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JunJie Wu

This study develops theoretical and empirical models to analyze the motivations and outcomes of Oregon business decisions for voluntary environmental management. More specifically, the following issues are explored in this study: What motivates a facility to over-comply with environmental regulations? Why does a facility adopt an environmental management plan (EMP)? Does the adoption of an EMP actually change the facility's behavior for environmental management? Are the EMP adoption and environmental actions effective in improving facilities' environmental performances?

To explore those issues, a theoretical model is developed to analyze the interaction between decisions made at the facility, parent company and industry levels. The model is built upon the following three assumptions. First, facilities are profit maximizers. Second, a parent company sets the level of environmental spending for all facilities in the company to maximize the company's welfare, where company welfare is a function of both profit and non-profit related benefits and pollution costs from gaining additional market share. Third, an environmental authority for the industry creates a pollution standard dictating the necessary level of companies' emission reduction spending. This level is chosen in a way that will maximize social welfare. The result is that a parent company will choose to increase emission reduction spending above the industry regulated level when the marginal benefits of increasing emission reduction spending is greater than the marginal cost of increasing emission reduction spending. Companies choose to increase emission reduction spending because the marginal net benefits of emission reduction spending are greater than zero at the industry

optimal level. Under this condition, facilities will over-comply with industry level environmental regulations.

Three empirical models are estimated to examine facilities decisions for environmental management. The first empirical model examines facilities motivations to over-comply with environmental regulations. The model is specified based on the theoretical model and estimated as both a probit and logit model. The second empirical model studies a facility's decision to adopt an EMP and to take environmental actions. This model contains two equations that are estimated simultaneously. The third empirical model examines the effect of the EMP adoption and environmental actions on the facility's environmental performance. This model is a simultaneous equation system with three equations. In addition to the EMP adoption and environmental action equations, the third equation examines the effect of the EMP adoption and environmental action on the facility's environmental improvements. Both the second and third empirical models are estimated using a three-stage least squares estimation technique.

The data used in this study were gathered through the Oregon Business Environmental Management Survey. This survey was sent to 1,964 businesses in Oregon. The businesses were randomly selected from six industries including construction, food manufacturing, wood manufacturing, electronics manufacturing, transportation and accommodations. The overall response rate to the survey was 35.1% with 689 individual responses.

The results from the first empirical model suggest that regulatory pressure is the most significant variable affecting facilities' decisions for over-compliance with environment regulations. The regulatory pressure may come from both the current and potential future environmental regulations. Barriers to increasing the environmentally friendliness of the facility's process, products, and/or services are also found to be a significant factor affecting a facility's decision to over-comply with environmental regulations. The results from the second empirical model show that regulatory and consumer pressures directly affect a facility's decision for environmental action. The level of environmental effort in a facility is also affected by the comprehensiveness of the EMP in the facility and by managerial staff beliefs on environmental protection and performance. The results from the third empirical model suggest that managerial staff pressure for environmental management has the most significant impact on environmental performance.

The results of this analysis have important policy implications. To encourage over-compliance of environmental regulations, policymakers can create tax breaks or subsidies for facilities that increase the environmental friendliness of their process, products, and/or services. Policymakers can also encourage over-compliance of environmental regulations by providing information about techniques to increase the environmentally friendliness of the production process. Policymakers can also publicize future changes in environmental regulations well before the changes are finalized in order to encourage over-compliance of current regulations based on the future expected regulation levels.

The results from the second model suggest that educating managerial staff at facilities on the importance of environmental management can encourage facilities to take environmental actions. Early publication of future environmental regulations is also a relevant policy tool to increase the extent of environmental action taken by facilities. Labeling products with the environmental standards used in the production of the product or publicizing facilities environmental records can increase consumer influence on environmental management at facilities, leading to more environmental action taken by facilities.

The results from the third model indicate that policies aimed at reducing barriers to adopt environmentally friendly process, products, and/or services can also lead to improvements in environmental performance. These policies may include educating facility staff on environmental techniques and providing tax breaks or subsidies to facilities that adopt environmentally friendly process, products, and/or services. Educating managerial staff on the importance of environmental management can also lead to better environmental performance.

Business Decisions for Voluntary Environmental Management: Motivations, Actions, and Outcomes

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Approved:

Redacted for privacy

Major professor, representing Agricultural and Resource Economics

Redacted for privacy

Head of the Department of Agricultural and Resource Economics

Redacted for privacy

Dean of the Graduate School

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Teresa Hall, Author

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CHAPTER 1

Introduction

Private companies face many forms of pressure to reduce their environmental impacts. In addition to dealing with federal, state and industry regulations, they also face pressure from consumers, investors, regulators, competitors, and interest groups to participate in voluntary programs, adopt an environmental management plan (EMP), and take environmental actions. Standard economic theory dictates that companies should decrease emissions to regulatory standard levels but not below since additional reductions would increase costs without creating any marginal benefits for the company. Yet many companies choose to voluntarily adopt environmentally friendly practices and over-comply with environmental regulations.

This study examines the motivations and outcomes of business decisions for voluntary environmental management. More specifically, it examines firms' motivations to create environmental management systems voluntarily and to reduce pollution levels below emission standards imposed by the government. The motivations may include both internal and external company pressures. More specifically, this study explores the following questions: What motivates a facility to over-comply with environmental regulations? Why does a facility adopt an environmental management plan (EMP)? Does the adoption of an EMP actually change the facility's behavior for environmental management? Are the EMP adoption and environmental actions effective in improving a facility's environmental performance?

This study expands previous work on voluntary over-compliance of environmental regulations and adoption of environmentally friendly actions. Previous studies have looked at the motivations that compel a company to protect and over protect the environment. In addition to focusing on firm's motivations for environmental management, this study examines the impact environmentally friendly actions have on the environment. This study builds upon past work by examining the effect of motivational pressures on environmental decisions and actions and the resulting impact on environmental outputs. It makes a contribution to the literature on voluntary over-compliance by systematically examining the linkages among motivations, actions, and environmental performance.

This study is also designed to be of benefit to environmental policymakers. Government agencies increasingly rely on voluntary programs for environmental management due to the potential low cost of implementing and maintaining voluntary programs. Oregon businesses have a multitude of voluntary programs to choose from. This study focuses on six industries including wood product manufacturing, electronics manufacturing, food manufacturing, construction, transportation and accommodations. There are many voluntary environmental programs specific to each industry as well as programs in which all industries can participate, including Oregon Natural Step and WasteWise. Table 1.1.1 includes the name of some of these voluntary programs and the number of facilities in Oregon in each of the six industries included in this study.

Table 1.1.1: Oregon Industry Specifics

Industry	Number of Facilities	Voluntary Programs
Wood Product Manufacturing	538	Oregon Natural Step, WasteWise,Forest Stewardship Council Chain of Custody, Scientific Certification Systems (SCS)
Electronics Manufacturing	282	Oregon Natural Step, WasteWise, Electronic Waste Initiatives
Food Manufacturing	522	Oregon Natural Step, WasteWise, Food Alliances Oregon Tilth, Salmon Safe, Sustainable Industries Meat Processing Project, American Baker's Association
Construction	4819	Oregon Natural Step, WasteWise, EnergySTAR, Cement Sustainability Initiative, High Performance Buildings
Transportation	1640	Oregon Natural Step, WasteWise,

		Smartway Transport Partnership, Voluntary Diesel Retrofit Program
Accommodations	1221	Oregon Natural Step, WasteWise, EnergySTAR for Hotels, Green Hotel Initiative, Green Seal for Lodging, Ecotel

Source: Jones (2005).

The proliferation of voluntary environmental policies makes it important to study the effects of these voluntary programs on environmental performance. The information this study provides on the motivations for environmental practice adoption, voluntary program participation, and environmental performance is critical for effective environmental policymaking. The study will contribute to the existing literature on firm motivations to participate in voluntary environmental programs since few studies have systematically analyzed the impact of taking voluntary action on environmental performance.

The theoretical analysis assumes that companies are made up of individual polluting facilities. A facility's pollution affects its parent company by tarnishing its reputation and possible fines for non-compliance. Therefore, each parent company regulates the level of emission-reduction-investment of its facilities by dictating the level of facility compliance with industry level environmental regulations. Any parent company that increases its emission-reduction-investment standard above that of other companies within the industry can expect to decrease the number of facilities they own compared to other parent companies. This suggests that companies should set their emission-reduction-investment standard at the industry level so as to not lose market share and the sales associated with it. However, companies choose to increase their emission reduction spending requirement above the industry level when the marginal benefits of increasing emission reduction spending is greater than the marginal costs of increasing emission reduction spending.

