Three Essays on Managerial Decision Making in the Food Economy

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CHAPTER ONE

Introduction

The food economy has historically had a predominant governance structure of closely-held businesses such as family-owned businesses and cooperatives as noted by Boland, Golden, and Tsoodle (2008). Sporleder and Boland (2011) suggest reasons why the food economy differs from other sectors of the U.S. economy in their governance structures. These governance structures may lead to different managerial decision-making when the firm owners are also involved in the management of the firm as in the case of family-owned firms or are in close proximity to the managers of the firm as in the case of cooperatives.

Since 1990, Nobel Prizes in Economic Sciences have been awarded to, among others, Douglass North, Ronald Coase, Eleanor Ostrom, and Oliver Williamson. They have been recognized for contributions relating how the evolution of firms is affected by how they are governed (e.g., Coase 1937; North 1994; Ostrom 2000; Williamson 1971; Williamson 1979). Neoclassical economics assumes that price is the method of transaction between firms or individuals in an economy. In contrast, these economists have demonstrated that the property rights surrounding the ownership and governance of the firm have significant influence on how transactions occur in an economy. Much of the research done by institutional economists including these Nobel Prize winners is of a descriptive nature and is often based on extensive case studies and observations of an industry.

Table 1.1 from Williamson (2000) shows the relationship among the institutions in an economy and where these economists have been recognized for their contributions. In addition to the contributions of North, Coase, Ostrom, and Williamson, additional work has been done in the area of property rights theory and writing perfect contracts (e.g., Grossman and Hart 1986; Hart and Moore 1990). Many institutional economists believe this work is an important contribution to the literature. Cook and Barry (2004) summarize how these theories might be used in agricultural economics research.

Table 1.1. Relationship between various institutions in an economy and contributions of Nobel Prize winning economists

Level	Frequency (years)	Purpose
Embeddedness (North): Informal institutions, customs, traditions, norms, religions	100 to 1,000	Often noncalculative; spontaneous
Institutional environment (Ostrom, Williamson): Formal rules of the game	10 to 100	Get the institutional environment right
Governance (Coase): Play of the game, especially contracts (aligning governance structures with transactions)	1 to 10	Get the governance structure right
Resource allocations and employment (neoclassical economists): Prices and quantities, incentives alignment	continuous	Get the marginal conditions right

Source: Williamson (2000)

Capital decisions of publicly traded companies are different than family-owned businesses and cooperatives. In particular, family owned businesses and cooperatives are more conservative in their use of capital. Family-owned businesses tend to have a lower debt level than publicly held firms (Gallo and Vilaseca 1996). Cooperatives often are in the position of managing a limited amount of capital as it must be supplied from the owner-members of the cooperative. The goal of family-owned companies is typically focused on protecting the equity of the owners. This perspective channels their focus to the long term in a way that publicly traded companies cannot afford given the tendency toward meeting the short term interests of shareholders. Penrose's (1960) work in establishing the resource theory of the firm and how firms make investment decisions based on how managers learn how to use existing resources over time has increasingly been linked with this capital allocation research. Adams, Hermalin, and Weisbach (2010) provide an extensive literature review summarizing how boards of directors monitor organizations, such as closely-held companies, and how their investment decisions differ depending upon their ownership structure.

Impact of industry

Case studies are commonly used in organizational and institutional economics studies because industry membership is often a significant variable in explaining firm performance. Case studies allow a rich description of the role of industry membership not available from quantitative studies. The Industry Studies Association was formed in 2010 to further the work of social scientists in understanding various industries. The Harvard Business School has integrated its economists and management faculty through a doctoral program in managerial economics. The faculty has a long history of studying specific industries and analyzing the unique operational management characteristics in those industries. Ray Goldberg at Harvard Business School was one of the first agricultural economists to look closely at various industries in the food economy. Much of Michael Porter's seminal work on strategy begins with the idea that knowledge of the unique characteristics of an industry are needed in order to analyze firm performance. McGahan and Porter (1999) is the latest study at Harvard to analyze the performance of specific industries.

This view of industrial organization, which includes institutional economics in its widest definition, is used in this dissertation. Virtually every Harvard Business School case study includes a component that describes the industry before delving into a specific firm and its decision-making. A casual review of food economy journals that have published case studies (e.g., *Review of Agricultural Economics*, *International Food and Agribusiness Management Review*) finds that most authors follow a similar approach.

Individual industries in the food economy have been studied to examine how firm performance depends on the characteristics of the firm. For example, Schumacher and Boland (2004) analyzed 57 industries and 465 corporations in the food economy and found that profitability, as measured by return on equity and return on assets, was more persistent within an industry with the retail supermarket sector having the most stable profits. The authors identified industry membership as being most critical in profitability. Industry effects, often called Fama-French effects in industrial organization research after the two University of Chicago economists who first used industry as a fixed effect in a regression, are widely used in analyzing a broad set of industries.

Thus, there are many reasons to conduct research on individual industries in order to understand managerial decision-making. Analyzing at the industry level can provide insight into understanding why firms behave as they do with regard to strategy. This dissertation looks at three different industries in the food economy with unique governance structures. While these industries have been the subject of previous work by other authors, the specific research questions asked in each essay has not been studied directly. Thus, the essays contribute to a broader understanding over how decisions are made by firms in an industry with these types of governance structures.

Research Objective

The objective of this dissertation is to examine decision-making by firms whose ownership structure includes users (sugar beet producers, farmers) and families and employees (retail supermarkets). The decisions include exit and survival, investments in employee safety, and pricing decisions. This dissertation spans three food economy industries where closely-held governance structures are still typical of many firms in that industry. These include sugar beet processing firms, farm supply and grain and oilseed marketing firms, and retail supermarket firms.

The cooperative structure is a form of vertical integration in which firm owners tend to be one level above or below on the supply chain. In the case of the agricultural input suppliers and food processors in this dissertation, the owners are typically agricultural producers. Family-owned business, as defined by Anderson and Reeb (2003), are governance structures where family-members provide equity capital and control the board of directors. They may or may not be directly involved as CEO of the business.

The first essay looks at exit and survival decisions over time by sugar beet processors, which have ultimately resulted in this industry being composed of only cooperatives. This industry was originally comprised of investor-oriented firms and over time has evolved such that all ownership structures are now cooperatives. The second essay looks at the decision of allocating capital and labor inputs into developing a safety culture and reducing employee injuries in agricultural input supply and grain and oilseed marketing firms. The cooperative structure is the dominant organizational form in this industry. Because of their unique geographic nature, these cooperatives do not have 'cookie-cutter type' facilities of investor-oriented firms and often employ more labor relative to capital than investor-oriented firms in the same industry. The third essay looks at how family-owned retail supermarket stores make pricing decisions. Historically, this industry has been dominated by family-owned structures but publicly-traded firms such as Wal-Mart, Target, and Kroger have become dominant in the past two decades.

The industries under study are common in the food industry in Minnesota. Of the sugar beet processing firms examined in the first study, three operate in Minnesota. Agricultural cooperatives, the subject of the second study, are common in Minnesota as well as other parts of the Midwest. A number of the retail supermarket stores are headquartered and operated in Minnesota.

Summary of the Dissertation

The next three chapters are written as individual essays for each industry. Each essay stands alone with a unique objective statement, literature review, conceptual model development, set of hypotheses tests, discussion of methods, results, implications, and suggestions for future research. Finally, a concluding chapter follows that describes the conclusions and implications of each industry.

The first essay, "Survival of Sugar Beet Plants from 1897 to Present", examines the factors that have contributed to the survival and failure of sugar beet processing plants throughout the history of the industry. Survival analysis techniques are used to consider the contributions of sugar policies to the probability of survival for these plants. Such policies include tariffs, marketing quotas, and loan rates. Plant characteristics, industry variables, and historical events unique to this industry are also included in the analysis to account for their effects on plant survival. Policy variables, as well as plant characteristics and historical events, are found to contribute positively to the survival of sugar beet plants.

The second essay is entitled "Determinants of Occupational Safety in Agribusiness Workers". Using an extensive survey of occupational health perceptions of employees of agribusiness firms, this essay examines the determinants of safety culture in these organizations and the relationship between safety culture and safety performance. Firm investments in labor, such as safety training, accident investigations, and recognition for safety performance, are associated with improvements in safety culture. Improved safety culture among managers is also linked to safety performance.

The third essay, “Drivers of Pricing Decisions in Retail Supermarkets”, evaluates determinants of pricing decisions in conventional retail grocery supermarkets. The determinants examined include supplier prices, consumer demand, competitor prices, and store promotions. A survey of supermarket managers assesses the importance of these factors in price increase and price decrease decisions. Supplier prices are the most common driver of price increase and decrease decisions, which is consistent with the competitive nature of the conventional retail grocery supermarket industry. Loyalty card programs, as well as metropolitan or nonmetropolitan location and median family income, influence price increases and (or) decreases. This may indicate that consumer information and price elasticity are important in determining pricing decisions of conventional retail grocery supermarkets.

CHAPTER TWO

Survival of U.S. Sugar Beet Plants from 1897 to 2011

The U.S. sugar beet industry operates under highly complex and continuous legislation regulating sugar imports, deliveries of sugar, and production of sugar within the United States. The first tariff on imported sugar was written into law in 1789. Legislation was later passed to increase the tariff on refined sugar relative to raw sugar to encourage the development of a U.S. sugar production industry and a sugar refining industry. While initially designed for sugar cane production, the legislation later added sugar beet production, which developed in the late 19th century. These and other policies remain in existence today. The number of sugar plant plants and resulting capacity more than doubled from 1897 to 1967. Despite legislation supporting the sugar production and refining industries, the number of sugar beet factories as well as the total industry capacity has continually decreased since 1967.

The U.S. sugar beet industry has been widely studied, with more than 250 articles listed in JSTOR alone in more than 30 economics journals as of August 2012. No research, however, has examined the industry's exit and survival patterns at the plant level and how U.S. policy affects this industry by plant over the 1897 to 2011 time period. The objective is to identify determinants that influence sugar beet plant survival. Important determinants identified from the literature are hypothesized to include capacity, market concentration, ownership, government policies, and historical events unique to this industry.

These determinants are useful for policymakers for several reasons. Brester and

Boland (2002) report that every sugar beet plant in the United States are now owned by producers as cooperative. The conversion of ownership from investor-oriented firms to producer-owned cooperatives began in 1974 and culminated in 2004. Boland and Marsh (2005) discuss economic reasons why this vertical integration has occurred. Taylor and Brester (2005) find that the sugar policy program results in economic rents to land to sugar beet producers in Montana. Since this industry has been governed by U.S. policy since its very beginnings, understanding the important variables correlated to sugar beet plant survival is important for policymakers and the producers who own these plants.

Literature Review

Economists working in the area of industrial organization have long studied patterns of entry and exit (Caves 1998). Three methods have been used in the empirical literature: 1) case studies, 2) descriptive analysis of entry and exit using longitudinal firm and plant specific data and 3) econometric methods using longitudinal firm and plant specific data.

Case studies analyzing entry and exit have been done on the titanium dioxide manufacturing industry (Ghemawat 1984), the chemical industry (Lieberman 1987), and the steel castings industry (Baden-Fuller 1989). Descriptive analyses of entry and exit used statistical methods to look at the number of entry and exits of plants, their mean and variance, and growth rates over time using longitudinal data. Three of the largest studies on entry and exit were done by Dunne, Roberts, and Samuelson (1988, 1989a, 1989b) who examined the issue of entry and exit in great detail using U.S. Department of Commerce *Census of Manufactures* data. Their main conclusions about entry and exit in the time period from 1963 to 1982 are that large capacity firms with large numbers of employees are less likely to exit relative to small firms (Dunne, Roberts, and Samuelson 1989a; Klepper 1996) and a diminishing rate of exit exists over time the older a firm gets (Dunne, Roberts, and Samuelson 1989b). Evans (1987a and 1987b) finds similar results in 100 different manufacturing industries.

More recently, econometric analyses have used survival analysis techniques to look at survival patterns of firms. At present such analyses are few because the techniques are still not widely disseminated in the profession and there is generally a lack of data on historical firm entry and exit. Disney, Haskel, and Heden (2003) find that the duration of survival is influenced by firm size, firm age, and the interaction between size and age in the United Kingdom manufacturing industry. Supporting the findings of the descriptive analyses, older and larger firms are found to be less likely to close. The hazard rate of business failure also increases as the gap between minimum efficient size and start-up size increases as shown by Audretsch and Mahmood (1995).

This survivor analysis methodology was first introduced to the agricultural and applied economics literature by Key and Roberts (2006). These authors use data from the 1987, 1992, and 1997 U.S. Department of Agriculture's *Census of Agriculture* and find that government programs affect all farms' survival but disproportionately affect larger farms through greater survival rates. This is the first empirical study in the literature studying the impact of policy variables on entry and exit. This research furthers Key and Roberts (2006) methodological and empirical contribution by evaluating the probability of survival in a specific industry subject to government policy where annual information is available on every plant constructed, closed, and still in operation in 2011. In addition, the specific policies in place affecting each plant over time in the United States have been identified.

Conceptual Model

A proportional hazards regression model, first proposed by Cox (1972), is widely used when no priors exist about the underlying survival distribution. The Cox proportional hazard model is a flexible functional form that also allows for time-varying regressors in a straightforward manner which is beneficial in this analysis. The hazard function for each plant *i* is specified as the product of a baseline hazard function of unknown functional form, $\lambda_0(t)$, and an exponential function of time-constant and time-dependent variables such that

(2.1) $$\lambda_i(t) = \lambda_0(t) \exp\left[\sum_k \beta_k x_{ik} + \sum_l \beta_l z_{il}(t)\right]$$

where x_{ik} is a set of *k* time-constant explanatory variables for plant *i*, x_{il} is a set of *l* time-dependent explanatory variables for plant *i,* and β_k and β_l are parameter vectors. Time *t* is defined as the unit of time since the plant was built. Examples of time-constant variables from the literature include start-up size (Disney, Haskel, and Heden 2003) and whether the plant was the sole plant owned by the firm or a branch of the firm at its opening (Audretsch and Mahmood 1995), and examples of time-dependent variables include macroeconomic variables, business growth rates, and price-cost margins (Audretsch and Mahmood 1995).

A key assumption in Cox's (1972) proportional hazards model is that the hazards for any two plants *i* and *j* are proportional. Thus, one can eliminate the baseline hazard, $\lambda_0(t)$, from the equation as seen below

$$\frac{\lambda_i(t)}{\lambda_j(t)} = \frac{\exp\left[\sum_k \beta_k x_{ik} + \sum_l \beta_l z_{il}(t)\right]}{\exp\left[\sum_k \beta_k x_{jk} + \sum_l \beta_l z_{jl}(t)\right]}. \tag{2.2}$$

Equation (2.2) can be written as

$$\frac{\lambda_i(t)}{\lambda_j(t)} = \exp\left[\sum_k \beta_k (x_{ik} - x_{jk}) + \sum_l \beta_l (z_{il}(t) - z_{jl}(t))\right]. \tag{2.3}$$

Equation (2.3) is the conceptual model upon which the analysis is based.

Data

Data was collected for annual plant entry and exit over time, as well as annual plant capacities, for all 155 sugar beet plants constructed in the United States from 1897 to 2011. These data were compiled and cross-checked using original data provided from the Beet Sugar Foundation, public libraries housing corporate records of sugar beet companies, books and dissertations tracking the history of sugar beet companies, reports of industry news collected annually and made available by Google as e-books, personal interviews with former plant managers and industry leaders, and U.S. Department of Agriculture reports. As such, the unique data set is the most complete historical record ever constructed for the United States sugar beet industry, which is represented by North American Industrial Classification System (NAICS) classification 311313 Beet Sugar Manufacturing.

