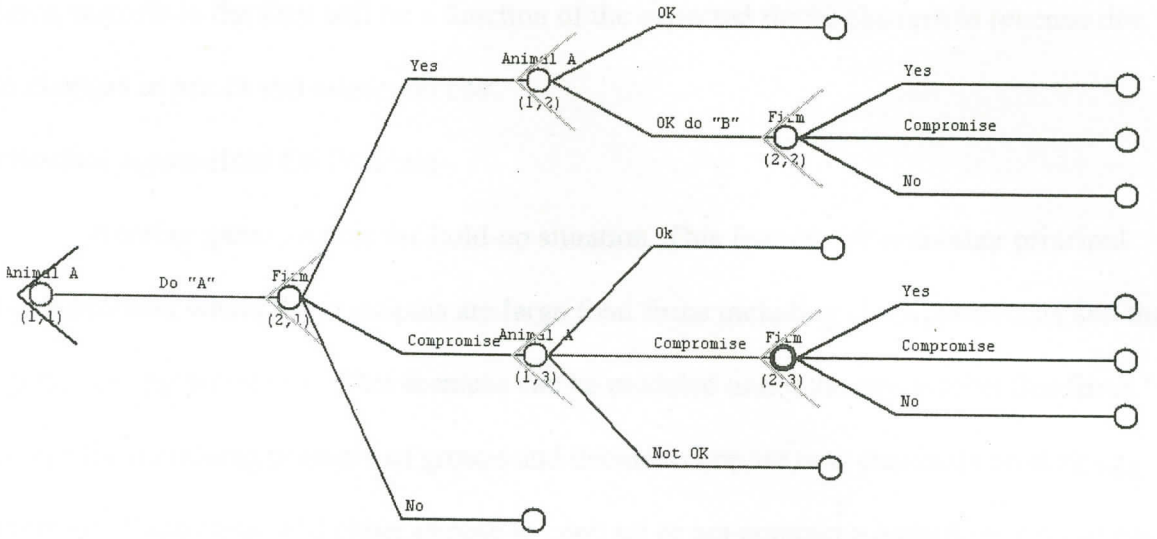

Figure 5.1. Slippery Slope. Game continues indefinitely.

Based on the decision that the firm makes, groups will either stop with this request or move on to propose another standard. The important question to answer is, up to what point will animal welfare groups continue pushing further on this agenda if firms decide to comply with an initial standard and hence impose them on their suppliers?

Based on the equilibrium obtained from this game, recommendations can be made as to whether it is a profitable short and long-run decision for firms to go ahead and be fully supportive of the standards and evaluate how their actions will affect their payoffs. It is assumed that the group has the capability to make a public protest against the firm if the firm does not agree to change its producer standards (and hence change the firm's payoff).

Payoffs are not included within this game tree. However, if this scenario was to be empirically evaluated, payoffs for the two players will be a function of different variables. For the animal activist it would be a function of increased animal welfare, the cost of setting the standard and the cost of protesting against the food firm if they decide on that action if the firm does not comply or if they do not accept the compromise. On the other

hand, payoffs to the firm will be a function of the expected future changes in revenue due to changes in prices and sales, and cost.

Principal Agent-Hold Up Problem

Another game models the hold-up situation. This framework is another principal agent problem where the principals are large food firms including chain restaurants and the agents are egg producers. This scenario can be modeled under the assumption that firms accept the increasing pressure of groups and decide to impose new standards on their egg suppliers. Food firms will either choose to contract or not contract a specific egg producer (Figure 5.2). The second stage of the game reflects the decision of the contracted egg producer as whether to invest in free-range production or not. We then move to account for market uncertainty that may result for the demand of 'free-range' eggs as opposed to conventional eggs from hens raised in a confined production system. After accepting the contract, the egg producer will decide whether to invest in free-range for its laying hens or if the contract will be breached and no investment will be made although the egg producer will still claim to having followed the specific standards set by the food firm.

The next stage of the game is where the focus of the game. Here we analyze how each party in the game will react depending on the market conditions that arise for eggs that are from chickens raised with access to outdoors. Food firms will want to 'hold-up egg producers' if the demand is low (indicated by a specific probability, p) since they will want to renegotiate the price of the initial contract. On the other hand if the demand for free-range eggs is high (indicated by the remaining probability, 1-p) then it will be the egg producers that will want to demand a higher price for their product from food firms.

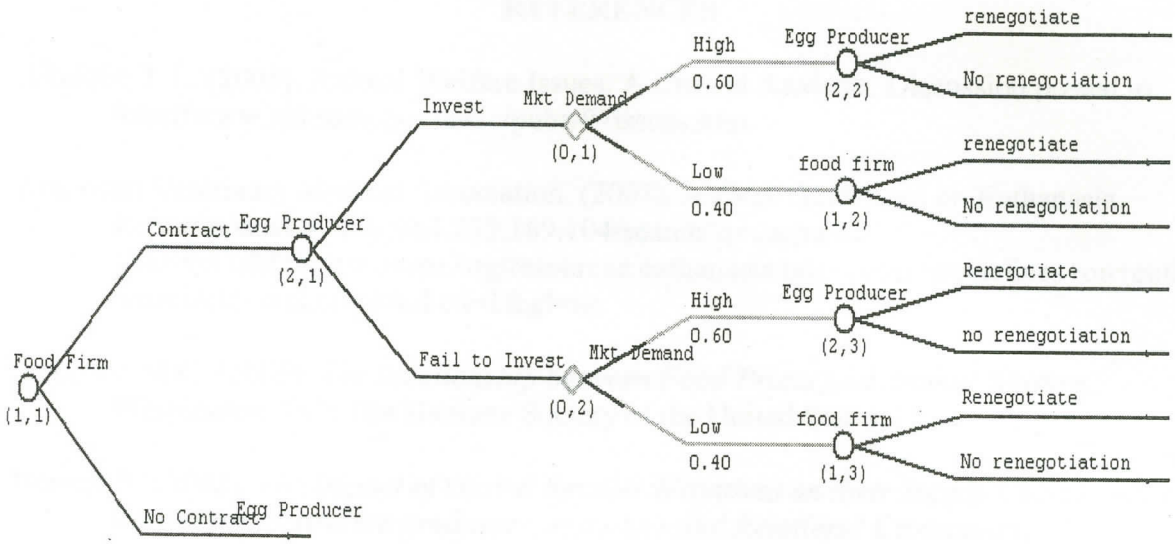

Figure 5.2. Hold-Up Problem.

The result of this game can aid in determining to what extent are egg producers willing to invest in range-free facilities which will constrain them to a specific asset that may be used to supply only one major food firm if other food firms do not agree to comply with animal activist's standards.

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