Three empirical models are estimated to examine facilities decision for environmental management. The first empirical model examines facilities' motivations to over-comply with environmental regulations. The model is specified based on the theoretical model and estimated as both a probit and logit model. The second empirical model studies a facility's decision to take environmental action based on the degree of environmental management plan (EMP) adoption. This model contains two equations that are estimated simultaneously. The third empirical model examines changes in environmental outputs based on the degree of EMP adoption and extent of environmental action taken by a facility. This model has three equations that are estimated simultaneously. The equations in both the second and third empirical models are estimated simultaneously using a three-stage least squares estimation technique.

The data used in this study was gathered through the Oregon Business Environmental Management Survey. This survey was sent to 1,964 businesses in Oregon. The businesses were randomly selected from six industries including construction, food manufacturing, wood manufacturing, electronics manufacturing, transportation and accommodations.

This thesis is organized into seven chapters. Chapter two reviews previous literature on topics relevant to this study including voluntary environmental policy. In chapter three, a theoretical model is developed to analyze firms' decisions to over comply with environmental regulations, and motivations behind the decisions are examined. Chapter four looks at the Oregon Business Environmental Management Survey and discusses the data used for this study including the creation of relevant variables. Chapter five contains the empirical models. Results from the estimation of these empirical models are presented in chapter 6. Chapter 7 discusses policy implications of the estimation results. The final chapter provides a summary and conclusion of this work, including a discussion of the limitations of this study and future research directions.

CHAPTER 2

Literature Review

Very few previous studies have examined the impact of voluntary environmental management plans on the overall environmental performance of a business. Instead previous research has looked at the motivations for firms to participate in these non-mandatory programs. This literature review focuses on the relevant research in these areas, and is split into five sections. The first section looks at the literature with similar theoretical models to the theoretical model developed in chapter three. The second section contains studies using analytical models similar to the one contained within this thesis. The third section examines incentives for firms to voluntarily adopt environmental management plans. Section four looks at factors that lead firms to create a voluntary over-compliance environmental management plan including the EPA's voluntary 33/50 program.

2.1 Studies with a Similar Theoretical Framework

The Race to the Bottom theory suggests that decentralized government control of emission standards will encourage firms to reduce their emissions below the centralized regulation level (Kunce et al, 2001). Kunce and Shogren (2001) examine a theoretical exception to the Race to the Bottom Theory and examines the efficiency properties of a decentralized direct emission control regime. This is accomplished through the development of an under-compliance condition in which the Race to the Bottom will occur and an over-compliance condition in which the Race to the Bottom will not occur.

Kunce and Shogren (2001) look at a theoretical exception to the Race to the Bottom. In a decentralized environmental management system, jurisdictions set emission standards above the centralized level. Kunce and Shogren (2001) relied on two modeling assumptions, which expand upon the two assumptions made by Oates and Schwab (1988): individuals that live in a jurisdiction also work in the same jurisdiction, and pollution does not move from one jurisdiction into another.

First, the competitive model with multiple regions has sufficiently small jurisdictions so that their policies do not directly affect equilibrium profits or indirectly effect the location of economic activity. Pollution rents are assumed to be captured only by the firms, and if the direct control standard is relaxed, residents of the jurisdiction are harmed by the increased level of emissions but do not share in the rents on pollution. The second assumption is that in a model with two large identical jurisdictions competing strategically for firms, jurisdictional benefits from gaining an additional firm are overwhelmed by additional environmental costs. Since the residents of a jurisdiction bare the brunt of higher emissions, and receive only small benefits from firm relocations, strategic interactions deal with deflection of environmental damages.

Kunce and Shogren (2001) expand upon previous voluntary over-compliance work by examining what happens if many jurisdictions compete strategically for a fixed number of firms. They also allow local residents to have a share in both pollution rents and costs in a strategic-multi-jurisdictional model. It is assumed that residents have equal ownership of the market share of total number of firms. If local ownership of firms is allowed along with greater competition by an increased number of firms, and additional benefits to follow firms, the risk of the Race to the Bottom will increase under direct control. The result is that the Race to the Bottom occurs when competition for firms grows, while the Race to the Bottom does not occur if the majority of jurisdictions cannot exploit their form of environmental market power.

In a study by Oates and Schwab (1988), there are two foundations of interjurisdictional competition, which are the level of local taxation and the choice of environmental standards. To look at the efficiency of competition among communities, Oates and Schwab (1998) maximize the utility of a representative consumer living within a particular jurisdiction subject to three constraints—representative consumers in all other jurisdictions achieve a certain level of utility, aggregate production equals aggregate consumption in society, and the stock of capital in society is allocated between all of the jurisdictions. This model promotes efficiency because both society and the jurisdictions have an identical evaluation of the costs and benefits of environmental standards.

Salop and Scheffman (1983) provide another way to look at firm competition for market share within a jurisdiction. They examine methods for firms to gain market power avoiding both anti-trust problems and predatory pricing. By raising a competitor's costs, a firm can encourage a competing firm to exit the industry. Advantages to this method include being profitable even if the competing firm does not leave the industry since it is better to compete against high-cost rivals than low cost ones. Also, increasing a competitor's cost decreases their output allowing the predatory firm to gain market share or raise its price. In addition, it is relatively inexpensive for a dominant firm to raise a competitor's prices by for example, introducing a mandatory product standard, which could be costless for the dominant firm while excluding the rival. These changes can be made irreversible making this a very serious method to gain market share.

There are many ways to increase a dominant firm's rival's costs. Government regulations or standards can raise the non-dominant firm's costs relative to the dominant firm. Both advertising and research and development can be used to gain market share by increasing a competing firm's costs.

In a competitive industry, the low-cost dominant firm is the price leader, and the competing firms must set output equal to some point on the dominant firm's supply curve producing until their price equals marginal cost. In equilibrium, the dominant firm will produce at the profit maximizing point on its demand curve. The smaller firms must react to the dominant firm's choice of strategies including technologies, advertising, input prices, etc. If these strategies increase the dominant firm's marginal costs, then the competing firms may have to drop output, increase price or in extreme cases exit the industry. Of course, much of this depends on the elasticity of supply and demand, the effects of which can be welfare decreasing for the consumer.

Kunce and Shogren (2001) used a game-theoretic model consistent with past literature on voluntary over-compliance of environmental regulations, focusing on the choice of location by firm instead of firm formation and market entry. Comparative statistics on direct emission control found that an increase in the number of jurisdictions decreases the local policy influence on equilibrium profits. Also, increasing emission control investment in a jurisdiction decreases the number of firms in that jurisdiction.

To decide if the Race to the Bottom is on, Kunce and Shogren (2001) look at the social planner's problem of maximizing social welfare by deciding the amount of direct emission control investment in all jurisdictions. The local planners play a Nash game by selecting their own level of firm regulation while treating other jurisdictions levels as fixed. They find that the race to the bottom is off if the fraction of the total firms owned by locals is greater than the net marginal jurisdiction benefits to marginal firm benefits.

$$mN > \frac{B' + k^* - 1}{-P'}$$

The Race to the Bottom is on if the fraction of the total firms owned by locals is less than the net marginal jurisdiction benefits to marginal firm benefits.

$$mN < \frac{B' + k^* - 1}{-P'}$$

Where mN is the fraction of firms owned by locals, B' is the marginal non-profit benefits to the jurisdiction for attracting additional firms (e.g. lower probability of unemployment and producer surplus), k* is the equilibrium level of emission reduction spending for jurisdictions, and P' is the rate firms lose profits before emission reductions as more firms locate within the jurisdiction. If B' is sufficiently small than the race is off no matter the amount of the jurisdiction's market share, which suggests that when jurisdictions gain few benefits from additional firms, but bear the costs of the additional pollution from the firms, there is an incentive for the policymaker to set a higher standard than the socially optimal level. When the number of jurisdictions grows, there are fewer incentives for the policymaker to set the standard above the socially optimal level.

This thesis expands upon the theories presented above on voluntary over-compliance and the race to the bottom. The theoretical model in the following chapter is based on the over-compliance condition developed by Kunce and Shogren (2001). This thesis goes one step further than Kunce and Shogren (2001) by looking at the effect various over-compliance motivations have on the over-compliance condition. We will also examine the result that motivations through the over-compliance condition have on the environment.