Figure 2.1 shows the number of plants in the sugar beet processing industry from 1897 to 2011. Note that almost one-third of plants were constructed by 1912. Taussig

(1912) and Blakey (1913) discuss reasons for the early part of that building boom, which included supportive sugar policy. State-sponsored subsidies (so-called bounties) in the late 1890s and high tariffs on refined sugar in the early 1900s encouraged construction of new sugar beet plants. Historical information on the formation of sugar beet plants show the role the sugar beet industry played in local economic development with many references to increased employment, increased net farm income, and development of allied industries. Starting in the 1970s, there starts to be a net exit of plants with plant numbers decreasing over time. This life cycle is present in many industries, as noted by Klepper (1996) and is evident in the pattern of plant entry and exit in Figure 2.1.

Figure 2.1. Number of sugar beet plants in operation from 1897 to 2011

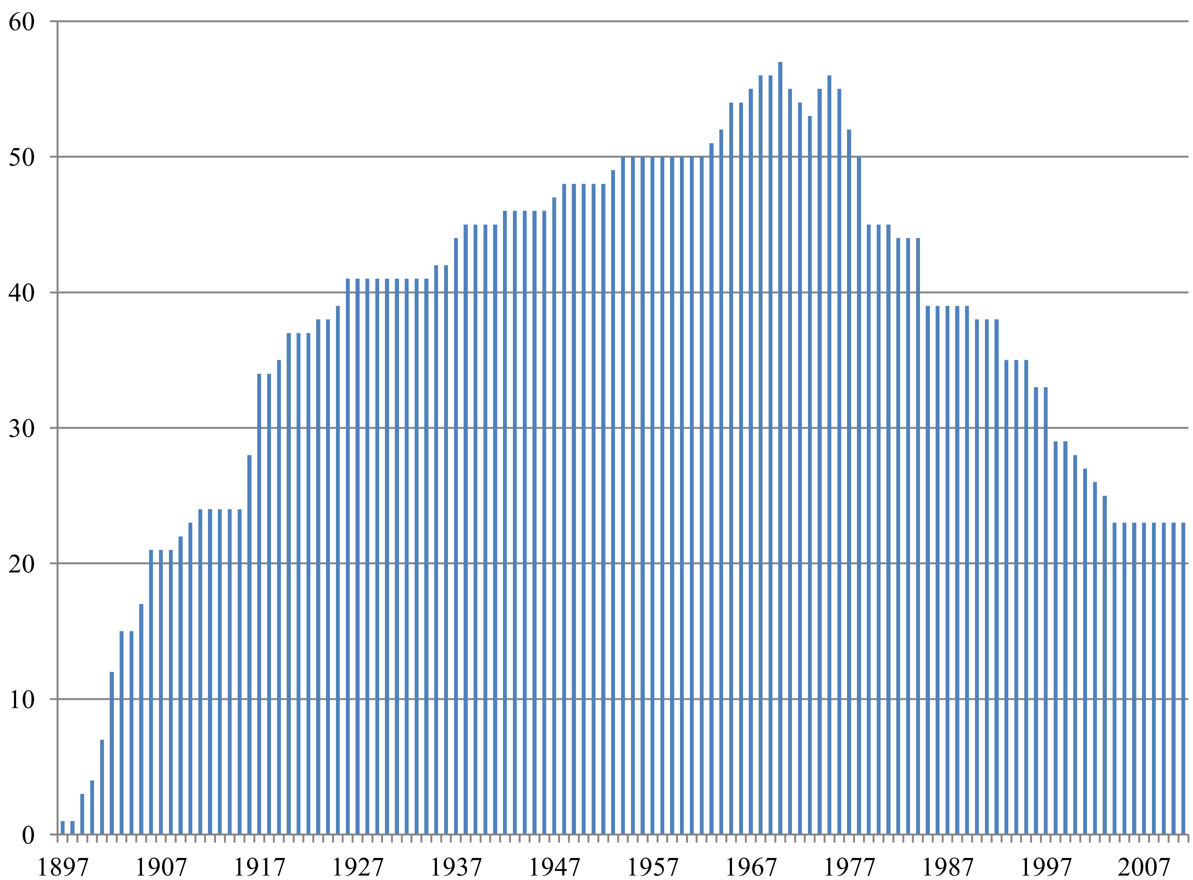


Figure 2.2 shows the changing industry capacity (bar scale) and average plant capacity (single line) during the 1897 to 2011 period. Figure 2.3 shows the distribution of capacity during a similar time frame. Note that early plants were of a much smaller scale relative to newer plants built as the 20th century progressed. The most common size plant built in the early 1900s was 600 tons per day, as that was considered the minimum efficient size, and plants were built to reflect the acres necessary to supply the plant with sugar beets. Many of these plants doubled in size to 1,200 tons per day by 1920 due to demand caused by both World War I and favorable government policies that saw increases in sugar tariffs.

The lifespan of the plant was defined as the time from its opening until its closure or moving the equipment to another location for subsequent closure of the plant. The first sugar beet plant in the data set was built in 1897 and observations of the data ended in 2011. Twenty-three plants were still in operation in 2011 and, hence, 132 plants in the data set exited prior to 2011. Table 2.1 shows the lifespan of plants.

Hypotheses

Twelve time-dependent variables are utilized that represent plant characteristics, industry characteristics, policy instruments, and historical events.[1] The discussion is broken into three categories: variables specific to each plant, variables linked to specific sugar policies that impact every plant, and historical events that impacted the sugar beet

[1] A variable was constructed to measure the change in price over time. However, beet sugar prices are available only since 1929. Refined sugar prices are available but it is apparent upon examination that an assumption of a constant margin between refined and beet sugar is not valid and this variable would not be appropriate. There are no other identifiable variables to measure demand impacts. Analysis was conducted with this variable, and results are presented in Appendix 2.1.

Figure 2.2. Total capacity and average capacity of sugar beet plants in operation from 1897 to 2011

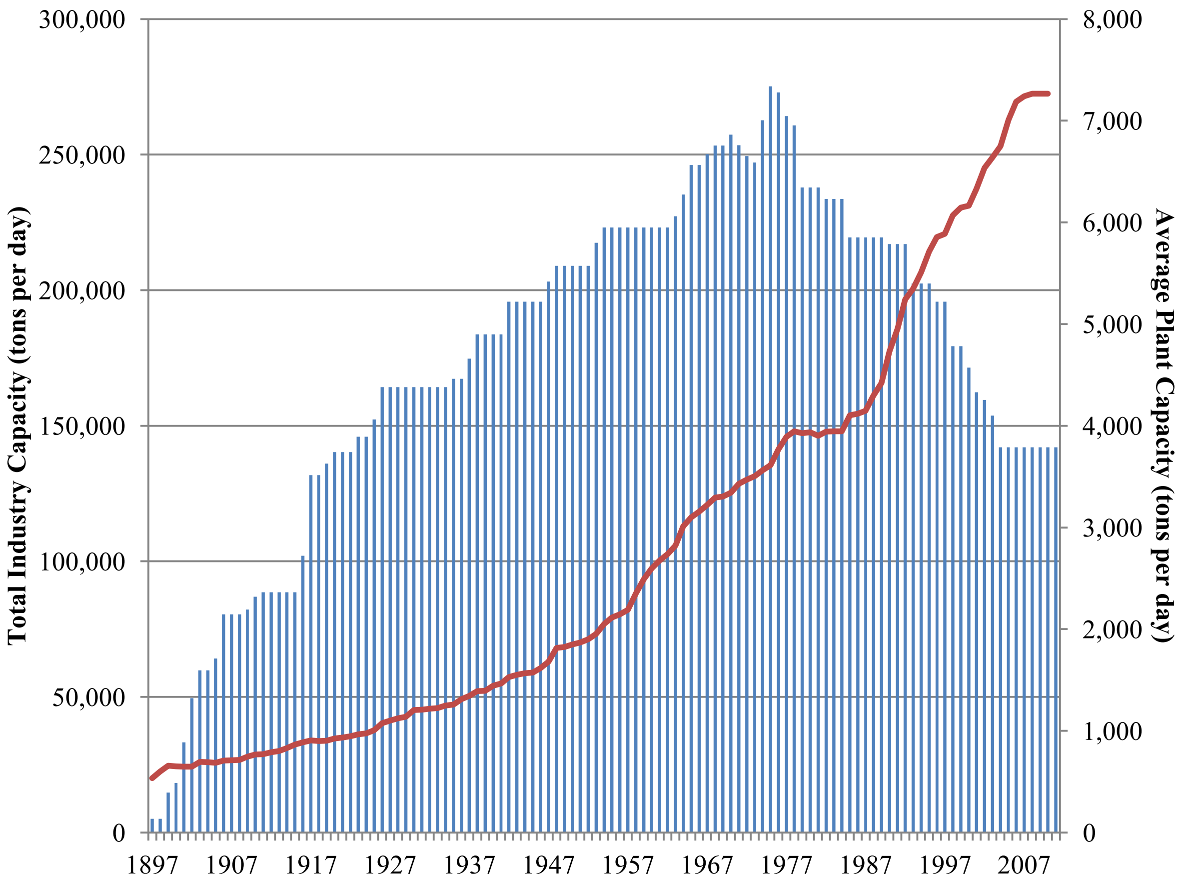
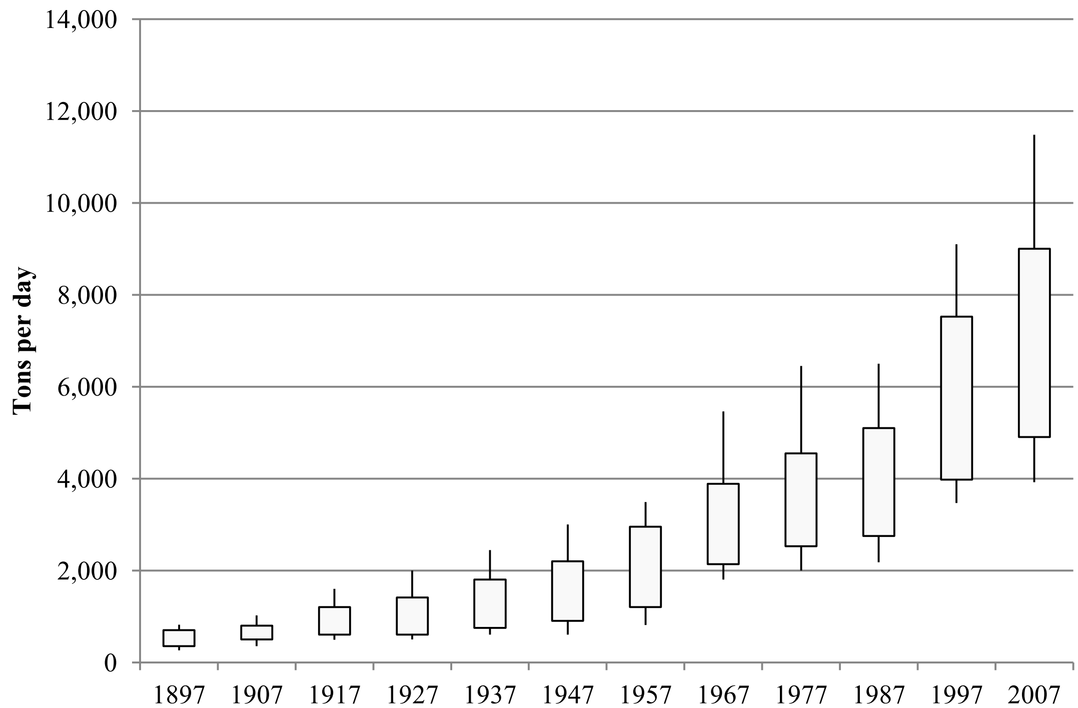


Table 2.1. Lifespan of sugar beet plants, 1897 to 2011

Lifespan	Currently Closed	Currently Open	All Plants	% of total
20 or fewer years	45	0	45	29
21 – 40 years	32	3	35	23
41 – 60 years	28	2	30	19
61 – 80 years	19	3	22	14
81 – 100 years	7	7	14	9
More than 100 years	1	8	9	6
TOTAL	132	23	155	100

Figure 2.3. Distribution of capacity in the sugar beet processing industry from 1897 to 2011



Note: Bars represent 25th through 75th percentile. Lines represent 10th through 90th percentile.

industry. Table 2.2 provides the variable names and definitions of the variables used in the Cox proportional hazards model. Descriptions of their construction follow.

Capacity, Ownership, and Concentration Variables

Production capacity for each plant is represented in thousands of sugar beet tons processed per day and reflects capacity in each year of the plant's life. Dunne, Roberts, and Samuelson (1989a) found that manufacturing firms with smaller capacity tend to exit an industry. Klepper (1996) shows that larger firms invest more in process research and development to reduce production costs, thus creating the expectation that smaller firms

Table 2.2. Definitions of variables used in the study

Variable	Definition
$Capacity_{it}$	Beet processing capacity of plant *i* as a percentage of the average plant capacity in year *t*
$Ownership_{it}$	Binary variable that equals one if plant *i* is owned by a firm that runs multiple plants and zero if the firm owns only that single plant
$Cooperative_{it}$	Binary variable that equals one if plant *i* is owned by a firm structured as a cooperative and zero if the plant *i* is owned by an investor-oriented firm.
HHI_t	Hirschman-Herfindahl Index in year *t*
$Tariff_t$	Binary variable that equals one if a tariff was imposed on sugar imports in year *t*; zero elsewhere
$Quota_t$	Binary variable that equals one if import quotas were imposed on sugar imports in year *t*; zero elsewhere
$Allotment_t$	Binary variable that equals one if marketing allotments were imposed on sugar processing plants in year *t* of plant *i*'s life; zero elsewhere
Price $support_{it}$	Index of sugar processing costs relative to world costs of plant *i* if price supports were in place in year *t*

are more likely to exit over time. This is expected to be the case with sugar beet plants, particularly since all plants surviving through 2011 have grown from their original size. Thus, a large plant built in 1900 is a small plant by today's standards. Because of the lengthy history of the data set and how efficient scale has changed over time, the relative capacity is more important than total capacity. Consequently, plant capacity was divided by the average capacity in the industry in that year. A value greater than one means the plant is above average capacity and below one means a plant is below average capacity.

Hypothesis 1: Larger capacity is associated with a lower hazard rate.

Each plant was classified as belonging to a firm with a single plant or a firm with multiple plants in each year of its existence. A binary variable was created to reflect this status, with a value of one indicating it was part of a multi-plant firm and a value of zero indicating its parent firm owned only the single plant. Firms with multiple plants can spread their resources out more efficiently across plants. In particular, these firms have more experience and knowledge to use among their multiple plants as noted by Scherer et al. (1975). Audretsch and Mahmood (1995) provide evidence that establishments that are branches or subsidiaries of existing firms have a lower hazard rate than single establishments. Thus, it is expected that plants that are owned by firms with more than one plant have a lower rate of exit.

A cooperative form of governance where the producers own the sugar beet plants was first used successfully in 1974 when growers in the Red River Valley region of Minnesota bought American Crystal Sugar Company and converted it to a cooperative. The rationale was that the investor-oriented company had not made improvements in the plants and growers were concerned that the plants would close. Within several years, three additional plants in Minnesota and North Dakota were built and starting in 1996 and continuing through 2004, every plant in the United States became owned by producers as cooperatives.