2.2 Studies Using a Similar Analytical Model

Fuglie and Bosch (1995) analyze the impact of testing soil for nitrogen on the overall amount of nitrogen used by farmers. The level of nitrogen fertilizer being used is socially inefficient since there is a loss of nitrogen through runoff and leaching which creates a negative externality. A switching regressing model is used to analyze the data. First, the choice of adopting nitrogen testing or not is modeled with a binomial probit model and then other decision variables are estimated separately on the adoption decision. Farmers who believe testing for nitrogen will be useful often adopt testing creating the problem of self-selection in the model. The paper concluded that the value of adopting soil nitrogen testing is highest where the level of soil nitrate is unknown. Once farmers know the level of nitrogen in their field, they do not over apply nitrogen fertilizer to their crops, decreasing the overall level of nitrogen pollution.

Wu and Babcock (1998) go one step further than Fuglie and Bosch (1995). Wu and Babcock (1998) analyze the choice among crop management plans before estimating the effects of management decisions on the environment. This model accounts for the problem of self-selection, which was a problem in the switching regression model. The paper looks at both the environmental and economic implications of adopting combinations of agricultural management practices on farm management in the Central Nebraska Basin.

Existing literature has analyzed factors behind using a single agriculture management plan, which ignores the simultaneous decisions made by farmers. This paper utilizes a polychotomous-choice model in order to analyze multiple combinations of nutrient management practices, tillage, and rotation decisions simultaneously. First, the choice among crop management plans is modeled by a multinomial logit model, which is often used to deal with the element of choice. In deriving the model, the factors behind the choice of crop management system are taken into account. After the multinomial logit model is estimated, it is used to make predictions. The predictions are added to the original equation, which are then estimated by OLS. Though the two-stage regression allows for unbiased estimators, the OLS estimators are biased estimates of the variance. This is because of the violation of the assumption of homoscedastic and non-autocorrelated error terms. The cross sectional data limited the scope of this research. In conclusion, Wu and Babcocks' method of simultaneously analyzing joint management choices found that adopting multiple management tools related to a decrease in pollution. Specifically, the paper found that adopting crop rotation, conservation tillage, and/or soil nitrogen testing led to reductions in both soil erosion and nitrogen fertilizer use.

Khanna's (2001) paper analyzes the sequential decision to adopt two site-specific technologies and its implications for nitrogen productivity. The two technologies are soil testing and variable rate technologies (VRT). This paper also looks at the implications of adopting one or both of the technologies. The two-stage estimation procedure begins with a bivariate probit model, which analyzes the determinants of adoption decisions. The model takes into account the sequential nature since the VRT can only be adopted if soil testing is adopted first. The next stage of the two-stage estimation looks at the implications of adoption. There are three sub-groups that arise. They are adoption of both technologies, adoption of only soil testing, and adopting neither technology. At this point, the model is corrected for self-selection since farmers choose to adopt a technology or not based on whether or not they think they should adopt such a technology. Farmers want to maximize the present value of expected benefits from production over a specific time horizion. Both multicollinearity and heteroscedastic error terms exist. In conclusion, the paper finds that it is more economically beneficial to use the technologies with higher quality soils, but it is more environmentally beneficial to lower quality soils. There is a need to focus voluntary policies on lower quality soils.

Wu, Adams, and Boggess' (2000) work with optimal targeting of conservations efforts examines threshold effects in environmental policy when the desired environmental improvements only occur after environmental efforts reach a threshold level. Particularly, this study examines the importance of cumulative effects in conservation funding allocation for steelhead trout habitat in Oregon. The empirical model focuses on conservation investment in steelhead trout habitat using economic, biological and hydrological data from the John Day River Basin in central Oregon.

The two-equation model is analyzed using a recursive equation system. The first equation looks at the affects of hydrological and riparian characteristics on water temperature. The second equation examines the affects of temperature and hydrological and riparian characteristics on the abundance of juvenile trout. Since the error term in the steelhead production function may also be affected by stream temperature, which is one of the independent variables, using ordinary least squares (OLS) will result in biased coefficient estimates. Therefore, a three-staged least squares (3SLS) process is used to estimate the model. The results from the regression analyses are used to explore the importance of cumulative effects and find that in the presence of cumulative effects, the typical allocation of funds will not be efficient.

2.3 Incentives to Encourage Voluntary Adoption:

Recently, private companies have voluntarily adopted EMS without government regulations dictating such behavior. Khanna and Antons' (2002) paper 'Corporate Environmental Management: Regulatory and Market-Based Incentives' examines the reasons behind corporate adoption of environmental management systems (EMS). The authors create four hypotheses that explain the decision by firms to adopt an EMS.

They first hypothesize that the higher the perceived chance of environmental liabilities and the greater the compliance costs of existing mandatory regulations, the greater the quality of the firm's environmental management system. Secondly, firms with an increased threat from expected regulations or firms expecting increased benefits from regulations are predicted to create better quality EMS. Firms with greater social pressure and consumer and investor that may have adverse reactions to their environmental performance are expected to use greater quality EMS. A more concentrated industry is expected to have greater incentives for firms to develop higher quality EMS. Lastly, relatively more innovative firms are expected to have increased quality EMS.

In order to examine the data, the authors use both a Poisson regression model and an Ordered Probit model. These specific models are used because the discrete non-negative nature of the dependent variable violates both the normality and homoscedasticity assumptions of the CLRM. The dependent variable is the quality of the firm's EMS, which creates a non-linearity problem. Using data from a survey of S&P 500 firms from 1994 and 1995, the study employs variables including the number of compliance inspections, presence of a civil penalty, ratio of pollution abatement to sales, and the number of environmental management practices being used by the firm.

Both the Ordered Probit and Poisson models verify the first and third hypotheses. Hypothesis two was supported by the Poisson model but was found to be statistically insignificant when using the OP model. There is mixed support for the fourth hypothesis. The Poisson model shows that a firm in a more concentrated industry is slightly more likely to adopt higher quality EMS, while the OP model is found to be insignificant. Both models show that firms with greater multinational presence are more likely to have more comprehensive EMS. Lastly, more innovative firms (firms with greater R&D expenditures) are more likely to adopt higher quality EMS through less costly solutions to environmental problems.

Cooper and Keims' (1996) paper "Incentive Payments to Encourage Farmer Adoption of Water Quality Protection Practices" examines the farmer adoption rate of voluntary environmental policy as a function of the payment offered to the farmer. To do this, information from the 1992 Area Studies data collection is used. Data used by this paper include physical land characteristics, slope and erosion potential of the land, current practices, farmer's experience, willingness-to-adopt conservation tillage, and other information affecting a farmer's decision to adopt conservation tillage.

A bivariate probit model is used with a dichotomous choice (DC) approach to analyze the data in accordance to the proposed guidelines for contingent valuation method (CVM) studies by the National Oceanic and Atmospheric Administration Blue Ribbon Panel. Using this approach the farmer's profit function does not need to be identified. Simply, the farmer's minimum WTA must be found and compared to the offered payment. This model is used to avoid biases and inefficiencies due to the nonrandom nature of the data, which comes about from selecting respondents who do not currently use the preferred method of environmental management strategy.

The relationship between the current offer amount and the probability of acceptance is only 10% at $10/acre that is being offered. Though some farmers will accept the new management strategy for $0, they would require complete information on the new practice. In order to achieve 50% compliance, the offer would have to increase to over $30/acre, which would be very costly for the regulating agency.

2.4 Factors Leading to the Adoption of an Over-Compliance EMS

Established theory dictates that firms will exactly match the minimum standards set forth in a command and control style of environmental regulation. Some firms choose to over-comply with the minimum standards suggesting that voluntary programs encouraging such over-compliance can be successful. The EPA's voluntary 33/50 program encourages companies to reduce pollution from 17 toxic chemicals. Arora and Carson (1996) use data about this program to look at the factors leading firms to participate in purely voluntary programs over and above current policies.

The EPA's 33/50 program encouraged firms to reduce the release and transfer of 17 toxic chemicals by 33% by the end of 1992 and by 50% at the end of 1995. The program was designed to reduce the pollution levels of these chemicals by prevention instead of clean up. Of the 5,555 companies invited to participate in the voluntary program, 734 signed up. The EPA emphasized the fact that companies choosing to participate will not receive special treatment from the government in any way. To verify that the participants did not enjoy special treatment, Arora et al, found the proportion of EPA penalties received by participants compared to non-participants. At 35%, it does not appear that participants enjoyed special treatment from the EPA. Companies participating in the program do enjoy benefits including public recognition and innovation awards.

In order to track the program, the EPA created the Toxic Release Inventory (TRI), which falls under the EPCRA act requiring firms to report information on the release and transfer of 320 toxic chemicals including the 17 chemicals covered in the 33/50 program. Since the TRI publication closely followed the 33/50 program initiation, it is impossible to tell whether the negative publicity from the TRI or the positive publicity from the 33/50 program influenced over-compliance more. During the first year of the 33/50 program, releases and transfers of the 17 toxic chemicals decreased by a greater percentage than the previous year while non 33/50 chemicals decreased by less than the previous year. This creates the possibility that the decrease in 33/50 program chemicals may be "crowding out" potential decreases in other chemicals.

The theoretical framework for the study was originated by Arora and Gangopadhyays' (1995) work on voluntary compliance. They conclude that industries that are more closely related to consumers are more likely to voluntarily participate in pollution reducing programs. They also drew from the EPA's uniform best available control technology rule, which encourages firms to participate in research and development for new and more efficient ways to reduce pollution. The best method is set as the standard thereby keeping the firm originating the new method one step ahead of their competitors.

The data for this project came from a few sources. TRI provides the environmental data. The EPA's Human Health and Ecotoxicity database assigned toxicities to the 17 toxic chemicals, and Standard and Poor's Compustat database is used for financial information. The dependent variable is the decision to participate in the 33/50 program, which creates a dichotomous dependent variable. The explanatory variables include SIC codes (indicating the companies primary production activity), total assets, net income, employment, debt to asset ratio, market share of the company in its industry, advertising intensity and research and development intensity. A bivariate probit model with the maximum likelihood method is used to estimate the model under the assumption of a normally distributed error term.

Large firms (in terms of thousands of employees) are found to be more likely to participate across industries, while chemical firms are found most likely to participate and rubber and plastic firms are found least likely to participate. Also, the higher the aggregate releases and the larger the number of categories of chemicals released, the greater the chance of participation. It is found that firm size, chemical releases, and industry concentration are all statistically significant factors leading to participation.

Since the firms with the greatest amount of toxic releases are found to be the most likely to participate in this program, Arora et al, believe the voluntary approach can achieve reductions in pollution levels by targeting those firms that pollute the most. They also conclude that in providing public recognition and awards to firms that achieve release reductions, the EPA encourages competition in environmental quality, which itself encourages more firms to participate.

Henriques and Sadorskys (1996) build a structure to empirically test whether and how much certain groups influence the environmental policy of private firms. The pressure groups included in this study are consumers, government, shareholders, employees, neighborhood groups, and trade associations.

The data used in this research was gathered through a survey of Canada's 750 largest firms (according to sales figures from 1990). The survey asked a plethora of questions ranging from general firm information to specifics about current environmental practices. The response rate to the mailing was 53% and only 41% of those respondents had an environmental plan in place. Firms responding to the survey said that government regulations were the most important source of pressure to firms and customers were the second.

Both the possible gains and costs from adopting environmental management systems are examined. Gains include monetary, increased or continual market share, efficiency gains, and a boost in reputation. Negatives to implementing a new EMS are implementation costs, regulatory compliance costs, and opportunity costs.

In order to examine the data, a logit model is used. The Lagrange Multiplier tests for omitted variables and heteroskedasticity are used to verify that the logit model is a correctly specified model. The dependent variable is whether the firm has created a system to deal with environmental problems or not. Independent variables are pressures faced by the firm and industry dummies. The dummy variables indicate the sectors surveyed. The pressures faced by the firm include customers, shareholders, government regulations, communities, lobby groups, and the importance of environmental issues to the firm.

Most of the variables are found to be influential. The sales-to-asset ratio is used to determine the efficiency of the firm. This variable has a small but negative relationship to the firm having an environmental plan in place, which can be explained by the fact that the higher the ratio, the closer the company is working to capacity suggesting that expansion or restructuring are its first priorities. The government regulation pressure and the sector dummy variable are statistically significant at the 1% level. The threat of boycotts did not have an effect on the firm having an environmental plan in place.

Farmer's have the option of using soil conservation methods to decrease soil erosion issues. Ervin and Ervin (1982) look at the three main reasons that soil conservation has become such an important issue in recent decades. Concern about the long-term productivity of farmland increased as a boom in the food exporting industry triggered an increase in agricultural production. Few changes have been made to soil conservation policies since their creation in the 1930s. Water quality policies created in the 1970s looked at soil erosion as a source of water pollution. This paper suggests that voluntary policies should be adopted and attempts to create the framework of a conceptual model of farmer's use of conservation policies. The result of which should be able to be used to determine future conservation policies. Past research in this field has looked at the factors behind the decision to use certain policies individually. The conceptual model expands on past studies to look at the factors behind decision-making including personal, physical, economic, and institutional factors simultaneously.

Each factor effects most of the decision making process, which are the perception of an erosion problem, the decision to use a soil conservation practice, and the resulting soil conservation effort. The data was gathered through a random sample of 92 farmers in Monroe County, Missouri. The region was chosen because Monroe County was among the highest priority counties in Missouri for control of non-point water pollution from agriculture.

Using multiple regression analysis, many of the variables were found to be significant. These variables include, the farmer's education level, the potential of soil erosion, risk aversion, personal characteristics, and subsidies. For example, the expectation of severe erosion problems is associated with a greater conservation effort, while economic factors including debt concerns, the percentage of off-farm income and transfer of farm from parents to child are not statistically significant to conservation efforts.

CHAPTER 3

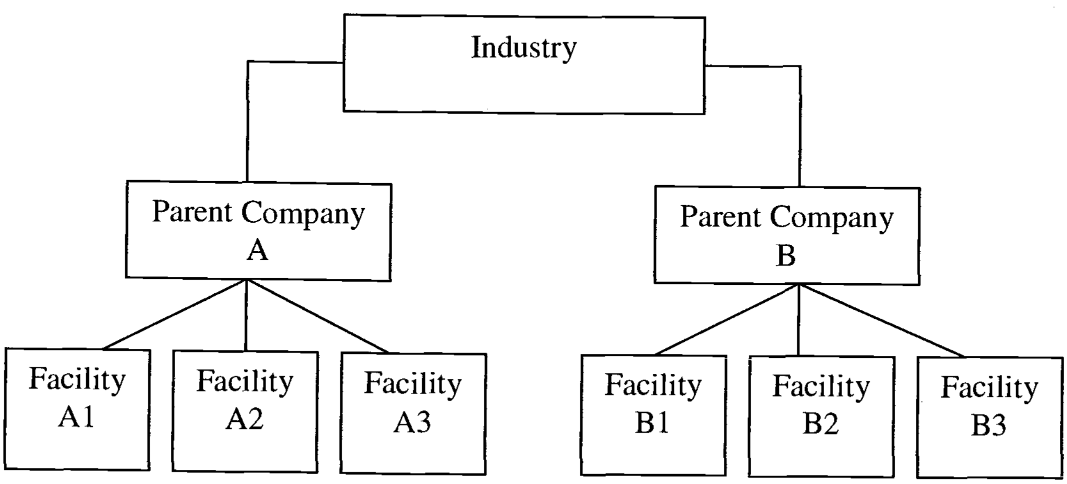
Theoretical Model

This chapter will detail the theoretical model established in this study. A condition under which over-compliance will occur is developed. The object in developing this condition is to understand a firm's motivations for voluntarily adopting environmental management programs and over-complying with environmental regulations. This model assumes that environmental regulations are not set at the socially optimal level, so over-compliance of these regulations is socially desirable.

3.1 An Industry Model

Identical parent companies within an industry compete for market share. The amount of market share a parent company has is indicated by the number of facilities they own, so parent companies effectively compete for a share of the N polluting facilities that make up the market.

Figure 3.1.1 An Industry Model



The total number of facilities in the industry, N, is exogenously determined by the total demand for the industry's output . There are C parent companies within the industry indexed by j (j=1,...,C). The endogenously found number of facilities belonging to company j is n_j where,

$$\sum_{j=1}^{C} n_j = N \qquad \text{(e3.1)}$$

We treat n_j as a continuous variable for simplicity.