> Hypothesis 2: Plants owned by firms with multiple plants and plants owned by producers as cooperatives have a lower hazard rate than plants owned by firms with only one plant or with an investor-oriented governance structure.

A firm-level Hirschman-Herfindahl Index (HHI) measuring concentration in the industry was created for each year of the analysis using capacity from each firm in the industry. The index was created with a maximum value of 10,000. Until 1995, the HHI for the sugar beet processing industry was less than 1,500, the U.S. Department of Justice threshold for moderate concentration. After that time, it remained fairly stable between

1,600 and 1,650 through 2011. Wagner (1994) and Caves (1998) provide evidence that market concentration has a negative impact on new firm survival in low turnover industries due to price competition. Since the sugar beet industry experiences low technological innovation and industry turnover, it is expected that increasing market concentration increases the rate of exit of industry entrants.

Hypothesis 3: Increasing market concentration is associated with higher hazard rates.

Sugar Program Policy Variables

Time-dependent variables were constructed for each of the policy instruments used to support the sugar beet industry over the 1897 to 2011 time period. In order to understand how these variables were constructed, some background on U.S. sugar policy is required. A tariff on raw sugar and refined sugar was used until 1934 when the Jones-Costigan Act created the first domestic sugar policy program. The 1934 legislation created a mechanism designed to regulate the supply of sugar, dividing the domestic demand market and exporting country supply regions into quotas and using of allotments as quotas for each domestic processor with subsequent adjustments for domestic demand.

The 1934 sugar legislation was amended and reauthorized periodically until 1974. Ballinger (1978) describes the various changes to the sugar reauthorizing language in the 1934 legislation over time. For example, increases in demand were shared between the export suppliers and domestic processors. In 1948 Cuba was given additional quota, which was taken away when the Cuban government nationalized the sugar industry under the leadership of Fidel Castro and trade with the U.S. was suspended. In 1966, additional geographical regions were given part of the domestic allotment (so-called "virgin allotments") for processors to encourage sugar beet production Arizona, west-central California, Kansas, Maine, and Texas where sugar beets had not been grown.

These policies lasted until 1974 when worldwide demand for sugar increased rapidly due to supply shortages and the program was suspended for 1975 and 1976. Congress passed a program of price supports which included loan rates for 1977 to 1979. In 1980 and 1981, there were no policies as in 1975 to 1976 due to high prices. However, the price supports, loan rates and import quotas by country were reauthorized for 1982. In 1990, import quotas became a tariff-rate quota. These loan rates and price supports are set in every Farm Bill (i.e., 1981, 1986, 1991, 1996, 2002, 2008) but are not indexed to inflation. In real prices, the loan rates on sugar beets and price supports on refined sugar are less today than in 1981.

Thus, plants that survived this time period must have achieved lower production and processing costs to remain in business. The introduction of technologies such as molasses desugarization to obtain more sugar, removing water from beet sugar pulp and pelletizing the dry matter into animal feed for greater value, replacement of equipment to encourage greater throughput, construction of sugar beet storage to extend the ability of processing more sugar beets, and research and development on reducing pile losses during this time period provide evidence for this observation. These investments have been significant.

Five policy variables were identified that were unique and not concurrent with each other. The first policy variable is the annual value of the refined sugar tariff in cents per pound. This variable began in 1897 and remained in effect through 1934. The 1934 sugar legislation introduced additional policy variables. A second policy variable is the use of domestic marketing allotments. These were used from 1934 to 1974; reintroduced in 1994, eliminated in 1996, and reinstituted in 2002. The allotments are based on historical data. For example, the allotments in the 2008 Farm Bill are based on market shares that existed from 1998 to 2000 for sugar beet plants.[2] A third policy variable is the use of import quotas from various countries which was instituted in the 1934 legislation. These quotas have changed over time but the relative quota shares do not impact an individual U.S. sugar beet plant.[3]

A fourth policy variable is the implementation of loan rates and price supports which began in 1977, ended in 1979, and were reinstated for 1982. The U.S. Department of Agriculture provides a summary of production and processing costs by geographic region in the U.S. from detailed studies done periodically by LMC International (Haley 1998, 2001, 2004, 2007; Haley and McConnell 2011). These processing data are published in index form with the numerator being a measure of cost per plant by region and denominator being the world average cost. These data were used as a variable to

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[2] Alternative measures for this variable, such as an index of the marketing allotment by firm over average marketing allotment per firm, were examined. However, any variable measuring the quantity of allotment is highly correlated with capacity and the binary variable was used instead.

[3] Two policy instruments that are not modeled included payments going to producers to eliminate the use of child labor and the excise tax used to pay for the programs, as these variables were concurrent with the quota variable.

measure the impact of the price support program with each plant being assigned to the cost index for their respective geographic region for that year.[4]

The final policy variable represents the years when the programs were rescinded in 1974-1975 and 1979-1980. In those years due to worldwide droughts in Brazil and other regions, sugar prices were sufficiently high that all U.S. sugar policy programs were suspended or not reauthorized. When the supply of sugar increased, the U.S. Congress reinstituted these programs. These were the only time periods in the history of the U.S. sugar industry where there was no government intervention in this industry.

Thus, the variables representing import quotas and marketing allotments are binary variables valued at one in the years when firms are protected by import quotas and allotments, respectively, and zero when they are not. The tariff variable is the annual value of the import tariff in cents per pound. The price support variable is the LMC cost index for the region where the plant is located. Table 2.3 summarizes plant closures in times where each of the policies was in place and not in place. In general, more plants closed when policies were not in place than when policies were active.

> Hypothesis 4: Sugar policy programs designed to support the sugar industry, including tariffs, quotas, and marketing allotments, decrease hazard rates of plants in the industry. A lower cost index under the price support is associated with a

[4] The 1981 Farm Bill also authorized a loan support program for sugar beets. The U.S. Department of Agriculture has periodically published costs and returns on sugar beet production regionally. In addition, LMC publishes an index of costs. This index closely resembles the processing index (i.e., regions where it is low cost to produce sugar beets also has low processing costs), is positively correlated with the processing cost index variable, and is concurrent with this processing index variable. Thus, like the other policy variables noted previously, this policy variable was not used.

Table 2.3. Presence or absence of policies at closure of sugar beet plants

Policy	Currently Closed	Currently Open
Tariff		
Present	42	
Not present	90	23
Quota		
Present	57	23
Not present	75	
Allotment		
Present	27	23
Not present	105	
Price Support		
Present	62	23
Not present	70	

lower hazard rate of sugar beet plant closure. The time periods with no government policy programs have an increase in the hazard rate.

Historical event variables

A set of variables was included to account for the effects of significant events in the history of the sugar beet industry. During World War I (1914-1918), global trade was disrupted. The United States increased trade with other counties, as sugar demand increased, and this stimulated plant capacity increases and new construction. It is common in industry studies to treat 1941 to 1945 (World War II) as a unique time period because of the food rationing (including sugar) that occurred, disruptions in world trade, and conversion of industrial assets such as sugar beet processing plants to other uses in the war effort.

Historically, the U.S. sugar beet industry was governed by two alternative contracts negotiated periodically by growers and sugar beet firms. The "Western Contract" was used by plants west of the Mississippi and the "Eastern Contract" was used by plants east of the Mississippi which were located primarily in Michigan and Ohio. In 1985, growers in Colorado, Kansas, Montana, Texas, and Wyoming went on strike, refused to sign a contract, and did not plant a crop. Eleven factories were idled and five plants never reopened after the contract was successfully negotiated the following year. All of these historical events are represented as binary variables valued at one in years of the events and zero otherwise.

> Hypothesis 5: World War I decreases the hazard rate of sugar beet plant closure in the industry. World War II and the 1985 strike increase the hazard rate of sugar beet plant closure in the industry.

Results

Table 2.4 presents the parameter estimates for the Cox proportional hazards model as well as the results of the likelihood ratio test and the Akaike Information Criterion (AIC) results for the model fit with and without the covariates. As discussed, the model includes explanatory variables for capacity, plant ownership, market concentration, policy instruments, and historical industry events. The covariate analysis shows smaller plants are more likely to close. Results indicate that the hazard rate, or the failure rate of sugar beet plants in year *t* conditional upon survival to year *t,* decreases as the size of the plant relative to the average capacity of plants in the industry increases. This provides support for Hypothesis 1. The ownership structure of plants had some impact on the survival of sugar beet processing plants. Plants belonging to firms owning multiple plants had 45.6%

Table 2.4. Cox proportional hazards model parameter estimates, standard errors, hazard ratios and hypotheses test results

Variable	Parameter Estimate	Standard Error	Hazard Ratio
Plant characteristics			
Capacity (1,000 tons)	-1.730***	0.299	0.177
Ownership	-0.785***	0.205	0.456
Cooperative	-0.965	0.614	0.381
Industry characteristics			
HHI	-0.0004	0.0004	0.9995
Policies			
Tariff	-0.828***	0.284	0.436
Quota	-2.452***	0.763	0.086
Allotment	1.553**	0.618	4.726
Price support	0.027***	0.007	1.027
No programs	0.391	0.539	1.478
Historical events			
World War I	-1.072*	0.605	0.342
World War II	0.605*	0.337	1.831
1985 Strike	2.381***	0.656	10.820
Likelihood Ratio Test	105.43***		
AIC with Covariates	1055.96		
AIC without Covariates	1137.39		

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

of the hazard of closure as plants owned by firms with only the single plant (p<0.01).[5] Although not significant (p=0.11), results suggest that plants structured as cooperatives may have a lower hazard rate. These results provide partial support for Hypothesis 2.

Results failed to support Hypothesis 3. Market concentration was not significantly influential in the closure of plants in the sugar beet processing industry. Although the parameter can be interpreted as expecting a reduction in the hazard rate 4.9% for every 100-point increase in the Hirschman-Herfindahl Index, this is not significantly different than zero. This failure to reach significance may be attributable to the limited variation in concentration of the sugar beet industry and the failure of the industry to reach a high level of concentration.

Policy instruments used to protect the sugar beet processing industry have a significant impact in reducing the closure rate of sugar beet processing plants, providing support for Hypothesis 4. With each one-cent increase of import tariff, firms experienced a 56.4% reduction in the hazard rate of plants. Likewise, in years with quotas on imports from different countries, plants had a reduction of the hazard rate of 91.4% over years without a quota. Marketing allotments were found not to be supportive of the survival of sugar beet plants. This variable was anticipated to reduce the hazard rate. Higher processing costs once price supports were enacted were associated with a higher hazard rate. As hypothesized, the price support program encouraged plants to become more cost

[5] The estimated coefficients in the Cox model shown in table 2 are used to construct the marginal effects or hazard ratio for a firm. The hazard ratio is simply exp $\left[\frac{d\lambda_i}{dx}\right]$ and, for binary variables, can be interpreted as the ratio of the estimated hazard when the variable equals one to the hazard when the variable equals zero. For continuous variables an often useful calculation is exp $\left[\frac{d\lambda_i}{dx}\right] - 1$, which when multiplied by 100 gives the estimated percentage change in the hazard for a one-unit change in the continuous variable.

efficient in order to survive. The hazard rate did not significantly change in years without supportive sugar policies. This is not unexpected, as world prices were high during these years.

Historical events had the expected impacts on survival of sugar beet plants, although not all impacts were significantly different than zero. Results suggest that events during World War I were supportive of sugar beet plant survival, significant at the 10% level. In contrast, the hazard rate during World War II increased, also significant at the 10% level. The 1985 strike increased the hazard rate of sugar beet plant exit, with plants nine times more likely to exit during the strike than at other times in the industry's history ($p<0.01$). Thus, the data provided support for Hypothesis 5.

Limitations of the Research

One limitation of using data that extends back more than a century is that the analysis may not account for all causes of plant closure. The industry has experienced changes over time that may not be reflected in the analysis. The inclusion of these key events in the history of the industry into the analysis, such as World War I, World War II, the 1985 strike, and the conversion of investor-owned firms to cooperatives, should mitigate this issue to some extent. These industry and policy variables were deemed the most important in influencing hazard rates for plants over the 1897 to 2011 time period.

Additional industry variables could have been included for events such as 1921 with first documented widespread outbreak of curlytop disease due to leafhoppers, the development of resistant varieties in 1938 by the USDA Agricultural Research Service, the increase in sugar beet acreage due to reduction in sugar cane purchased from Cuba after the U.S. imposed trade sanctions in 1955 to 1959, the addition of the so-called “virgin allotments” in 1966, and the years leading up to 2002 when there was widespread speculation that the Farm Bill would radically change the sugar program. But these events are not expected to impact the hazard rate as much as the other industry events that were chosen as variables in the model. They were tested and found not to have a significant effect on hazard rates of sugar beet plants.

Beginning in the late 1970s, most food and beverage manufacturers switched from using liquid sugars to liquid sweeteners due to the cost effectiveness of corn-based sweetener products. Hence, a demand variable such as price would be expected to be an important variable. If a wholesale price series for sugar beets could be found for 1897 to 1928, this variable could be included. Appendix 2.1 provides results for modeling refined refined sugar as a variable.

Summary and Implications

The sugar beet industry has been widely studied by agricultural economists. The industry has been subject to government policy in all but four years of its existence. One critical issue is how long it can survive in view of possible changes in government policy. The industry was analyzed since its inception to better understand factors related to plant survival. As suggested by industrial organization theory, plants with greater capacity and plants belonging to firms owning multiple plants and (or) structured as cooperatives have lower rates of closure. Historical events, such as World War II and the 1985 strike, impacted survival of sugar beet plants. The use of a high tariff on imports of refined sugar, the use of quotas on imports of sugar from various countries, and a price support program that encouraged plants to become more cost efficient have lessened the rates of closure. Thus, future survivors in this industry are likely to belong to firms who own more than one plant, have a cooperative governance structure, and have lower production and processing costs. Since the Red River Valley has been identified as the lowest cost region in North America according to the LMC studies, this region may be at an advantage for plant survival.

Agricultural policy has encouraged the development of this industry and encouraged it to become more cost efficient as noted in this study, but its profitability is dependent upon government policy. The implementation of policies designed to encourage development and protection of sugar beet processing has lasted for more than 100 years and is expected to continue to impact the future of this industry.

CHAPTER THREE

Determinants of Occupational Safety in Agribusiness Workers

Much has been written regarding the increases in crop yields in recent years due to advances in genetics and higher-yielding varieties (Pardey and Wright 2003; Hoisington et al 1999; Fernandez-Cornejo and Caswell 2006). In addition, cropping patterns have changed in certain geographic regions. For example, eastern South Dakota and North Dakota have more corn and soybeans today than ten years ago while facilities were designed for a smaller wheat crop. This increase in supply means greater volumes of grain and oilseeds being handled by grain elevators and other firms operating one stage removed from the farm gate. The facilities were not designed for these volumes. In addition, firms operating in crop nutrient, crop protectant, seed, and agronomic services industry have also seen increases in their volume of business. These increases in volume have placed stress on facilities which were not designed for this additional volume, which can increase the danger of physical injuries in these operations.

The types of agribusinesses involved in these industries lie within North American Industrial Classification System (NAICS) categories 42491 Farm Merchant Suppliers and 49313 Farm Product Warehousing and Storage. Data from the U.S. Department of Agriculture finds that many of these agribusinesses are organized as farmer-owned cooperatives. As of 2008, there were 958 cooperatives in these two industries.