Facilities maximize their profits, π within the parent company. The profit function is dependent on profits before emission reductions, $P(n_j)$ and emission reduction spending, k_j. In order for a facility placement equilibrium to exist, profits before emission reductions, $P(n_j)$, minus emission reduction spending, k_j (where $0 \le k_j \le 1$) must be the same across all parent companies. Profits before emission reductions are a function of the total number of facilities belonging to parent company j since in equilibrium profits are the same across all parent companies. Therefore the profits must be equally divided among the facilities belonging to company j, $P(n_j) = \frac{P_j}{n_j}$ where Pj is the total value of profits before emission reductions in parent company j. If parent company j gains an additional facility (increase n_j), the equilibrium profits before emission reductions level, $P(n_j)$, will decrease for all facilities belonging to the parent company j, so P'<1.

$$\pi = P(n_j) - k_j \qquad \text{for all } j = 1, \ldots, C. \qquad \text{(e3.2)}$$

The level of emission reduction spending is decided by an environmental manager within each parent company and is then imposed upon that company's facilities. The above equations provide us with a system of C+ 1 equations that determines the number of facilities each parent company owns and the equilibrium level of profits. Differentiating the system of equations with respect to k_j and solving for $\frac{\partial \pi}{\partial k_j}, \frac{\partial n_j}{\partial k_j} and \frac{\partial n_i}{\partial k_j}$ will yield the following results (see Appendix A),

$$\frac{\partial \pi}{\partial k_j} = \frac{-1}{C} = -s < 0 \qquad \text{(e3.3)}$$

$$\frac{\partial n_j}{\partial k_j} = \frac{(C-1)}{C \cdot P'} = \frac{(1-s)}{P'} < 0 \qquad \text{(e3.4)}$$

$$\frac{\partial n_i}{\partial k_j} = \frac{-1}{C \cdot P'} = \frac{-s}{P'} > 0 \qquad \text{(e3.5)}$$

Subscript i denotes a parent company keeping its environmental management system while subscript j denotes a parent company changing its environmental management system. Equilibrium company market share is $\frac{1}{C} = s$. A brief interpretation of the results follows.

Equation (e3.3) suggests that as a parent company increases emission reduction spending, their equilibrium facility profits decrease proportional to their market share, s. Equation (e3.4) shows that an increase in emission control spending for parent company j will decrease the number of facilities that belong to company j. Equation (e3.5) says as emission reduction spending increases in company j, parent company j decreases its number of facilities as parent company i increases its number of facilities.

There are additional benefits to parent companies for adding more facilities besides profit share. Benefits include producer surplus earned by employee shareholders that own a stake in the company, possible greater future returns to shareholders creating more permanent shareholders, and increased employee stability—with more jobs in the company, there is less of a chance of getting laid off. The general benefits function is $B(n_j)$, where benefits increase at a decreasing rate because of decreasing marginal returns B'> 0 and B"< 0.

The level of emissions for parent company j are $e\left[n_j\left(1-k_j\right)\right]$. Emission levels increase along with the number of facilities belonging to a parent company, so e is an increasing function, e' > 0. An increase in the level of emission reduction spending by company j will decrease the level of emissions.

3.2 Race to the Top

The 'Race to the Top' in which facilities compete for market share by increasing their investment spending in emissions reduction, is likely to occur under a certain condition. In order to derive this condition, we will first define the industry socially optimal level of emission reduction spending as a benchmark level. An environmental authority for the industry will create a pollution standard or regulation that creates the necessary level of emissions reduction spending for parent companies. This level is chosen in a way that will maximize social welfare, SW within the industry,

$$\max(\forall k_j)SW = \sum_{j=1}^{C}\left[B\left(n_j\right) - e\left(n_j\left[1-k_j\right]\right)\right] + N\pi . \qquad \text{(e3.6)}$$

This yields the results that each symmetric parent company has an equal number of facilities, $n_j = s \cdot N$, and each company sets an equal level of emission reduction spending at $k_j = k^*$. Another outcome is e'=1, which states that the additional environmental harm of adding additional facility to the constant total ownership shares of N is equal to one.

Each parent company must choose their level of emission reduction spending based on additional emissions, which will tarnish the company's reputation and the additional benefits from gaining market share. Every parent company sets their level of emission reduction spending at a level that will maximize the company's welfare, CW treating all other parent companies' levels as fixed creating a Nash game,

$$\max(k_j)CW = B(n_j) - e\left[n_j\left(1-k_j\right)\right] + n_j\pi . \qquad \text{(e3.7)}$$

This creates a best-response function,

$$B'\left(\frac{\partial n^e{}_j}{\partial k_j}\right) - e'\left[-n_j + (1-k_j)\cdot\frac{\partial n^e{}_j}{\partial k_j}\right] + \frac{\partial n_j}{\partial k_j}\cdot\pi + n_j\cdot\frac{\partial \pi}{\partial k_j} = 0 \quad \text{(e3.8)}$$

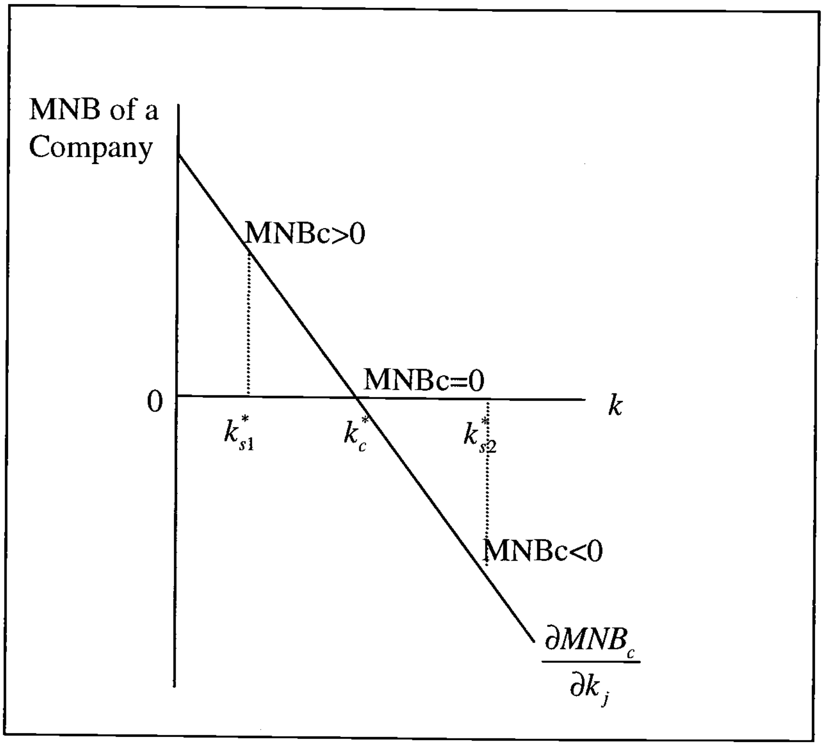
The Nash equilibrium level of emission reduction spending for each company is defined by the best-response function. We will now examine what happens when companies choose to reduce emissions past the socially optimal level within the industry.

Externalities exist when the parent company controls the level of direct emission reduction investment. In this case, parent company j will decrease its number of facilities when company j increases its level of emission reduction spending, which will increase benefits and costs in other parent companies. Since parent companies do not internalize their externalities (i.e. pollution), deviations from the industry social optimal can occur. To look at company variations from the social optimum, we must first find the Nash equilibrium level of emission reduction spending for each parent company at the socially optimal level within the industry. When we rewrite the left-hand side of the parent companies' best-response function (see Appendix B) at the socially optimal levels found from solving equation e3.6 we find,

$$(1-s)\left[\frac{B'(sN)-1+P(sN)}{P'(sN)}+sN\right]. \quad \text{(e3.9)}$$

We use only the left-hand side of equation 8 because we want to look at what happens when parent companies in Nash equilibrium are not at the socially optimal level in which case equation 9 will not equal zero. When parent companies at the Nash equilibrium level of emission reduction spending are at the socially optimal level within the industry, equation 9 is equal to zero. When the industry has only one company (s=1), equation 9 becomes zero and the socially optimal level of emission reductions equals the optimal company level.

Figure 3.2.1: Marginal Net Benefits of Emission Reduction Spending



If equation (e3.9) is greater than zero, marginal net benefits of emission reduction spending is still positive at the social optimum and parent companies will wish to spend more on emission reduction than the socially optimum level. This will be greater than when maximized company welfare is equal to zero and we are at the socially optimal level. In this case, parent companies have an incentive to over protect the environment relative to the social optimum. Following the same logic, when equation (e3.9) is less than zero, parent companies will under protect the environment relative to the social optimum.

To find the threshold condition under which the race to the top is on, we will set equation (e3.10) equal to zero and plug in the profit function at the socially optimal level $\pi = P(s \cdot N) - k^*$ which results in,

$$sN = \frac{B'(sN) - 1 + P(sN)}{-P'(sN)}. \qquad \text{(e3.10)}$$

The Nash equilibrium with C >1 parent companies suggests that the social optimum will be reached when the average number of facilities per parent company within the industry is equal to the ratio of net marginal parent company benefits to marginal facility benefits. Investment in emission reduction will be greater than the socially optimal level ('the race to the top') when,

$$sN > \frac{B'(sN) - 1 + P(sN)}{-P'(sN)}. \qquad \text{(e3.11)}$$

$$-P'(sN) * sN > B'(sN) - 1 + P(sN) \qquad \text{(e3.12)}$$

$$MB_{\text{increasing emission reduction spending}} > MC_{\text{increasing emission reduction spending}} \qquad \text{(e3.13)}$$

Equation (e3.11) suggests that parent companies will choose to reduce emissions past the industry standard level ('race to the top') when the average number of facilities per company is greater than the ratio of marginal parent company benefit to marginal facility benefits. In this case, the marginal benefits of increasing emissions reduction spending are greater than the marginal costs of increasing emission reduction spending to a parent company. Under this condition, facilities will over-comply with industry level environmental regulations. Where P' is the rate at which facilities lose profits-before-emission-reduction as the parent company becomes larger and attracts more facilities within the industry (P'< 0). The increase in the parent company's non-profit share benefits for an increase in the number of facilities belonging to that company is B', while $s \cdot N$ is the relative size of the parent company within the industry or the average number of facilities per parent company. The numerator of the right hand side of equation (e3.11) represents the parent company's net marginal benefits from gaining market share in the form of additional facilities. In our industry example, a parent company will choose to exceed the required level of emission reductions and therefore its facility will over-comply with industry level environmental regulations, if the size of the parent company within the industry is greater than the ratio of marginal parent company benefits to the marginal facility benefits for an additional facility joining the parent company.

If $B'(s \cdot N) + P(s \cdot N) \leq 1$, then companies will overprotect the environment regardless of the parent company's market share. When parent companies gain little from adding another facility but bear the entire burden of the additional pollution emissions, the companies will have the incentive to raise emission standards above the socially optimal level. Therefore, facilities will over-comply with the industry level environmental regulations. In the following section of this chapter we will examine how this condition is affected by various environmental management motivations. The affected variables in equation (e3.11) are P', B' and P.

3.3 Implications for Environmental Over-Compliance

This section looks at seven motivational variables for environmental management that will encourage parent companies to increase emission reduction investment spending and facilities to over-comply with industry level environmental standards. The motivational variables affect marginal benefits, marginal profits before emission reductions, and equilibrium store profits within a company. The seven motivational variables are created in chapter 4 of this study. Table 3.3.1 lists the environmental management motivations that affect the over compliance condition (equation e3.11).

Table 3.3.1: Environmental Management Motivations

Variable	Motivational Variable	Definition of Motivational Variable
M1	COMPETIT	The extent competitive pressure has influenced environmental management in the last 5 years
M2	BARRIERS	Barriers to increasing the environmental friendliness of the process, products, and/or services
M3	INVESTOR	The priority of investor pressure in encouraging environmental management in the last 5 years
M4	REGULATO	The priority of regulatory pressure in encouraging environmental management

		in the last 5 years
M5	MANAGEME	The extent management pressure has encouraged environmental practices and performance
M6	INTEREST	The extent investor pressure has influenced environmental management in the last 5 years
M7	CONSUMER	The extent consumer pressure has influenced environmental management in the last 5 years

To examine what affects the environmental management motivations have on the over-compliance condition (e3.11), we will first examine how these motivations affect P, P' and B' in condition (e3.11). Where P is profits before emission reduction spending, P' is marginal profits before emission reduction spending, and B' is the marginal non-profit benefit from gaining additional facilities.

$$B'(sN) = B'(sN \mid M1, M2, M3, M4, M5, M6, M7)$$

The marginal benefits are affected by M1 through M7. A decrease in the marginal benefits from gaining additional facilities (B') will increase the chance a parent company will set higher environmental regulations than the industry level, which will create facilities that over-comply with industry level environmental regulations. Under motivations M1, M3, M4, M5, M6, and M7, a parent company will gain less non-profit-share-marginal benefits since adding additional polluting facilities will increase pollution levels for the company when there exists a motivation to decrease emissions. Therefore, the presence of these motivational variables will encourage parent companies to increase their emission standards and facilities to over-comply with environmental regulations. Under barrier pressures motivation M2, a parent company will gain more marginal benefits for adding one more facility since the motivational variable BARRIERS creates an incentive for facilities not to over-comply with environmental regulations. If barrier pressures are reduced, a facility will be encouraged to over-comply with industry level environmental regulations.

As a parent company facing consumer environmental pressures (M7) receives public recognition and therefore consumer goodwill for reducing emissions, the additional benefits from gaining one more polluting facility will decrease. The facility will bring pollution with it decreasing the goodwill the parent company has gained, so there are fewer marginal benefits to the parent company for attracting polluting facilities. In addition, companies that face pressure from environmental interest groups will have an incentive to reduce emissions. Gaining additional polluting facilities will increase the parent company's pollution therefore decreasing the marginal benefits of gaining the additional facilities, which encourages over-compliance of environmental regulations.

When competitive pressures influence environmental management at a facility, there exists an incentive for that facility to increase emission reduction spending. This decreases the marginal benefits to a parent company for adding additional polluting facility encouraging over-compliance of environmental regulations. As lenders and/or investors request to decrease a company's environmental risks and liabilities or to enhance the value of the facility by encouraging environmental management (M3), that parent company will not receive as many benefits for gaining one more facility that brings along additional pollution—the vary thing the lenders and/or investors want to decrease. This will decrease the parent company's marginal benefits (B') for gaining more facilities. Thus encouraging that parent company to increase emission reduction requirements, which makes facilities over-comply with industry level environmental regulations.

If a parent company expects future environmental regulations to be imposed upon them or faces current environmental regulations (M4), they will not wish to increase their pollution levels for fear of future or current penalties. The marginal benefits for gaining additional facilities will decrease for parent companies facing current and future environmental regulation pressures since companies will not wish to increase emissions and risk current or future penalties. If managerial staff encourages environmentally friendly actions, the facility will face motivational pressure M5.

Under this pressure, a parent company will have an additional incentive to act in an environmentally responsible manner. This incentive decreases the marginal benefits (B') of attracting facilities that come with pollution since managers at facilities are pressuring the facility to increase environmental practices or performances.

$$P\ (sN) = P\ (sN \mid M3, M7)$$

A decrease in equilibrium profits before emission reduction spending, P will create an incentive for a parent company to overprotect the environment. Profits-before-emission-reduction-spending is made up of benefits and costs to a facility. Decreasing benefits or increasing costs will encourage companies and therefore facilities to over-protection the environment compared to the socially optimal level. Profits before emission reduction spending, P is affected by motivations M3, and M7.

When consumer's request environmentally friendly products, and have goodwill towards companies producing such products companies face motivational pressure M7. As long as consumers are willing to pay a higher price for environmentally friendly products, the equilibrium profits across the industry will fall. The facilities that choose to produce products in an environmentally friendly manner will gain consumers and market share, which will increase their profits.

If investors and lenders pressure facilities to reduce environmental risks and liabilities, the equilibrium profits across the industry will decrease. Facilities that do not reduce environmental risks and liabilities will lose lender and investor support, which will create profits for the facilities with reduced environmental risks and liabilities.

$$P'\ (sN) = P'\ (sN \mid M2, M3, M7)$$

A decrease in the marginal profits before emission reduction spending, P' will make a parent company more likely to overprotect the environment. This suggests that facilities make less additional profits as more facilities join their parent company when there exists an incentive to overprotect the environment compared to the socially optimal industry level. Marginal profits before emission reduction spending are affected by motivations M2, M3, and M7.