These two industries have long been studied by agricultural and applied economists with the most current literature review by Boyd et al. (2007) reporting more than two dozen unique research studies conducted on these two industries since the 1980s. These industries have collaborated on unique data including the long-running Purdue University Large Commercial Producer data which has been widely used in graduate student research and publications (see Borchers et al 2012 for most recent review of literature using this data), the Retail Fertilizer Efficiency Data which has been used in production economics research (for examples, see Akridge 1989 and Akridge and Hertel 1986), Precision Agriculture Dealer Survey (Whipker and Akridge 2009), and a lender database of more than 600 agricultural cooperatives which has been used in a number of studies (Boyd et al. 2007). This research examines safety issues of employees of agricultural cooperatives, the most common business structure in the two NAICS industries under study.

Awareness of safety in agricultural cooperatives is increasing within the industry. In recent years, the pace of inspections by the Occupational Safety and Health Administration (OSHA) has increased significantly, and there have been a large number of incidents in these industries. The average injury rate in both NAICS industry categories exceeds the national average for private industry (US Department of Labor 2013). During the last three years, Iowa and Nebraska have created a safety professional group for cooperatives similar to those in this study. In addition, the Agricultural Safety and Health Council of America (ASHCA) was recently formed. There is no doubt safety has become an important issue. However, the economics of occupational safety on workers in the food economy has not been widely studied by agricultural economists.[6]

Land grant universities have significant research and extension programs in safety at the farm level. Thirty-one universities have extension programs focused on farm safety, with program activities including emergency training, safety training, and hazard analysis tools. The National Institute for Occupational Safety and Health was funded by Congress with $20 million in the 2012 fiscal year for development of research and educational programs in their Agricultural, Forestry, and Fishing division. Nine center grants were awarded multiple year funding with Colleges or Schools of Public Health being most prevalent in receiving the funds. The funded abstracts of these centers suggest a need for the work of applied economists in doing some of the modeling projects since economists have seldom been involved with these centers.

Safety in agribusinesses and in particular, agricultural cooperatives is an important extension to farm-level safety research. Many of the hazards are similar, such as bins and machinery. As in farming, injury rates in many types of agricultural cooperatives are higher than in private industry as a whole. Farm product warehousing and storage businesses, for example, had nearly twice the rate of recordable injuries as private industry in 2010 (US Department of Labor 2013). Also like farms, many agricultural cooperatives experience seasonality in their operations and employ

[6] Sixteen articles were found on occupational safety in farm families and farm laborers but only one on agribusiness workers. These articles were primarily surveys focusing on risk identification and riskiness of farming practices.

temporary workers in their busiest times. As owners of agricultural cooperatives, farmers have an interest in the safety of the employees at these businesses.

The objective of this study is to gain insight into the relationship between safety culture and safety performance and to identify the determinants of safety culture. The data used in this analysis contains surveys of more than 3,000 employees and includes seasonal, part-time, and full-time workers; mid-level managers; and senior executives at more than 180 locations in agricultural cooperatives in 11 states. These agribusinesses market grain and oilseeds, as well as supply crop nutrients, crop protectants, seed, agronomic services, energy, feed, and other products to farmers and ranchers.

Literature Review

From an economic efficiency perspective, the primary incentive to improve safety is the reduction of costs associated with accidents. Direct costs of accidents, including sick leave, workers compensation benefits, workplace disruptions, and damaged machinery were estimated at nearly $170 billion per year across all private industry in the United States in 2009 (National Safety Council 2011). The workers compensation premiums of larger firms are experience rated, or dependent upon the firm’s accident history and higher accident rates results in higher premiums. Experience rating is associated with lower accident rates, due in part to investments in safety of firms with greater experience rating (Thomason and Pozzebon 2002). Another incentive to invest in safety is the potential fines that can be levied due to violations of governmental regulation. However, empirical research suggests that OSHA fines do not lead to significant reductions in accident rates (Ruser and Butler 2009).

Injury risk is determined by the firm's quantity of labor and the investment of the firm into inputs that improve safety (Oi 1974). Additional labor inputs increases the injury risk level in that risk level is a function of labor numbers. Firms invest in safety inputs to reduce accidents within the company. To do this, they invest in safety inputs that affect labor and (or) capital. Safety inputs through capital have a direct impact on reducing the injury risk, preventing accidents by removing physical hazards and making equipment safer. Safety inputs through labor include safety training, safety meetings, creation and enforcement of safety rules, safety investigations, and safety audits. These may reduce accidents by influencing the safety culture of the organization.

Zohar (1980) introduces the concept of safety culture, which he defines as "the shared perceptions, attitudes, and beliefs about safety in the organization". Lee and Harrison (2000) use the following definition from the Advisory Committee on the Safety of Nuclear Installations (ACSNI):

> "The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to and the style and proficiency of an organization's health and safety management." (ACSNI 1993)

Studies have examined dimensions of safety culture, generally using descriptive analysis and factor analysis or principal components analysis. Safety culture dimensions identified include management concern for safety, worker satisfaction with the company's safety system, and the conflict between production and safety (Flin et al. 2000). With a strong safety culture, employees believe that managers, supervisors, and other employees take safety seriously and are concerned for their well-being. Employees feel that they are kept informed about current safety values, rules, and performance. They are satisfied with safety rules, systems, and, procedures and further believe that safety is valued above production (Stewart 2002).

> Hypothesis 1: Investments into labor to improve safety, such as trainings, meetings, inspections, and investigations, improve safety culture.

Research indicates that executives and supervisors (collectively, management) often differ from workers in their evaluations of safety culture in the organization. Cox et al. (1998) find that permanent workers had more positive attitudes than management about quality of safety training, as well as management actions for safety including quality of accident reporting and prioritizing of safety. In contrast, Harvey et al. (2002) find that workers had more negative views than management about management commitment to safety, management communication, and personal responsibility for safety, although some differences varied across firms. Clarke's (1999) survey of British Railway employees indicated that workers believed more so than executives that profitability harms safety performance, and Niskanen (1994) finds that workers believed that supervisors placed cost-effectiveness above safety.

> Hypothesis 2: Investments into labor that influence management safety culture perceptions will differ from those that influence the safety culture perceptions of hourly workers.

Safety culture has been linked to various measures of safety performance, including injury rates and injury severity. Several studies find a positive correlation between safety culture and safety performance. Studies using objective data such as OSHA-reported injuries show a significant relationship between safety culture and safety performance (Hofmann and Stetzer 1996; Varonen and Mattila 2000; Mearns, Whitaker, and Flin 2003). Lee and Harrison (2000) find a link between management commitment to safety and accident rate. Safety culture is linked to safer behavior on the part of workers (Hofmann and Stetzer 1996; Varonen and Mattila 2000). Neal and Griffin (2006) show that safer behavior may mediate the relationship between safety culture and safety performance. Many of these studies employed correlations or regressions with variables such as age and tenure in their analysis of these relationships.

Hypothesis 3: An increase in safety culture is associated with lower accident rate.

Evidence in the literature suggests that, in addition to the effect of safety culture on safety performance, safety performance can affect safety culture. Rundmo (1995) find that workers who had been injured report less satisfaction with the organization's safety measures than those who had not experienced an injury. Cree and Kelloway (1997) find that accident history is a predictor of risk perceptions in the workplace, which influence the willingness of employees to participate in safety and health programs. Mearns, Whitaker, and Flin (2003) find that organizations with lower accident rates report higher safety culture ratings. A meta-analysis performed by Clarke (2006) does not yield further evidence of a causative relationship from safety performance to safety culture, but she notes that a small sample size of studies in which safety culture measurements are taken prior to safety performance measurements limits the strength of her conclusion. This suggests the possibility of an endogenous relationship between safety culture and safety performance, which should be further examined.

This study furthers the literature by using an economic model to examine the relationship of labor investments and safety culture, as well as the relationships between safety culture and accident rates, in an industry with high accident rates undergoing significant changes. A comprehensive data set of more than 3,000 employees at 189 locations is used with information about employee and business characteristics, and regression analysis is used to control for these characteristics.

Conceptual Model

Oi (1974) asserts that safety performance is determined by inputs into safety. Key categories of safety inputs are labor inputs and capital inputs. Capital inputs directly improve the safety performance of the organization through creating a safer work environment. The effect of labor inputs comes about through a change in safety culture. Investments in labor inputs improve the perceptions, attitudes, and beliefs about safety in the organization, which reduces the injury risk through safer behavior of management and hourly workers. These investments in labor have a differential effect on the safety culture at the management and hourly worker level. A conceptual model for safety performance in a firm can be written in two steps. First, the safety performance of a firm is

$$\text{SAFETY}_j = f(\text{SC}_j, \text{CAPITAL}_j) \tag{3.1}$$

where $SAFETY_j$ is the safety performance of firm *j*, SC_j is the level of safety culture in firm *j*, and $CAPITAL_j$ is the investment of firm *j* in capital to improve safety. The level of safety culture in firm *j* is then

(3.2) $$SC_j = g\left(\frac{\sum_{i=1}^{n} SC_{ij}(LABOR_j, LTYPE_{ij})}{n}\right)$$

where g(.) represents a function operator denoting firm safety culture as a function of the average of individuals' safety culture perceptions (*i*=1,…n). SC_{ij} is the level of safety culture perceived by individual *i* in firm *j* , $LABOR_j$ is the investment of firm *j* in labor inputs toward safety, and $LTYPE_{ij}$ is the type of labor, either management or hourly worker reporting to management, of individual *i* in firm *j*.

Data

The world's largest service provider of occupational health and safety education and training is DuPont. The industries in which DuPont has historically operated were gunpowder and chemicals which were very hazardous to employees. In 1998, DuPont acquired Pioneer Hi-Bred International, one of the largest agricultural seed breeding and distribution firms in the United States, which brought an awareness of the unique safety issues in agriculture. By the late 1990s, DuPont had developed an internationally known reputation for occupational safety, and a number of firms sought them out to learn more about how to improve their own safety culture. To benchmark their plants against each other with regard to safety culture, DuPont acquired an assessment tool built around an employee survey and adapted it for their plants (Stewart 2002). Shortly thereafter, they began selling this assessment tool and related educational services to other firms.

A number of wholesale agribusinesses operating in the two NAICS industries previously discussed and their related business entities (e.g., retail locations, trucking divisions) became interested in this program. DuPont partnered with the University of Minnesota on a research and education program in these industries to better understand safety culture in these two industries (US Department of Agriculture 2013).

DuPont was consulted in the process of identifying suitable firms for the sample that capture an accurate representation of the industry population. The data includes firms who primarily handle corn, soybeans, or wheat because that is where there has been the greatest improvement in crop yields. Chosen firms have a diversity of employees (seasonal, part-time, full-time, and a variety of age and tenure) and multiple locations including headquarter locations with office and management staff as well as remote locations with less than five employees. In addition, firms were selected such that it would be possible to get response rates close to 100 percent so as to have an accurate determination of safety culture in those firms.

A 30 question survey was developed based upon the survey designed by Stewart (2002) and was administered electronically in June 2011. An English and Spanish version was created by the University of Minnesota. Employees from twelve firms operating in 11 states with a total of 189 locations were used. Response rates averaged 96.3 to 99.1 percent. A total of 3,023 employees were surveyed. Data from 363 observations from employees that did not complete the question to classify themselves as either hourly workers or management were dropped. Data from respondents who did not answer one or more questions were also dropped. Surveys from 2,533 respondents remained. Table 3.1

shows the breakdown of remaining observations by management and demographic characteristics.

Table 3.1. Management and demographic characteristics of respondents

Characteristic	Number of observations	Percentage of observations
Management status		
Management	684	27
Hourly workers	1,849	73
Tenure		
Less than 1 year	444	18
1-4 years	663	26
4-10 years	592	23
10-20 years	485	19
More than 10 years	349	14
Full time status		
Full time	2,172	86
Part time	181	7
Seasonal	180	7

Empirical Model

In order to examine both the relationship between inputs into labor and safety culture, as well as the relationship between safety culture and safety performance, the model is estimated in two separate analyses. The first analysis uses investments in labor as explanatory variables for safety culture. The second analysis seeks to establish the connection between safety culture, as well as investments into capital, toward improvements in safety performance.

An ordered probit model is used in the first analysis to explain safety culture in terms of inputs intended to increase labor effort into safety. The dependent variable measures safety culture with a question addressing the respondent's feeling of empowerment to take action to ensure safety in the organization.[7] Respondent's answers are scored from 1 (not at all empowered) to 5 (fully empowered). This question is used by DuPont to embody safety culture since it reflects key dimensions of safety culture including communication of safety rules, management commitment to safety, and involvement of employees in safety programs (Stewart 2002). An ordered probit is used in this analysis because the dependent variable is a Likert-style question with answers representing ratings rather than a continuous value.

Following Cameron and Travedi (2005), the underlying model of the ordered probit is

$$SC^*_{ij} = \alpha_0 + \sum_{k=1}^{8} \alpha_{1k} \, LABOR_{ij,k} + \epsilon_{ij} \quad (3.3)$$

where SC^*_{ij} is the unobserved safety culture value by individual *i* at location *j* and $LABOR_{ij}$ is a vector of survey answers to eight labor input questions by individual *i* at location *j*. The parameters to be estimated are α_0 and α_{1k}, and the error term is ε_{ij}, which is assumed to have a standard normal distribution.

The observed answers to the survey correspond to

$$SC_{ij} = \begin{cases} 1 \text{ if } & SC^*_{ij} \leq \mu_1 \\ 2 \text{ if } & \mu_1 < SC^*_{ij} \leq \mu_2 \\ 3 \text{ if } & \mu_2 < SC^*_{ij} \leq \mu_3 \\ 4 \text{ if } & \mu_3 < SC^*_{ij} \leq \mu_4 \\ 5 \text{ if } & SC^*_{ij} > \mu_4 \end{cases} \quad (3.4)$$

[7] Other questions were used to represent alternative dimensions of safety culture. None showed significant relationships between safety culture and accident rate.

where SC_{ij} is the observed survey answer to the safety culture question by individual *i* at location *j* and μ_1, μ_2, μ_3, and μ_4 are the threshold parameters. The observed variable SC_{ij} is equal to the k^{th} answer if $\mu_{k-1} < SC^*_{ij} < \mu_k$, k = 1,…,5. The unknown parameters μ must be estimated along with α and β. The probability that $SC_{ij} = k$ in an observation can be written as

$$(3.5) \qquad Pr [SC_{ij} = k] = F (\mu_k - Z) – F(\mu_{k-1} – Z)$$

where F is the cumulative standard normal distribution and $Z = \alpha_0 + \alpha_1 LABOR_{ij} + \varepsilon_{ij}$.

Eight questions are used in the first analysis as explanatory variables for safety culture. Each question is scored from on a scale of 1 to 6, with each value reflecting the level of input into labor with the intent of improving safety, as assessed by each individual respondent. Higher numbers reflect a greater level of inputs. Some questions included an option for "I don't know", which is considered to be the lowest level of input. This is done on the assertion that a firm committed to instilling a safety culture should consider a response of "I don't know" to be an indicator that the culture is not being communicated effectively to this employee and, hence, is equivalent in this case to a low level of input.[8] These questions are summarized in Table 3.2 and presented in full in Appendix 3.1. The data was divided between management and hourly workers and the analysis was conducted separately for individuals identifying as management and those identifying as hourly workers. Summary statistics for the labor variables for management and hourly workers are presented in Tables 3.3 and 3.4.

[8] This is consistent with DuPont's perspective on the state of safety culture in organizations where employees are uninformed in regards to safety values, priorities, and initiatives.