When consumers request environmentally friendly products and are willing to pay a higher price for them (M7), marginal profits decrease. A facility's marginal profits decrease as consumers request environmentally friendly products because the facility has an incentive to decrease pollution. When consumers want environmentally friendly products there is an incentive to decrease pollution. As more facilities join the parent company, they bring more pollution, which is exactly what they are trying to avoid, so marginal profits decrease when there is an incentive to overprotect the environment. When investors and lenders desire reduced environmental risks and liabilities (M3), there is an incentive to overprotect the environment, which as we just saw leads to a decrease in the marginal profits. In motivation M2, barriers increase costs to facilities for adopting environmentally friendly processes, products, and/or services, which lead to the same or higher marginal profits. Therefore barrier environmental management pressure does not decrease the incentive to attract additional polluting facilities since the costs of reducing pollution are too high in the first place.

The first motivation we will examine, M7 is when consumers influence environmental management at facilities by requesting environmentally friendly products and services and have goodwill to facilities that create such products/services. If consumers simply request environmentally friendly products without changing their purchasing behavior or willingness to pay for the item, companies and therefore facilities will have no incentive to incur the additional costs of reducing emissions without gaining profit. If this motivation accompanies a higher willingness to pay for the product or substitution to products that are produced in a more environmentally friendly manner, than the facilities that choose to produce environmentally friendly products will capture more of the profits in the industry while the facilities that do not increase their emission reduction spending will lose part of their share in the profits. This will lead to a decrease in equilibrium profits for a parent company at any given emission reduction level. The decrease in profits for a given level of investment reduction spending will decreases the benefits ratio and makes parent companies more willing to overprotect the environment, which encourages facilities to over-comply with industry level environmental regulations.

In addition, the marginal profits before emission reduction spending will decrease for each additional facility joining a parent company since the facility brings pollution. Since consumers are willing to pay more for environmentally friendly products there is an incentive for the parent company to decrease their pollution emission levels, so parent companies do not wish to gain additional polluting facilities, which will increase their pollution levels. Therefore P' will decrease due to consumers being willing to pay more for environmentally friendly products, and –P' will increase. This will decrease the over-compliance condition (e3.11), which will make parent companies more willing to over protect the environment and encourage facilities to over-comply with environmental regulations.

Interest group pressure for environmental management is motivation M6. An increase in pressure from environmental interest groups will lead to a decrease in a parent company's benefits for attracting additional polluting facilities. Therefore facilities that face interest group pressure are more likely to over-comply with environmental regulations. Facilities facing environmental pressure from management staff (M5) will be encouraged to decrease pollution. Therefore parent companies will not wish to gain additional facilities that will increase the company's pollution, which will decrease the general benefits of attracting more facilities to the company. Regulatory pressure (M4) also creates an incentive for parent companies to increase emission reduction spending, which decreases the benefits of attracting additional facilities that will increase the company's pollution level. A decrease in B' will decrease the marginal company to facility benefits increasing the chance that the company will choose to increase their emission reductions above that of the industry equilibrium regulation level.

The motivation based on lenders request to decrease environmental risks and liabilities and enhance the facility's value is M3. Under motivation M3 the parent company voluntarily increases their emission reductions. This will reduce the marginal benefits to a parent company for increasing their number of facilities (B'). In addition, facilities facing investor environmental pressure lose profits to facilities that have reduced environmental risks and liabilities effectively reducing the equilibrium level of profit in the industry. The additional profit to a parent company for adding one more facility will also decrease because the facility will increase the company's pollution, which it is trying to reduce. The three affects of lender environmental pressure will decrease the benefit ratio in equation (e3.11) making parent companies more likely to over protect the environment compared to the social optimum, which will make facilities over-comply with industry level environmental regulations.

Barrier pressure (M2) is the only environmental management motivational variable that is predicted to decrease over-compliance. Facilities that face barriers to increasing the environmental friendliness of the production processes, products and/or services will have the same or higher marginal benefits than a facility facing no such pressure. The additional profits to a parent company for gaining another facility increase as barrier pressure increases since there is less of an incentive to reduce the company's pollution as costs of reducing pollution increase. Therefore facilities facing barrier pressure are less likely to over-comply with environmental regulations. Competitive environmental pressure will lead to a decrease in the marginal benefits to a company for gaining additional facilities because additional facilities will increase the parent company's pollution. Since there is an incentive for facilities to reduce pollution under this pressure, facilities facing this pressure are more likely to over-comply with environmental regulations.

Chapter 4 explains the creation of these seven index variables through principle component analysis (PCA). In chapter 5, the theoretical model is decomposed into Model 1, so it can be empirically analyzed. Section 6.1 in chapter 6 contains the results of the regression analysis and a discussion of the affects of the motivational variables on a facility's decision to over-comply with environmental regulations.

CHAPTER 4

Survey and Data Description

This chapter details the design of the Oregon Business Environmental Management Survey and presents the data used in the following chapter of this study. The first section in this chapter examines the structure of the survey. The survey questions that are used to construct variables in the empirical model are examined in detail. These include both industry specific and industry wide questions. The second part of this chapter examines the data. In this section, we present and explore the data collected through the survey. The transformation of data to create new variables is also presented in this section. This information will be helpful in Chapter 6 where the results of the regression analysis are examined.

4.1 Survey Process and Design

The Oregon Business Decision for Environmental Performance Survey was developed over a two-year period by professors and graduate research assistants at three major universities—Oregon State University, Portland State University and the University of Illinois. In addition, the Social and Economic Sciences Research Center at Washington State University assisted with sampling strategy and prepared the dataset.

Four versions of the survey were created in order to accommodate differences in the type of pollution emitted by the individual industries. While the transportation, construction, and accommodations industries received surveys tailored to their industry specifics, the three manufacturing industries, food, wood, and electronics received an identical version of the survey. Section three of the survey contains the industry specific questions that differ among the versions of the survey, which are detailed in this section.

Oregon businesses were randomly selected from four industry classifications Manufacturing, Transportation, Accommodation and Construction, to participate in this study. The surveyors first attempted to contact all 1,964 businesses by phone in order to update contact information. Randomly selected facilities in each industry were then contacted for an in-person interview in order to pretest the survey and make changes before sending the self-administered survey to the selected businesses. Implementation of the survey was carried out between October 2005 and March 2006.

The survey mailing process followed a Tailored Design Method (TDM) survey protocol (Dillman, 2000). One thousand, nine hundred and sixty four questionnaires with cover letters were mailed to Oregon businesses within the six specified industries (See Appendix 3 for a complete version of the survey). After the survey was mailed, a post card reminder was sent to all of the businesses selected for the survey. Replacement questionnaires were sent to all non-respondents followed by a second postcard reminder. Non-respondents in the Transportation and Manufacturing groups were mailed a third replacement questionnaire. Facilities with positive environmental records may be more likely to respond to the survey. This is called a self-selection bias. The similar response rate per industry suggests that if a self-selection bias exists, it is constant across all industries. The overall response rate for the survey is 35.08%, which is broken down by industry in Table 4.1.1.

Table 4.1.1 Response Rate by Industry

Industry	Sample Size	Completes	Refusals	No Response	Other	Response Rate
Construction	394	135	12	233	14	34.26%
Manufacturing (Combined)	752	284	68	358	43	37.77%
Food	286	106	32	124	24	37.06%
Wood	317	118	26	157	16	37.22%
Electronics	149	51	10	85	3	34.23%
Transportation	343	128	24	162	29	37.32%
Accommodations	475	142	12	296	25	29.89%
Totals	1964	689	116	1048	111	35.08%

The survey was designed with four sections in order to obtain the necessary data for this study. The first section looks at the facility's environmental management. This section covers environmental issues at the facility, factors that influence environmental management, beliefs about environmental management, barriers to environmental management and annual revenue spent on environmental management. From questions 3, 4, 5, 7, and 8 in the environmental management section of the survey, we obtain the necessary information to create environmental management motivations, which are key variables used in all three of the empirical models. The seven environmental management motivations are developed in section two of this chapter. Question 3 indicates the influence of consumer and interest group pressure in a facility's environmental management decision.

Table 4.1.2 Percentage of Responses to Question 3: Please indicate the extent each of the following factors has influenced environmental management at your facility in the last 5 years.