Table 3.2. Labor investment variable definitions for the ordered probit model

Symbol	Variable	Definition
SC_{ij}	Safety Culture	Rating of safety culture by individual *i* at location *j*
$LABOR_{,ij,1}$	Training	Amount of formal safety training, as rated by individual *i* at location *j*
$LABOR_{ij,2}$	Meetings	Frequency of safety meetings, as rated by individual *i* at location *j*
$LABOR_{ij,3}$	Discipline	Rating of extent of disciplinary action for safety violations by individual *i* at location *j*
$LABOR_{ij,4}$	Investigations	Rating of extent that injuries and incidents are investigated by individual *i* at location *j*
$LABOR_{ij,5}$	Inspections	Rating of quality and effectiveness of inspections by individual *i* at location *j*
$LABOR_{ij,6}$	Modified Duty	Rating of strength of modified duty and return to work initiatives by individual *i* at location *j*
$LABOR_{ij,7}$	Off-the-Job	Extent that off-the-job safety is addressed, as rated by individual *i* at location *j*
$LABOR_{ij,8}$	Recognition	Extent that safety achievement is recognized, as rated by individual *i* at location *j*

Table 3.3. Summary statistics for labor investment variables in the ordered probit model for management

Variable	Mean	Standard Deviation	Minimum	Maximum
Training	3.558	0.835	1	5
Meetings	3.364	1.045	1	5
Discipline	3.447	1.303	1	5
Investigations	4.324	1.709	1	6
Inspections	4.077	1.495	1	6
Modified Duty	4.515	1.463	1	6
Off-the-Job	2.345	0.909	1	4
Recognition	3.399	1.414	1	6

Table 3.4. Summary statistics for labor investment variables in the ordered probit model for hourly workers

Variable	Mean	Standard Deviation	Minimum	Maximum
Training	3.364	0.952	1	5
Meetings	3.024	1.167	1	5
Discipline	2.989	1.628	1	5
Investigations	3.837	1.994	1	6
Inspections	3.732	1.702	1	6
Modified Duty	4.109	1.693	1	6
Off-the-Job	2.160	1.020	1	4
Recognition	3.212	1.601	1	6

The second analysis consists of a negative binomial model used to evaluate safety performance as a function of safety culture and investments into capital intended to improve safety. This regression used number of accidents adjusted for labor hours, representing the exposure to accident risk, labor hours, as the dependent variable. Typically a Poisson model is used to analyze count data such as the number of accidents in a population. The basic Poisson model is

(3.6) $$\ln(\lambda_j) = \sum_{k=0}^{k} \beta_k x_{jk}$$

and

(3.7) $$P(Y = y) = \frac{e^{-\lambda_j} \lambda_j^{y_j}}{y_j!}$$

where λ_j is the expected number of accidents, y_j is the dependent variable (here, accidents), x_{jk} are explanatory variables, and β_k are parameters to be estimated. This model can be modified to adjust for different levels of exposure to accidents, in this case the number of labor hours such that

(3.8) $$\ln\left(\frac{\lambda_j}{n}\right) = \sum_{k=0}^{k} \beta_k x_{jk}$$

or

$$\ln(\lambda_j) = \ln(n_j) + \sum_{k=0}^{k} \beta_k x_{jk} \tag{3.9}$$

where n is the number of labor hours during which employees were exposed to accident risk at location *j* (Osgood 2000). The Poisson model, however, requires equidispersion, under which the conditional mean and variance of the number of accidents are equal. This would mean that underlying mean accident rates are equal for locations with identical covariates. When equidispersion is not present, the negative binomial model, first proposed as an alternative to the Poisson model by Greenwood and Yule (1920), is an appropriate choice. The negative binomial model combines the Poisson model with a gamma distribution to accommodate the differing mean and variance

$$P(Y = y_j) = \frac{\Gamma(y_j + \phi)}{y_j!\Gamma(\phi)} \frac{\phi^{\phi}\lambda_i^{y_j}}{(\phi+\lambda_j)^{\phi+y_j}} \tag{3.10}$$

where y_i is the dependent variable, Γ is the gamma function and ϕ is the reciprocal of the residual variance of the underlying mean counts, α. One can test for equidispersion by testing that the null hypothesis of equidispersion such that the residual variance is zero ($\alpha = 0$). In this case, the Poisson is an appropriate model. If not, then the negative binomial model is a better choice. Tests of the data reject the null hypothesis that $\alpha = 0$ at the 1% level with a Chi-square statistic of 6.71, indicating that equidispersion is not a valid assumption for this data. As a result, the negative binomial model is used.

The safety culture variable aggregated to the firm level is included as an explanatory variable in the accident regression. Mean individual safety culture ratings are used for each location, because accident statistics are provided at the location level. Due to privacy rules, individual accidents are not reported to OSHA. A second explanatory variable is a survey question reflecting investments into capital that improve safety. The question asks for a rating of the safety of physical facilities at the location. Similarly, mean capital rating values from each location are used in the analysis.

Other variables are employment status, tenure with the company, and job classification. Employment status categories include full time, part time, and seasonal. Full-time employees have more opportunity for injury than part-time employees and more training and experience than seasonal employees to avoid accidents. Tenure is broken down into four categories, from less than one year on the job to more than twenty years. Accidents are most common among new employees (Breslin and Smith 2006). Job classification includes ten departments identified by the cooperatives, including agronomy, administration, convenience stores, corporate and financial, energy and petroleum, feed, grain, maintenance, transportation, and other departments. Like the safety culture and capital variables, these variables are averaged to the location level resulting in a variable representing the proportion of employees with each characteristic at each location. The accident rate represents the number of accidents per 100 full time employees per year. As such, the value would be 100 if all employees were involved in an accident once during the year. The maximum value in the data is 48.1. A total of 182 locations had safety culture ratings for both management and hourly workers. Variables are summarized in Table 3.5, and summary statistics for these variables are presented in Table 3.6.

Table 3.5. Variable definitions for negative binomial model

Symbol	Variable	Definition
ACC_j	Accident rate	Incidents per 100 full time employees at location *j*
SC_j	Safety culture	Safety culture rating of employees at location *j*
$CAPITAL_j$	Capital	Rating of capital inputs into safety by employees at location *j*
$NEMPL_j$	Number of employees	Total number of employees at location *j*
$LTYPE_j$	Labor type	Proportion of employees that identify as management at location *j*
$TENURE_{kj}$	Tenure	Proportion of employees at location *j* with the k^{th} class of job tenure length at the *j*th location, k = 1,…,3
FT_{lj}	Employment status	Proportion of employees at location *j* with the full time status of the l^{th} class (full time, part-time, seasonal), l = 1,…,3
JOB_{mj}	Job classification	Proportion of employees at location *j* with the m^{th} job classification, m = 1,…,10

The underlying model to be estimated in the second analysis is

$$(3.11) \qquad \ln ACC_j = \ln(LBRHRS_j) + \beta_1 SCM_j + \beta_2 SCE_j + \beta_3 CAPITAL_j + \beta_4 NEMPL_j + \beta_5 LTYPE_j + \sum_{k=1}^{5} \beta_{6k} TENURE_{jk} + \sum_{l=1}^{3} \beta_{7l} FT_{jl} + \sum_{m=1}^{10} \beta_{8m} JOB_{jm} + \nu_j$$

where ACC_j is the accident rate at location *j*, $LBRHRS_j$ is the number of labor hours that occurred at location *j*, SCM_j is the mean safety culture rating of managers at location *j*, SCE_j is the mean safety culture rating of hourly workers at location *j*, $CAPITAL_j$ is the mean survey answer regarding capital input to safety by individuals at location *j*, $NEMPL_j$ is the number of employees at location *j*, $LTYPE_j$ is the proportion of employees identifying as management at location *j*, $TENURE_{jk}$ are variables representing the proportion of individuals at location *j* with job tenure in the k^{th} (k = 1,…,5) class, FT_{jl} are variables representing the proportion of individuals at location *j* with full time status *l*

Table 3.6. Summary statistics for variables in the negative binomial model

Variable	Mean	Standard Deviation	Minimum	Maximum
Accident Rate	6.001	9.027	0	48
Safety culture for hourly workers	4.256	0.599	1	5
Safety culture for management	3.685	0.547	1	5
Capital	3.761	0.384	1	5
Number of employees	13.698	9.524	2	56
Labor Type	0.282	0.136	0	1
Tenure				
Less than 1 year	0.162	0.147	0	1
1-4 years	0.255	0.191	0	1
4-10 years	0.239	0.167	0	1
10-20 years	0.200	0.172	0	1
More than 20 years	0.144	0.152	0	1
Employment Status				
Full-time	0.877	0.152	0	1
Part-time	0.056	0.109	0	1
Seasonal	0.067	0.119	0	1
Job Classification				
Administration	0.056	0.117	0	1
Agronomy	0.263	0.290	0	1
Convenience stores	0.044	0.166	0	1
Corporate / Financial	0.047	0.121	0	1
Energy and Petroleum	0.107	0.205	0	1
Feed	0.068	0.189	0	1
Grain	0.299	0.316	0	1
Maintenance	0.010	0.039	0	1
Other	0.056	0.106	0	1
Transportation	0.049	0.095	0	1

(l = 1,..,3), and JOB_{jm} are variables representing the proportion of individuals at location *j* with job classification *m* (m = 1,…,10). The error term is ν_j. The parameters to be estimated are β_0, β_1, β_2, β_3, β_4, β_5, β_{6k}, β_{7l} and β_{8m}.

Results

Because the literature suggests that accident rates may influence safety culture, the data was evaluated for the presence of endogeneity. A Hausman test was conducted on the firm-level safety culture variable using the method from Cameron and Travedi (2005), fitting both predicted values of the safety culture from the first regression as well as actual values of the safety culture variable in the regression on accident rate. By testing whether the predicted values of the variable add explanatory power to the model, the test would reveal the presence of endogeneity. Predicted safety culture for management and hourly workers were not statistically significant at the 10% level. Thus, this Hausman test does not reject the null hypothesis of exogeneity of the safety culture variable which suggests that accident occurrences do not influence safety culture. Parameters, standard errors, and test statistics from the regression are included in Appendix 3.2.

Tables 3.7 and 3.8 show the results of the ordered probit regressions for management and hourly workers. A Chow test was used to test whether the set of coefficients was the same for hourly workers and managers. The null hypothesis that all coefficients are equal for management and hourly workers was rejected at the 1% level with a Chi-square value of 157.02. Similarly, the null hypothesis that coefficients from each group of employees are equal to the coefficients on the pooled data is rejected at the

1% level. Results indicate that investments in labor toward increasing safety improve the safety culture perceptions of both management and hourly workers, thus supporting Hypothesis 1. Both groups show improvements in safety culture perceptions with increases in the extent of training, discipline, and effectiveness of modified duty programs, all significant at the 1% level. There were also some differences in the factors affecting the safety culture perceptions of management and hourly workers.

Table 3.7. Parameter estimates, standard errors, and hypothesis tests for management in the ordered probit model

Variable	Coefficient	Std Error	P-values
Training	0.311***	0.061	0.000
Meetings	-0.036	0.046	0.436
Discipline	0.147***	0.038	0.000
Investigations	0.030	0.032	0.336
Inspections	0.114***	0.037	0.002
Modified Duty	0.098***	0.033	0.003
Off-the-Job	-0.006	0.055	0.912
Recognition	-0.006	0.038	0.862
μ_1	-0.483*	0.293	
μ_2	0.487**	0.240	
μ_3	1.516***	0.240	
μ_4	2.473***	0.247	

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

The quality and effectiveness of safety inspections and audits influence the safety culture perceptions of management ($p<0.01$) but do not influence hourly worker safety culture perceptions. The safety culture perceptions of hourly workers are affected by the extent of recognition of safety achievements ($p<0.01$). This supports Hypothesis 2. These results collectively underscore the importance of investing in programs that impact labor efforts toward safety in order to improve safety culture.

Table 3.8. Parameter estimates, standard errors, and hypothesis tests for hourly workers in the ordered probit model

Variable	Coefficient	Std Error	P-values
Training	0.293***	0.030	0.000
Meetings	0.008	0.023	0.713
Discipline	0.084***	0.018	0.000
Investigations	0.013	0.016	0.394
Inspections	0.027	0.018	0.150
Modified Duty	0.068***	0.016	0.000
Off-the-Job	0.010	0.028	0.722
Recognition	0.060***	0.019	0.002
μ_1	0.082	0.102	
μ_2	0.835***	0.099	
μ_3	1.797***	0.102	
μ_4	2.637***	0.107	

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 3.9 shows the results of the negative binomial regression evaluating the effect of safety culture on accident rates. The sign of the safety culture coefficient is negative for both management and hourly workers, indicating that a higher safety culture rating by both groups is associated with lower accident rates. However, only management ratings showed a statistically significant effect ($p<0.10$). Thus, the results provide partial support for Hypothesis 3. Management safety culture perceptions are important because they provide leadership for safety improvement efforts. Although results suggest a negative relationship between the safety culture of hourly workers and accident rates, the lack of significant effect is surprising. More research should be conducted to further understand these findings. [9] Results suggest that rankings of the investment into capital

[9] Analysis was also done using predicted values of the safety culture variable used instead of actual values in order to examine the effects under endogeneity. Results were generally similar, but the effect of safety

intended to improve safety have a positive relationship with accident rates but do not show a statistically significant effect. This, too, is a surprising result given the expectation that safer equipment would decrease accident rates.

Characteristics of employees also influence accident rates. Results indicate that locations with a higher proportion of management employees (as opposed to hourly workers) have lower accident rates, significant at the 1% level. An increase in the proportion of individuals in management of 10 percentage-points is associated with a decrease in accident rates of 23%. This may result from the lower accident risk associated with management jobs. Results also indicate that locations having a higher proportion of seasonal employees are subject to higher accident rates than full-time employees, significant at the 10% level. For every 10 percentage-point increase in the proportion of employees that are seasonal, there is a 19% higher accident rate. This may be because seasonal employees are subject to less training than full time employees. Tenure on the job does not significantly affect accident rates.

Location characteristics influence accidents as well. Although the effect of the number of employees was significant at the 5% level, the increase in accident rate of larger firms was relatively small given the size of the locations. Each additional employee is associated with 2% more accidents per 100 employees. This is consistent with United States Bureau of Labor Statistics (2013) data of total recordable cases that indicate slightly higher accident rates for larger firms. In addition, three job classifications showed significantly different accident rates than the grain classification.

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culture on accident rate was not significant for management or hourly workers. Full results are presented in Appendix 3.3.

Table 3.9. Parameter estimates, standard errors, and hypothesis tests in the negative binomial model

Variable	Coefficient	Std Error	Incidence Rate Ratio
Safety culture for management	-0.295*	0.168	0.744
Safety culture for hourly workers	-0.163	0.223	0.849
Capital	0.472	0.315	1.603
Number of employees	0.019**	0.936	1.019
Labor Type	-2.689***	0.009	0.068
Tenure			
Less than 1 year	--	--	--
1-4 years	0.176	1.009	1.192
4-10 years	1.398	0.930	4.046
10-20 years	0.116	1.018	1.122
More than 20 years	1.168	1.004	3.214
Employment Status			
Full-time	--	--	--
Part-time	1.194	1.196	3.303
Seasonal	1.741*	0.930	5.705
Job Classification			
Administration	-1.023	1.009	0.359
Agronomy	-1.006**	0.441	0.366
Convenience Stores	-0.988	0.924	0.372
Corporate	0.679	0.763	1.972
Energy and Petroleum	-0.057	0.538	0.944
Feed	-0.481	0.582	0.618
Grain	--	--	--
Maintenance	3.303*	1.994	27.203
Other	0.648	0.848	1.912
Transportation	-2.699**	1.306	6.667
Constant	1.897	1.489	

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

-- denotes reference category

Agronomy and transportation show lower accident rates, and maintenance shows a higher accident rate relative to grain.

Limitations of the Research

Limitations of this data include heterogeneity of respondents' jobs, lack of objective measures of safety inputs, and biases in reporting of accidents. Because of the varying job classifications of the respondents, there may be differences in both accident rates and safety culture perceptions. The first analysis which examines differences in safety culture rating indicate that only respondents with job classifications of energy and feed for management and administrative and feed for employees differ significantly from those with grain job classifications, thus indicating that this problem may have limited impact.

Additionally, the data in this study is limited to perceptions of labor and capital inputs into safety. Perceptions may vary by individual for the same location, which is particularly an issue for capital investment. Future research should capture the value of capital inputs into safety through an objective measure. Finally, firms focused on improving safety culture may have a higher tendency to report injuries, as they seek to improve safety control measures. Future research should consider matching self-reported injury rates to rates reported to OSHA. However, this may be problematic due to privacy concerns and inability to match up survey data with injury rates.

Summary and Implications

Managers benefit from reducing accident rates by reducing costs to the firm of employee injury, such as lost productivity, worker's compensation costs, OSHA fines, and insurance premiums. Firm managers employ inputs into labor in order to reduce accidents in their firm. They train employees and conduct safety meetings to keep employees informed of safety rules with the intention of reducing accidents. Similarly, firms recognize safety achievements to demonstrate management commitment to safety and reinforce safety behavior as efforts to reduce accidents. The first analysis indicates that managers can improve safety culture of all individuals in the organization, both management and hourly workers. Frequent training, consistent discipline, and effective modified duty programs are all associated with stronger safety culture. Management safety culture is further improved with thorough inspections and hourly worker safety culture with recognition of safety achievements.

The second analysis indicates that safety culture perceptions, particularly of management, impact accident rates. These findings imply that firms can influence their accident rates through improving safety culture, which can be done through inputs into labor. A direct relationship between inputs into labor and safety performance cannot be claimed. Future research should investigate whether safety culture is indeed the intermediate step between labor investments and improved safety performance.

CHAPTER FOUR

Drivers of Price Changes in Retail Supermarkets

Supermarket managers make pricing decisions on a regular basis as conditions change around them. Many heterogeneous products makes price setting a complicated process. Supply side, demand side, and competitive factors all influence pricing decisions by managers (Nagle and Holden 1995). This essay provides insight into the factors influencing price change decisions in retail supermarkets. The objectives are to examine the determinants of decisions by supermarkets to change food prices and evaluate characteristics of these stores that influence these decisions.

Literature Review

Supermarkets choose to change their prices when potential changes in revenues or costs exceed the cost of repricing the products. Repricing costs may include labor costs of changing price tags, costs of printing new price labels, and costs of mistakes in the pricing process. Levy et al. (1997) find that repricing costs for large supermarket chain stores average $105,887 per year, which totals 37.2% of their net margins or $0.52 per price change. Azzam (1999) shows that the same price declines experienced at the farm level may not be seen at the retail level, due in large part to repricing costs. Factors that affect price changes, or drivers of price change, include changes in supplier prices, consumer demand, and competitor prices (Nagle and Holden 1995). In addition, stores change product prices for store promotions.

Supplier price changes alter costs while unit revenues remain constant, thus causing a change in profit margin. For supplier cost increases, the manager must determine whether to increase prices to maintain their profit margin. Alternatively, a manager could reduce operating costs to offset the increase. For a decrease in supplier costs, the decision is whether to pass on the cost decrease to consumers. Markup pricing, in which products are priced at a constant proportional margin above cost, is a traditional method of pricing. However, it requires allocation of overhead costs and thus may be more difficult to manage successfully than other methods of pricing (Nagle and Holden 1995).

Economic theory suggests that price changes would follow prices paid by supermarkets to their suppliers in a competitive industry. However, the literature suggests that competition on the industry may be imperfect due to increasing concentration and product differentiation (Schumacher and Boland 2005; Sexton 2013). While this may be true of large supermarket chains and supercenters (i.e., stores that carry mass merchandise in additional to food products), studies have not isolated the effect across smaller conventional retail grocery supermarkets. Chen (2004) finds that the presence of smaller supermarkets in the industry increases competition and lowers retail food prices.

Hypothesis 1: Supplier price changes are a primary driver of price changes in conventional retail grocery supermarkets.

Hypothesis 2: Smaller stores are more influenced by supplier price changes than larger stores.

Consumer demand changes represent a shift in the demand curve, with increases in demand providing the opportunity to increase price while unit costs remain constant. Changing price in response to changes in consumer demand allows stores to keep up with changing consumer tastes and preferences. Nijs, Srinavasan, and Pauwels (2007) analyze price variation with data from 55 supermarkets from the Denver market using time series methods to investigate the relative influence of retail price drivers. They show that consumer demand accounts for approximately 16% of price variation. Customer loyalty programs (McLaughlin 2004) and utilization of price optimization programs (Bolton, Shankar, and Montoya 2010) make stores more sensitive to changes in consumer demand by providing more information about consumer demand changes.

Hypothesis 3: Stores with loyalty card programs are more likely to use consumer demand for pricing decisions than stores without such a program.

Changes in competitor prices have the potential to change revenues by shifting customers among stores. Decreases in the competitor's prices shift consumers toward the competitor, while increases in the competitor's prices provide the opportunity for the store to increase its price without losing customers. Dickson and Urbany (1994) find theoretical and empirical support that price cuts, but not price increases, are likely to follow from competitor price changes. However, Nijs, Srinivasan, and Pauwels (2007) find that competitive pricing creates only 5.5% of price variation.

Hypothesis 4: Competitor prices are more likely to be the top-ranked price change driver for price decreases than price increases.

Price decreases due to store promotions are intended to increase revenues by drawing in customers from other stores as well as increasing demand for individual products from current customers, despite the fact that they may reduce margins on an individual product. Using U.S. Bureau of Labor Statistics data from 20 product categories in 30 geographical areas across the U.S., Hosken and Reiffen (2004) show that 20% to 50% of price variation comes from store promotions.

Research on pricing decisions suggests that there may be some differences in pricing decisions across departments. Shankar and Bolton (2004) suggest that storability and necessity of goods influence pricing decisions. Binkley and Connor (1998) find that pricing of storable items is more likely to be driven by costs and that the characteristics of stores that affect pricing decisions depend upon food characteristics, such as perishability.

Hypothesis 5: Storable product prices are more likely to follow supplier prices, while perishable product pricing is more likely to be driven by competitor prices.

The present study evaluates which factors influence pricing decisions using data acquired directly from supermarket managers to reflect their decision making process. Unlike previous literature, factors influencing price increases are separated from those influencing price decreases. These factors are evaluated separately across six departments, including grocery, frozen, produce, meats, dairy, and bread.

Conceptual Model

The price driver, or primary factor that causes the manager to change product prices, depends upon competitive factors, store characteristics, and consumer characteristics such that

(4.1) $$DRIVER_i = f\,(COMP_i, STORE_i, CONS_i)$$

where $DRIVER_i$ is the choice of driver for price increases and price decreases by store *i*, $COMP_i$ reflects competitive factors affecting store *i*, $STORE_i$ contains characteristics of store *i*, and $CONS_i$ are characteristics of consumers shopping at store *i*. Competitive factors might include the intensity of competition in the geographic area of the store and pricing strategies of competing stores. Store characteristics that influence pricing drivers could include store size, size of the chain containing store *i*, and pricing strategy. Important consumer characteristics might include income and population density.

Data

The data used in this study comes from a survey of U.S. grocery retailers who operate in North American Industrial Classification System (NAICS) category 445110 Supermarkets and Other Grocery (except Convenience) Stores. The 2012 Supermarket Panel survey conducted by The Food Industry Center at the University of Minnesota surveyed approximately 1,000 supermarkets representing 350 banners, which are the individual brand names under which firms operate their stores. Stores vary in characteristics such as size and location.

In the 2011 Progressive Grocer Annual Report, Major and Chanil (2011) classify stores as independent or chain retail supermarkets based upon the number of stores operated by the firm. Chain stores are those operated by firms that own more than ten stores, and independent stores are those operated by firms with ten or fewer stores. According to Major and Chenil (2011), independent retail grocery supermarkets with ten or fewer stores account for 17.8% of all supermarkets and 5.46% of total supermarket sales. The stores surveyed in the 2012 Supermarket Panel survey were conventional retail grocery supermarkets. Supercenters, convenience stores, and online grocers were not included in the survey. Thus, the pool of respondents targeted by this survey represents a very specific set of retail supermarkets. Table 4.1 illustrates the mix of independent and chain retail grocery stores in the data and across the industry. Note that the stores in this data are likely to be smaller than the stores dominating the industry. The governance structure of conventional retail grocery supermarkets is comprised mostly of family or employee ownership, as opposed to supercenters which are owned primarily by multinational firms.

Table 4.1. Number of independent and chain grocery stores in the 2012 University of Minnesota Supermarket Panel and the 2011 Progressive Grocer Annual Report

	2012 Supermarket Panel		Industry[a]	
Type	Number	% of total	Number	% of total
Independent retail grocery supermarket (10 or fewer stores)	145	83.3	6,422	17.8
Chain retail grocery supermarket (more than 10 stores)	29	16.7	29,727	82.2
TOTAL	174	100.0	36,149	100.0

[a]Source: 2011 Progressive Grocer Annual Report

Major and Chenil (2011) note that there are approximately 36,000 retail supermarket stores in the United States, including supercenters, convenience stores, and online grocers. Of those, conventional supermarkets represent 74.2% of all supermarkets and 65.6% of supermarket sales. Supercenters follow with 9.6% of all supermarkets and 26.4% of sales. Major and Chenil's (2012) survey of leading retail supermarkets by sales finds that Wal-Mart dominates this category with approximately 90% of supercenter stores and 80% of supercenter grocery sales. Other supercenters include Meijer and Target. Limited assortment supermarkets, such as Aldi and Save-A-Lot, provide a smaller selection at lower prices. Warehouse stores provide limited services in order to sell lower priced grocery products, while military commissaries sell groceries at a a discounted rate to military members and their families. Total supermarket numbers and sales are provided in Table 4.2 from Progressive Grocer's 2011 Annual Report (Major and Chenil 2011). Note that Table 4.2 does not distinguish between independent and chain retail grocery supermarkets.

History of the Supermarket Panel survey

The inaugural University of Minnesota Supermarket Panel survey was conducted in 1998. The survey was conducted in 2001, 2002, 2003, 2007, and now in 2012. In previous years, between 270 and 865 surveys were collected at the store level. These surveys studied services, sales, technology, products, unionization, and competition. Performance characteristics measured included weekly sales, sales per square foot, sales per labor hour, and annual percentage sales growth (King, Jacobson, and Seltzer 2001;

Table 4.2. US supermarket numbers and sales by format, 2010

Format	Number of stores	% of total	Sales ($ millions)	% of total
Conventional supermarket	26,828	74.2	369,469	65.6
Supercenter	3,468	9.6	148,838	26.4
Limited assortment supermarket	2,792	7.7	12,945	2.3
Natural / gourmet foods supermarket	2,405	6.7	23,192	4.1
Warehouse grocery	479	1.3	3,556	0.6
Military commissary	177	0.5	4,746	0.8
TOTAL	36,149	100.0	562,746	100.0

Source: Progressive Grocery Annual Report, 2011

King, Jacobson, and Seltzer 2002; Kinsey et al., 2003; Chung et al., 2010). Additional questions were added to the 2012 survey on topics such as private label offerings and factors influencing pricing decisions. Previous Supermarket Panels were sampled from the entire retail supermarket industry, whereas the recipients of the 2012 Supermarket Panel survey were conventional retail grocery supermarkets rather than supercenters which had become a small percentage of all respondents in previous panel surveys.

Past analyses of the Supermarket Panel survey data provided insights into productivity, human resources practices, and information sharing between stores and suppliers. King, Jacobson, and Seltzer (2001) linked various measures of productivity to population density, warehouse format, unionization of the labor force, and competitive position. King and Park (2004) evaluated the connection between productivity and store performance. Volpe (2011) linked store performance to pricing strategy of competitors and competition from supercenters. Park and Davis (2011) documented the relationships of improvements in human resources training, full time hiring, benefits, and incentives with improved store performance. Park (2008) found that larger store size is associated with higher marginal value of labor and greater use of part-time employees. Park and Sauer (2013) examined the effects of labor input use and store characteristics on labor input value. Park and King (2007) found that decision sharing technology between suppliers and stores were associated with improved store performance measures. Mohtadi (2008) examined determinants of information sharing technology and found that firms with many suppliers and self-distributing firms were most likely to adopt the technology.

2012 Supermarket Panel Survey

Questions in the 2012 Supermarket Panel survey assessed the most common driver of price increases and the most common driver of price decreases. Four drivers were examined – supplier prices, competitor prices, consumer demand, and promotional activities. The four factors were ranked one through four with one being the most common and four being the least common driver. The question was asked separately for price increases and decreases. The Supermarket Panel provides much of the pricing decision information for individual departments. Six departments were examined – grocery, frozen foods, produce, meat and seafood products, dairy, and breads. Phone interviews were conducted to supplement the survey to increase the completeness of the data.

Data was collected at the store level but aggregated to the banner level because it was believed that pricing decisions are primarily made at that level. Rankings and store characteristics were generally the same across stores within a banner. Data was accumulated from 250 different banners. Complete data was available for 174 banners, which represent a total of 1,457 stores. The most common missing data was total sales. The data was primarily composed of independent retail grocery supermarkets (10 or fewer stores per firm) rather than chain stores (more than 10 stores per firm). Over 80% of the banners in the data were owned by firms with 10 or fewer stores. In the industry, only 17.8% of firms have 10 or fewer stores, while 82.2% of firms have 11 or more stores (Major and Chenil 2011). Only two banners in the 2012 Supermarket Panel survey are owned by firms in the 2011 Progressive Grocery top 50 firms by sales (Major and Chenil 2012). Thus, this data is not representative of all retail supermarket stores. Average sales per store in this data are shown in Table 4.3.

Table 4.3. Average sales per store for banners in the 2012 University of Minnesota Supermarket Panel and 2011 Progressive Grocer Annual Report

Variable	2012 Supermarket Panel 1 to 10 stores	2012 Supermarket Panel 11 or more stores	Industry[a] 1 to 10 stores	Industry[a] 11 or more stores
< $2.0 million	16	1		
$2.0 to $4.0 million	68	11	2,187	2,968
$4.0 to $8 million	28	6	3,711	6,743
$8.0 to $12.0 million	24	7	374	3,563
$12.0 to $20.0 million	6	4	116	5,157
> $20.0 million	3	0	34	11,296
TOTAL	145	29	6,422	29,727

[a]Source: 2011 Progressive Grocer Annual Report

Results

Initial analysis of the rankings

Initial analysis examined the drivers of price increases and decreases across banners by department, which includes grocery, frozen, produce, meat, dairy, and bread. Rankings were surprisingly consistent. In fact, for many departments, rankings were identical for all banners. This is likely due to the fairly homogeneous nature of the survey data. Supplier prices were the top ranked driver by all banners for price increases and price decreases in meats and bread, as well as price decreases in produce. This provides support for Hypothesis 1 that supplier prices are an important driver of product pricing decisions. Supplier prices were most commonly followed by promotional activities and consumer demand. Competitor prices were ranked last. These results imply that the industry is competitive in these products, as market prices follow the prices paid by the stores for these products.

Price decreases in the grocery and frozen departments were primarily driven by competitor prices, followed by supplier prices, promotional activities, and consumer demand. This implies that demand for these products is more elastic than the other departments, with consumers expected to respond to prices with their choice of store, causing stores to maintain similar prices to competitors in order to avoid losing customers. This finding supports Hypothesis 4 that competitor prices are more likely to be a top-ranked driver for price decreases than price increases and is consistent with Dickson and Urbany's (1994) finding that stores follow competitors' prices down but not up. However, these results are not particularly supportive of Hypothesis 5 that storable products are more likely to be priced by supplier prices than perishable products.

Variation in rankings across banners was found in (1) price increases for the grocery, frozen, and produce departments, (2) price increases in milk, and (3) price decreases in the grocery and frozen departments. Rankings within each of these groups were identical. Variation was primarily in the top-ranked driver with those ranked lower generally the same. For example, 150 store banners ranked supplier prices first, followed by promotional activities, competitor prices, and consumer demand for grocery, frozen, and produce department price increases. Twenty-two store banners ranked promotional activities first and supplier prices second, followed again by competitor prices and consumer demand. One store banner ranked consumer demand second to promotional activities, with supplier prices and competitor prices following in third and fourth, respectively.

Additional information about the top ranked price change drivers is shown in Table 4.4. Departments are in groups for which rankings are identical across the selected department. For example, price increase rankings for grocery, frozen, and produce departments are identical but different than milk, meats, and breads. Price decrease rankings for grocery and frozen departments are identical but different than produce, milk, meats, and bread, which were all the same.

Table 4.4. Top ranked price driver for banners in the 2012 University of Minnesota Supermarket Panel

Driver	Price increases: Grocery, frozen, & produce	Price increases: Milk	Price increases: Meats & bread	Price decreases: Grocery & frozen	Price decreases: Produce, milk, meats, & bread
Supplier prices	134	14	174	13	0
Consumer demand	0	0	0	0	0
Competitor prices	0	0	0	161	174
Promotional activities	40	160	0	0	0
TOTAL	174	174	174	174	174

Secondary analysis of the rankings

Three logit analyses are conducted to further examine the top-ranked answer for the following groups of departments: (1) price increases in grocery, frozen, and produce departments, (2) price increases in milk, and (3) price decreases in grocery and frozen departments. This method was chosen because only the top two rankings varied across stores. Third and fourth place rankings are identical across stores with only one exception. Although it was intended to analyze the rankings of factors influencing pricing decisions separately for each department, the rankings across groups of departments are identical for all stores in the data. As a result, price increases for grocery, frozen, and produce departments are combined into one group for this analysis and price decreases for grocery and frozen departments in another.

Explanatory variables in each analysis include store characteristics and consumer characteristics, summarized in Table 4.5. Store characteristics include chain size, store size, sales per square foot, and in-store services. Stores are considered to be a chain if there were more than ten stores under the same ownership, reflected in a binary variable equal to one if the firm that owns the banner is considered to be a chain and zero otherwise. Stores are considered to be independent if there were 10 or fewer stores under the same ownership. Store size was measured in total revenues of the firm owning the banner, measured in units of $1,000,000. Sales per square foot, a common measure of productivity, were measured at the firm level in units of $1,000.

Table 4.5. Definitions of variables in the model

Symbol	Variable	Definition
P_i	Supplier prices	Probability that banner *i* chose supplier prices as the top driver of price changes for banner *i*
<u>Store characteristics</u>		
$CHAIN_i$	Chain	Binary variable equal to one if the banner *i* owns a chain of stores (more than 10 stores), zero otherwise
$SALES_i$	Total sales	Total sales of banner *i*
$SSQFT_i$	Sales per square foot	Retail sales per square foot of store space of banner *i*
$BAKERY_i$	Bakery	Binary variable equal to one if banner *i* has in-store bakeries, zero otherwise
$LOYALTY_i$	Loyalty card program	Binary variable equal to one if banner *i* has a loyalty card program, zero otherwise
<u>Consumer characteristics</u>		
$URBAN_i$	Urban location	Binary variable equal to one if banner *i* is located in an urban area, zero otherwise
$FAMINC_i$	Median family income	Median family income (in $1,000s) in the zip code where banner *i* is located

Services examined include the presence of an in-store bakery and a butcher and are considered to reflect the level of service provided by the store. Butchers are responsible for processing large cuts of meat into retail-ready portions. Alternatively, stores may choose to purchase retail-ready portions of meat which limits the necessary in-store preparation. Store managers identified whether their stores have an in-store bakery and (or) a butcher, each of which is recorded as a binary variable with a value of one if the service is present and zero otherwise. However, all stores in the data set indicate the presence of a butcher, so this variable is dropped from the analysis.

Consumer characteristics evaluated include urban or nonurban location and median family income of the area the stores are located. Shankar and Bolton (2004) find that the degree of stability in prices varies depending upon whether the store is located in a urban or rural setting. Each store's location is classified as rural or urban using classifications from a 2003 analysis by the USDA Economic Research Service (2013). Counties are classified into nine categories as metropolitan and nonmetropolitan, with each classification divided into categories by population. A banner is considered to be urban if the majority of stores within the banner are located in a metropolitan county and nonurban if the majority of stores were located in a nonmetropolitan county. A binary variable was created with a value of 1 if the majority of stores within the banner are located in an urban area and zero if the majority are located in a rural area.

Median income is measured in units of $1,000 for families in the zip code at the location of the stores using the 2010 census (United States Census Bureau 2010). Although many banners operate stores in numerous zip codes, median income is similar across zip codes within the banner. In order to accommodate multiple zip codes per banner, the median family income is averaged across the stores within the banner. Levy et al. (2004) indicates that customers in more affluent areas may be less sensitive to prices and price relationships.

Summary statistics are presented in table 4.6. Banners owned by firms with more than 10 stores account for 16% of the data. Total sales of the banner averaged $25,163,000, and sales per square foot averaged $2,632. Banners with bakeries and loyalty card programs account for 89% and 65% of the data set, respectively. Just over

60% of banners have a majority of stores located in a metropolitan area. More than 70% of the population lives in metropolitan areas (United States Census Bureau 2013). Median family income over a banner averages $65,181. This exceeds the 2010 median U.S. income, which was $51,144. Approximately 65% of stores have a loyalty card program and 89% have a bakery. This suggests that these stores operate in higher income areas and provide higher levels of service than larger chain grocery supermarkets.

Table 4.6. Summary statistics for variables in the model

Variable	Mean	Standard Deviation	Minimum	Maximum
Firm characteristics				
Chain (> 10 stores)	0.160	0.368	0	1
Total sales, $1,000,000	25.163	13.383	2.5	66
Sales per sq ft, $1,000	2.632	4.611	0.065	32.759
Bakery	0.891	0.313	0	1
Loyalty card program	0.655	0.477	0	1
Consumer characteristics				
Urban location	0.603	0.490	0	1
Median family income, $1,000	65.181	26.568	27.704	201.112

Empirical model for the secondary analysis

A logit model is used to analyze binary choices, in this case that the top ranked driver for pricing decisions is supplier prices. The following logit model is estimated:

(4.2)
$$\text{Log}\left(\frac{P_i}{1-P_i}\right) = \alpha_1 \text{ CHAIN}_i + \alpha_2 \text{ SALES}_i + \alpha_3 \text{ SSQFT}_i + \alpha_4 \text{ BAKERY}_i + \alpha_5 \text{ LOYALTY}_i + \alpha_6 \text{ URBAN}_i + \alpha_7 \text{ FAMINC}_i + \varepsilon_i$$

where P_i is the probability that supplier prices are the top-ranked driver of pricing decisions for banner *i*, $CHAIN_i$ is a binary variable equal to one if the banner *i* is a chain of ten or more stores, $SALES_i$ is the total sales of banner *i*, $SSQFT_i$ is the sales per square foot of banner *i*, $BAKERY_i$ is a binary variable equal to one if banner *i*'s stores have an in-store bakery, $LOYALTY_i$ is a binary variable equal to one if banner *i* has a loyalty card program, $URBAN_i$ is a binary variable equal to one if the majority of banner *i*'s stores are located in urban areas, and $FAMINC_i$ is the median family income in the zip code where banner *i* is located. The parameters to be estimated are α_1, α_2, α_3, α_4, α_5, α_6, and α_7 and ε is the error term. In all three analyses, the binary choice variable was valued at one when supplier prices were the top ranked driver. For price increases in grocery, frozen, produce, and milk departments, the value was zero if promotional activities were ranked first. For price decreases in grocery and frozen departments, a value of zero reflected the choice of competitor prices as the top ranked driver.

Results

Price increases

Table 4.7 and 4.8 show the results of the logit analyses for price increases. McFadden's pseudo-R^2, which uses a ratio of log-likelihood statistics to measure goodness of fit, is 0.22 and 0.17 for the grocery, frozen, and produce department group and dairy department, respectively. Results indicate that some store characteristics influence the top-ranked driver of price increases. The presence of a loyalty card program influences the primary driver of price increase decisions, significant at the 1% level. Having a loyalty card program makes it less likely that the store uses supplier prices as the primary driver of their pricing decisions, providing partial support for Hypothesis 3.

The additional information consumer behavior provided by loyalty card programs may support decisions that depend more on consumer behavior, such as promotional activities. The finding that price increases for grocery, frozen, and produce products are less likely to be driven by supplier prices with the presence of a bakery is surprising. Bonanno and Lopez (2009) found that services are associated with a lower price elasticity of demand for milk, suggesting that stores would be more willing to increase prices with a supplier price increase. Further interviews with respondents did not provide further insight into this result.

Although not significant, both regressions suggest a negative relationship between belonging to a chain of ten or more stores and using supplier prices as the primary driver of price changes. Larger chains may have more information on consumers and competitors from which to make pricing decisions. Neither sales nor sales per square foot were statistically significant, failing to provide support for Hypothesis 2. Results suggest that larger stores are more likely to use supplier prices for pricing decisions and that stores with more sales per square foot are less likely to use supplier prices to drive their price increase decisions, but these results are not significantly different from zero.

Consumer characteristics, too, have an effect on price increase decisions. Price increases for grocery, frozen, and produce departments is more likely to be determined by supplier prices as median family income increases, significant at the 1% level. This is supported by work from Hoch et al. (1995), which showed that price sensitivity decreased for many grocery and frozen products with increasing income. The

Table 4.7. Logit analysis parameter estimates, standard errors, and hypothesis tests for price increases in grocery, frozen, and produce departments

Variable	Coefficient	Std Error	P-values
Chain[1]	-0.139	0.695	0.841
Size ($1,000,000)	0.010	0.017	0.549
Sales per sq ft ($1,000)	-0.026	0.041	0.512
Bakery[2]	-2.048*	1.092	0.061
Loyalty card program[3]	-2.086***	0.649	0.001
Urban location[4]	-0.001	0.458	0.998
Median family income ($1,000)	0.041***	0.015	0.008
Constant	2.198	1.508	0.145

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

[1] Chain is a binary variable equal to 1 if the store belongs to a chain of more than 10 stores and zero otherwise.

[2] Bakery is a binary variable equal to 1 if the store offers a bakery and zero otherwise.

[3] Loyalty card program is a binary variable equal to 1 if the store has a loyalty card program and zero otherwise.

[4] Urban location is a binary variable equal to 1 if the store is located in a metropolitan area and zero otherwise.

significant negative relationship between location in an urban area and using supplier prices in milk ($p<0.10$) indicates that promotional activities driving price increase decisions are more common in urban areas. This is not unexpected because competition would be heavier where there are more shopping options, and demand would be more elastic in these areas, leading to increased incentive for promotional activities.

Price decreases

Table 4.9 shows the results of the logit analysis for price decreases for grocery and frozen products. McFadden's pseudo-R^2 is 0.23. Like the results for the price increases,

Table 4.8. Logit analysis parameter estimates, standard errors, and hypothesis tests for price increases in milk

Variable	Coefficient	Std Error	P-values
Chain[1]	-0.013	1.497	0.973
Size ($1,000,000)	0.023	0.019	0.228
Sales per sq ft ($1,000)	-0.066	0.158	0.675
Bakery[2]	0.204	1.142	0.858
Loyalty card program[3]	-2.004***	0.703	0.004
Urban location[4]	-1.453*	0.742	0.050
Median family income ($1,000)	0.010	0.012	0.446
Constant	-2.125	1.434	0.138

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.
[1] Chain is a binary variable equal to 1 if the store belongs to a chain of more than 10 stores and zero otherwise.
[2] Bakery is a binary variable equal to 1 if the store offers a bakery and zero otherwise.
[3] Loyalty card program is a binary variable equal to 1 if the store has a loyalty card program and zero otherwise.
[4] Urban location is a binary variable equal to 1 if the store is located in a metropolitan area and zero otherwise.

loyalty card programs provide the most significant effect on pricing decisions. Stores with loyalty card programs are more likely to use competitor prices in their pricing decisions than stores without loyalty card programs. Stores in an urban location are more likely to use competitor prices as the primary driver of these pricing decisions, significant at the 10% level. Similar to price increases in milk, this is not surprising since metropolitan stores are more likely to have closer competition than nonmetropolitan stores. Most variables without a significant effect showed similar signs to price increases. Results suggest that for price decrease decisions larger stores and stores in areas with a higher median family income are more likely to use supplier as the primary driver of pricing decisions. Sales per square foot, presence of a bakery, and membership in a chain show essentially no effect on the driver of pricing decisions.

Table 4.9. Logit analysis parameter estimates, standard errors, and hypothesis tests for price decreases in grocery and frozen departments

Variable	Coefficient	Std Error	P-values
Chain[1]	0.174	1.568	0.912
Size ($1,000,000)	-0.019	0.021	0.371
Sales per sq ft ($1,000)	-0.050	0.157	0.748
Bakery[2]	0.044	1.172	0.970
Loyalty card program[3]	-2.443***	0.819	0.003
Urban location[4]	-1.774**	0.820	0.031
Median family income ($1,000)	0.011	0.013	0.392
Constant	-1.906	1.484	0.199

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.
[1] Chain is a binary variable equal to 1 if the store belongs to a chain of more than 10 stores and zero otherwise.
[2] Bakery is a binary variable equal to 1 if the store offers a bakery and zero otherwise.
[3] Loyalty card program is a binary variable equal to 1 if the store has a loyalty card program and zero otherwise.
[4] Urban location is a binary variable equal to 1 if the store is located in a metropolitan area and zero otherwise.

Limitations of the Research

This data does not allow analysis of the size, frequency, or probability of price changes. Although such an analysis would be useful to managers of retail supermarkets, it would be difficult to obtain the necessary data for the underlying causes and resulting action in price changes. Nijs, Srinivasan, and Pauwels (2007) observed price data for 55 stores in the Denver area to quantify the price variation associated with the various drivers of pricing decisions. Future research might consider combining such quantitative data with the subjective rankings of pricing decision drivers.

This data looks the influence of promotional activities on pricing decisions separately from the influence of supplier prices. However, in many cases, these factors are linked, since promotional activities are often driven by supplier price incentives. As a result, the analysis of price decreases, which looks at the choice between supplier prices and competitor prices, provides more information than the analysis of price increases, which sets supplier prices and promotional activities as separate choices.

This research is somewhat limited in the store characteristics examined, including only those available directly from the survey. Additional data is being collected in the 2012 survey about private label offerings, which could provide further information about appropriate variables to explore. In addition, Homescan data provides information about consumer purchases. Studies such as those by Volpe, Okrent, and Liebtag (2013) and Zhang et al. (2009) have utilized the Homescan data to analyze consumer purchasing patterns. Future research could explore the further effects of consumer characteristics and other data as the data collection process allows USDA ERS to link their Homescan and scanner data to this data set.

Summary and Implications

Results indicate that for most departments and the vast majority of stores, supplier prices are the most common determinant of pricing decisions. The data contained very little variation in drivers of price changes, likely due to the homogeneity of stores in the conventional retail grocery supermarket industry. The result implies that stores operate in a competitive industry, moving their prices with costs. It further suggests that smaller conventional grocery stores do not operate with market power, in contrast to literature which suggests possible market power in the food industry. In a number of personal interviews done for this study, respondents mentioned antitrust issues, noting that price increases must be supported by economic factors rather than simply following competitor price increases. It appears that price optimization techniques have not infiltrated this segment of the retail supermarket industry. As competing segments of the retail supermarket industry continue to grow, such as supercenters and limited assortment grocery stores, independent retail grocery supermarkets may need to incorporate this technology in order to better use consumer demand information.

CHAPTER FIVE

Conclusions

The objective of this dissertation is to examine decision-making by firms whose ownership structure includes users (sugar beet producers, farmers) and families (retail supermarkets). The decisions include exit and survival, investments in employee safety, and pricing decisions. The essays in this dissertation span three food economy industries where closely-held governance structures are still typical of many firms in that industry. These include sugar beet processing, farm supply and grain and oilseed marketing, and retail supermarkets.

Investor-oriented firms are not interested in owning sugar beet processing companies due to low profit margins. All plants built since 1968 have been under a cooperative structure. If owned by investor-oriented firms, modern factories would be much larger than the relatively small sized plants that are characteristic of most of the U.S. sugar beet industry. If a new plant was built, these companies would be more likely to shut down older plants and (or) invest in new equipment to reduce the operating costs of running a sugar beet processing plant. Cooperative sugar beet processing firms act in the best interest of their producer-owners, maintaining their location at a higher operating cost. In addition, they are less likely to exit because their existence benefits their producer-owners.

Agricultural input supply firms, the focus of the second study, are also commonly structured as cooperatives. The data used in the second study is composed entirely of cooperatives. With their more efficient asset base, publicly traded firms may choose to focus more on protecting their employees by investing more in safer equipment than in safety culture. With a smaller, less efficient asset base located in a small geographic area, cooperatives must focus on less capital-intensive investments that could increase employee safety, such as improving safety culture.

The third study examines the factors that influence pricing decisions in retail supermarkets, which in this data are primarily family-owned. Multinational supercenter store chains are more likely to invest in much deeper logistical systems suitable for operating multiple locations and operate single-desk buying systems relative to the family-owned independent supermarkets in this study. This provides them the opportunity to utilize consumer demand information much more efficiently, which can inform pricing decisions. Such firms are likely to have a deeper understanding of corporate finance and more apt to open and close facilities compared to these family-owned firms which are often tied to a piece of land in certain geography. The resulting higher operating costs and lower margins may lead to more emphasis on markup pricing based on supplier prices.

Unique Industry Characteristics

A unique feature of the sugar beet processing industry is the role of policy since the beginning of this industry's formation which has been designed to encourage the use of U.S.-produced refined sugar. The use of a high tariff on imports of refined sugar, the use of quotas on imports of sugar from various countries, and a price support program that encouraged plants to become more cost efficient have lessened the rates of closure.

Surviving plants in this industry are likely to have greater plant capacity, belong to firms that own more than one plant, and be located in geographic regions where production and processing costs are lower relative to other geographic regions. All plants in this industry are owned or operated by sugar beet producers. Owners of these plants are not likely to build new, more cost efficient plants but rather use equipment and technology designed to use the existing footprint in its most efficient way.

Firms operating in the farm input supply and grain and oilseed marketing industries have employee accident rates above the U.S. average. These industries are unique in terms of asset location and size relative to investor-oriented firms. Managers benefit from reducing accident rates by reducing costs to the firm of employee injury, such as lost productivity, worker's compensation costs, and OSHA fines. Firm managers employ inputs into labor in order to reduce accidents in their firm. They train employees and conduct safety meetings to keep employees informed of safety rules with the intention of reducing accidents. Similarly, firms recognize safety achievements to demonstrate management commitment to safety and reinforce safety behavior as efforts to reduce accidents. The analysis suggests that managers can improve safety culture of all individuals in the organization and in doing so, lower accident rates.

Retail supermarkets operate in direct contact with the consumer and must determine how to price their goods in contrast to other industries in the food economy. Smaller conventional retail supermarkets do this with limited consumer information, as their investment in consumer information tracking is lower than investor-oriented firms. Supplier prices are the predominant factor in making pricing decisions. This suggests a competitive nature in the independent retail supermarket industry. Store characteristics and consumer characteristics influence the factors that underlie pricing decisions. Loyalty card programs and higher family income decrease the reliance on supplier prices. This suggests that elasticity of demand and possibly consumer information influence pricing decisions.

Implications of the research

In order for organizational economics to build beyond its conceptual frameworks and theoretical models, careful attention to data collection and empirical work is needed as pointed out by Cook and Barry (2004). These three essays use data that provide unique information about each industry. The first essay includes information on every sugar beet plant ever constructed in the United States. The second essay has information on employee attitudes towards safety culture and OSHA accident rates from agricultural firms involved. This is the first time safety culture data has been tied to OSHA accident rates in the agricultural industry. The third essay has data on family-owned retail supermarket stores. While data on such chains has existed, no information on their decisions on how to handle price changes has been collected.

It would be ideal if future research could compare management decisions of investor-oriented firms with cooperatives and family-owned businesses. This could highlight some of the differences in management decision-making previously discussed. However, this is not likely to be possible since company policies often prohibit collection of this data, particularly in firms that report to the U.S. Securities and Exchange Commission.

Agricultural and applied economists are increasingly using concepts and frameworks pioneered by Nobel Prize laureates in institutional and organizational economics. Specific knowledge of an industry and its unique characteristics is needed to develop industrial organization research in this area. These essays seek to further understand managerial decisions of food economy firms with unique governance systems.

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Chapter 5

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Appendix 2.1

Impact of a price variable and prediction of probabilities of plant survival

Analysis was conducted using a price variable with subsequent prediction of survival probabilities. The price variable reflects the price of refined sugar. Wholesale prices began to be publicly reported in 1934 although a search of the literature found some wholesale prices between 1897 and 1934 reported in various journal articles on the sugar industry but no complete series. Even if there was an entire time series for this period, these data would not have been consistent with how the U.S. Department of Agriculture collected such data beginning in 1934. An examination of the data finds that the assumption of a constant margin is not accurate for this relationship between refined sugar prices and sugar beet prices. Nonetheless, the analysis is presented in order to consider possible impacts.

The price variable used is the average percentage change in price experienced by firm *i* in the last five years of a plant's life or the five years prior to censoring of the data in 2011. Because of the length of the time series, average percentage price change was seen as a better indicator to capture the direction of price changes, rather than the absolute value of price, in the years preceding plant closure. Plants close because of a period of low profitability rather than a single period. Retail US sugar prices from 1897 to 2011 were collected from the U.S. Department of Labor's Bureau of Labor Statistics. Five years was chosen because it was the length of most Farm Bills which contain sugar policy but three and four years were looked at as well with no difference in the results.

The hazard of closure is expected to increase as this price variable decreases. The mean of this variable was -0.5883 and standard deviation was 5.159.

Survival functions for each firm were evaluated for five-year survival probabilities, from 2011 to 2016. A five year time horizon was used because it corresponded to the length of most Farm Bills and the length of the price variable. The price variable was predicted using 5% and 10% average price declines over the five years from 2011 to 2016. A 5% average decline is consistent with projections from the Food and Agricultural Policy Research Institute. A 10% decline is consistent with projections for the world price of sugar from the Organization for Economic Co-operation and Development. A drop to the 2011 U.S. Department of Agriculture marketing loan rate for sugar beets loan rate would result in approximately an average 9% price decline by 2016 depending upon the region.

From the survival functions, the conditional probabilities representing the probability that the firms would still be open in 2016 given that they were open in 2011 were calculated as:

$$\frac{\Pr(S_{2011}\ AND\ S_{2016})}{\Pr(S_{2011})} = \frac{\Pr(S_{2016})}{\Pr(S_{2011})}$$

where S_{2011} represents firm survival until 2011 and S_{2016} represents firm survival until 2016.

When the average percentage price change 5 years prior to closure is zero, the hazard rate, decreases 45.6% for every 1,000 tons of capacity. Declining prices over the 5-year period prior to closure (or the 5-year period prior to the end of the data set for firms open in 2011) increase the probability of exit. Considering both the direct and interaction effects for every 1% decrease in the 5-year moving average of sugar price, the probability of firm exit increases by 4.9%. However, results show that price response is sensitive to plant size. The hazard rate for plants with larger capacity is more responsive to changes in price. With the estimates in hand, a forecast of firm survival in the near term was constructed. At a 5% average price decline, survival probabilities ranged from 0.5266 to 0.9997. At a 10% average decline, these probabilities drop to a range of 0.3886 to 0.9910.

Appendix 3.1

Survey Questions Used in the Analysis

Table A3.1. Survey questions used in the analysis of safety culture

Variable	Question
Safety Culture	To what extent do you feel empowered and expected to take action to prevent injuries and ensure the safety of yourself and others? 1 Not at all empowered 2 Not very empowered 3 Moderately empowered 4 Quite empowered 5 Fully empowered
Training	How much formal, structured training have you received in safety and occupational health in the last two years? 1 No training 2 Little training 3 Some training 4 Considerable training 5 Thorough and extensive training
Meetings	How often are safety meetings held in your workplace? 1 We don’t have safety meetings. 2 Less frequently than every two months 3 Every two months 4 Every month 5 Every week or two weeks
Discipline	How is disciplinary action used when people don’t follow safety rules? 1 I don’t know. 2 Disciplinary action is seldom taken for safety violations. 3 Disciplinary action taken for safety action is applied arbitrarily and inconsistently. 4 Disciplinary action is taken only for serious safety violations. 5 Disciplinary action is taken for all safety violations.

Investigations	To what extent are injuries, safety incidents, and near misses investigated, and are the recommendations acted upon? 1 I don't know. 2 Injuries and incidents are seldom investigated. 3 Only the most serious injuries and incidents are investigated. 4 Many of the injuries and incidents are investigated, and some of the recommendations are implemented. 5 Most injuries and incidents are investigated, and most of the recommendations are implemented. 6 All injuries and incidents are thoroughly investigated, and all the recommendations are implemented.
Inspections	How do you rate the quality and effectiveness of the safety audit and inspection system? 1 I don't know 2 Very poor 3 Poor 4 Satisfactory 5 Good 6 Excellent
Modified Duty	"The modified-duty and return-to-work initiatives include strong efforts to aid rehabilitation and find meaningful temporary duties for injured workers who cannot do their regular job." 1 I don't know 2 Strongly disagree 3 Disagree 4 Neither agree nor disagree 5 Agree 6 Strongly agree
Off-the-Job	To what extent is "off-the-job" safety dealt with in your workplace safety program? 1 I don't know 2 Off-the-job safety is not part of our workplace safety program. 3 ??? 4 Off-the-job safety is an important part of our safety program. We keep statistics on off-the-job injuries. We have an off-the-job safety committee and programs to promote safety at home, safe driving off-the-job, etc.

Recognition	To what extent does your organization recognize safety achievements and celebrate good safety performance? Recognition is: 1 I don't know 2 None 3 Little 4 Some 5 Frequent 6 Thorough and extensive
Capital	How do you rate the safety of the physical facilities in your area? 1 Very poor 2 Poor 3 Satisfactory 4 Good 5 Excellent

Appendix 3.2

Results of Hausman test regression

The data was evaluated for the presence of endogeneity which would be a problem if accident rates influenced safety culture values. Table A3.2 shows the results of a Hausman test that was conducted on the firm-level safety culture variable using the method from Cameron and Travedi (2005). The predicted values of the safety culture from the first regression analysis were included in a regression on accident rate of the actual values of the safety culture variable. If the predicted values of the variable add explanatory power to the model, the presence of endogeneity would be revealed. However, neither predicted safety culture for management nor predicted safety culture hourly workers showed a statistically significant effect on accident rates at the 10% level.

Table A3.2. Results of a Hausman test for endogeneity

Variable	Coefficient	Std Error	P-value
Safety culture of management	-0.341*	0.180	0.058
Safety culture of hourly hourly workers	-0.199	0.241	0.409
Predicted safety culture for management	0.277	0.359	0.440
Predicted safety culture for hourly workers	0.078	0.307	0.799
Capital	0.426	0.346	0.219
Number of Employees	0.019**	0.009	0.039
Labor Type	-2.546***	1.033	0.008
Job Tenure			
1-4 years	0.296	1.033	0.775
4-10 years	1.458	0.940	0.121
10-20 years	0.090	1.042	0.931
More than 20 years	1.354	1.035	0.191
Full Time Status			
Part-time	1.220	1.224	0.319
Seasonal	1.729*	0.964	0.073
Job Classification			
Administration	-0.736	1.056	0.486
Agronomy	-0.971**	0.447	0.030
Convenience stores	-0.750	0.990	0.449
Corporate / Financial	0.854	0.796	0.283
Energy and petroleum	0.037	0.552	0.947
Feed	-0.421	0.588	0.474
Maintenance	3.529*	2.028	0.082
Other	0.580	0.860	0.500
Transportation	-2.652	1.311	0.043
Constant	0.604	2.105	0.774

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Appendix 3.3

Results Using Predicted Values of Safety Culture

Table A3.3 shows the results of the negative binomial model using predicted values of safety culture for management and hourly workers to address potential endogeneity. The safety culture variable represents the predicted values of safety culture ranking using the first regression on safety culture. Predicted safety culture rankings were considered to be the ranking with the highest probability from the ordered probit analysis. Although the positive sign is contrary to expectations that stronger safety culture is associated with lower accident rates, the relationship is not significant. Like the negative binomial results, the relationship of accident rates with investments in safer equipment and job tenure were generally not significant. Larger firms and those with more management employees showed lower accident rates. Increasing proportions of seasonal employees were associated with higher accident rates, and some job classifications showed significant differences in accident rates.

Table A3.3. Parameter estimates, standard errors, and hypothesis tests in a second stage negative binomial model using predicted values of safety culture

Variable	Coefficient	Std Error	P-values
Predicted safety culture for management	0.026	0.339	0.938
Predicted safety culture for hourly workers	0.032	0.284	0.910
Capital	0.191	0.329	0.561
Number of Employees	-2.604***	0.961	0.007
Labor Type	0.019**	0.010	0.043
Tenure			
1-4 years	0.188	1.041	0.857
4-10 years	1.621*	0.950	0.088
10-20 years	0.152	1.049	0.885
More than 20 years	1.131	1.040	0.277
Full Time Status			
Part-time	1.513	1.256	0.228
Seasonal	1.737*	0.972	0.074
Job Classification			
Administration	-0.930	1.096	0.396
Agronomy	-0.915**	0.451	0.042
Convenience stores	-0.967	1.018	0.342
Corporate / Financial	0.786	0.816	0.335
Energy and petroleum	-0.024	0.566	0.966
Feed	-0.353	0.586	0.547
Maintenance	3.078	2.053	0.134
Other	0.591	0.877	0.500
Transportation	-2.647**	1.328	0.046
Constant	0.718	2.136	0.737

Note: *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.