Level of Influence from 1 = No Influence to 5 = great Influence	1	2	3	4	5
Q3a. Customer desire for environmentally friendly products and services	25.8%	16.4%	21.7%	19.0%	17.1%
Q3b. Customer willingness to pay higher prices for environmentally friendly products/services	38.8%	19.0%	20.3%	12.6%	9.3%
Q3c. Ability to earn public recognition and consumer goodwill with environmentally friendly actions	28.1%	16.8%	23.3%	18.9%	13.0%
Q3d. Environmental interest groups' perception that environmental protection is a critical issue	39.1%	20.3%	22.6%	11.8%	6.3%
Q3e. Preventing boycotts or other adverse actions by environmental interest groups	62.4%	15.9%	12.0%	4.2%	5.6%
Q3f. Promoting an environmentally friendly image to environmental interest groups	36.8%	18.4%	21.1%	13.4%	10.3%

Question 3 asks the respondent to 'please indicate the extent each of the following factors has influenced environmental management at your facility in the last

5 years'. The factors include consumer and interest group pressure on the facility's environment management system. The possible responses are scaled from 'No Influence'=1 to 'Great Influence'=5 and 'Do Not Know. Table 4.1.2 breaks down the percentage of respondents that answered question 3 on the influence scale from 1 to 5. Question 3 is used in section two of this study to create two environmental management motivational factors that represent pressure from consumers and interest group pressures.

Question 4 in the first section of the survey asks 'For your facility, please indicate the priority of each of the following factors in encouraging environmental management in the last 5 years'. The eight factors that encourage environmental management refer to investors, lenders and environmental regulations. The possible responses include a priority scale from 'No Priority'=1 to 'Great Priority'=5 and 'Do Not Know'. Question Q4 is used to create two motivational factors. The two environmental management motivational factors are regulatory pressures and investor pressure. Table 4.1.3 includes these eight factors and the percentage of answers on each point of the priority scale.

Table 4.1.3 Percentage of Responses to Question 4: For your facility, please indicate the priority of each of the following factors in encouraging environmental management in the last 5 years.

Level of Influence from 1 = No Influence to 5 = great Influence	1	2	3	4	5
Q4a. Satisfying investor (owner) desires to reduce environmental risks and liabilities	18.2%	8.7%	20.1%	21.7%	31.3%
Q4b. Protecting or enhancing the value of the facility or parent firm for investors (owners)	20.7%	8.8%	18.2%	24.2%	28.2%
Q4c. Satisfying lenders' desires to reduce environmental risks and liabilities friendly actions	42.0%	13.1%	19.9%	13.5%	11.5%
Q4d. Complying with current government environmental regulations	7.1%	5.0%	14.5%	18.0%	55.4%
Q4e. Taking environmentally friendly actions	22.2%	9.9%	18.9%	22.4%	26.5%

to reduce regulatory inspections and make it easier to get environmental permits					
Q4f. Being better prepared for meeting anticipated environmental regulations	16.8%	10.6%	22.7%	26.7%	23.3%
Q4g. Preempting future environmental regulations by voluntarily reducing regulated pollution beyond compliance levels	24.5%	12.5%	21.9%	22.6%	18.6%
Q4h. Preempting future environmental regulations by voluntarily reducing unregulated impacts	30.3%	14.6%	24.9%	17.8%	12.5%

Question 5 asks respondents to 'Please indicate the extent that each of the following factors has influenced environmental management at your facility in the last 5 years'. The six factors relate to competition within the facility's industry and are described in Table 5.1.4 along with the percentage of responses to the answers indicating influence of the specific factor. These answers range from 'No Influence'=1 to 'Great Influence'=5. The data from question 5 is used in the following section to create a motivational factor that represents competitive pressures that affect environmental management.

Table 4.1.4 Percentage of Responses to Question 5: Please indicate the extent that each of the following factors has influenced environmental management at your facility in the last 5 years.

Level of Influence from 1 = No Influence to 5 = great Influence	1	2	3	4	5
Q5a. Investing in cleaner products and services differentiates our products or our facility	24.3%	16.5%	24.8%	19.5%	14.9%
Q5b. Improving environmental performance helps us keep up with competitors	32.3%	16.6%	20.7%	20.1%	10.2%
Q5c. Environmentally friendly actions result in product or process innovations	31.0%	19.2%	25.2%	17.1%	7.5%
Q5d. Environmentally friendly actions can reduce costs	25.3%	14.0%	22.0%	20.8%	18.9%

Q5e. Being environmentally responsible attracts quality employees and reduce employee turnover	33.1%	22.1%	18.2%	17.1%	9.5%
Q5f. Being environmentally responsible improves employee morale, motivations and productivity	24.8%	17.6%	24.6%	21.9%	11.1%

In question 7, respondents are asked to 'indicate the extent of your agreement or disagreement with the following statements'. The statements relate to the environmental attitude of the management staff at the facility. In order to show the respondent's agreement/disagreement a scale from 'Strongly Disagree'-1 to 'Neither Agree nor Disagree'=3 to 'Strongly Agree'=5 is used with the possible reply of 'Do Not Know'. In section two of this chapter, Question 7 is used to create the motivational factor MANAGEME. Table 4.1.5 shows the six statements and the percentage of responses on the agreement scale.

Table 4.1.5 Percentage of Responses to Question 7: For your facility, please indicate the extent of your agreement or disagreement with the following statements.

Level of Influence from 1 = No Influence to 5 = great Influence	1	2	3	4	5
Q7a. Facility upper management believes it has a moral responsibility to protect the environment	2.1%	2.9%	12.8%	30.1%	52.1%
Q7b. Facility upper management supports protecting the environment even if substantial costs are incurred	8.4%	12.9%	24.2%	37.5%	17.0%
Q7c. Facility upper management believes that improvements in environmental performance will improve long-term financial performance	6.0%	13.7%	32.3%	31.6%	16.5%
Q7d. Facility upper management believes that customers and other stakeholders care about the environmental impacts of its products	3.9%	8.4%	22.9%	41.7%	23.1%
Q7e. Facility upper management believes that advances in technology can solve environmental problems while increasing profits at the same	6.4%	10.1%	34.9%	33.4%	15.1%

time					
Q7f. Facility upper management believes that the facility should help conserve society's limited natural resources	3.0%	3.1%	20.6%	37.7%	35.7%

Question 8 is 'For your facility, please indicate the extent to which the following factors are barriers to increasing the environmental friendliness of your process, products, and/or services'. The eight factors are reported in table 4.1.6. Respondents are asked to represent the level of barrier each factor creates on a scale with 'No Barrier'=1 to 'Large Barrier'=5 and 'Do Not Know'. Table 4.1.6 shows the percentage of respondents who represented their answer to each factor on the barrier scale. Question 8 is used to create the BARRIERS motivational factor in the following section of this chapter.

Table 4.1.6 Percentage of Responses to Question 8: For your facility, please indicate the extent to which the following factors are barriers to increasing the environmental friendliness of your processes, products and/or services.

Level of Influence from 1 = No Influence to 5 = great Influence	1	2	3	4	5
Q8a. High upfront investment expense	11.9%	8.62%	21.0%	22.1%	36.4%
Q8b. Availability of knowledgeable staff	20.3%	20.1%	30.8%	20.1%	8.7%
Q8c. High day-to-day costs	12.1%	13.4%	29.9%	22.8%	21.8%
Q8d. Significant upfront time commitment	12.7%	14.7%	28.4%	26.8%	17.4%
Q8e. Uncertain future benefits	17.2%	13.7%	28.8%	22.2%	18.2%
Q8f. Risk of downtime of delivery interruptions during implementation	23.9%	16.9%	25.4%	16.6%	17.1%
Q8g. Contributions to environmental performance are not included in performance appraisals	37.3%	15.7%	29.1%	9.9%	8.0%
Q8h. Employees are not rewarded for contributions to environmental performance	38.9%	17.4%	26.4%	9.3%	8.0%

Section two of the survey deals with the facility's current environmental actions and plans. Questions in this section include employee involvement in environmental management, implementation of environmentally friendly practices, current environmental action taken by the facility, and current environmental performance of the facility. The information contained within this section provides us with data about the facility's environmental management plans and environmentally friendly actions, which are used to create two variables in the second section of this chapter. These variables are ENVPLAN and ENVACTIO, which look at a firm's decision to adopt an EMP and a firm's decision to adopt environmentally friendly actions.

In question 12, respondents are asked to 'please indicate the extent of your agreement or disagreement with the following statements'. These eleven statements indicate current environmental management policies at the facility. Answers are scaled from 'Strongly Disagree'=1 to 'Neither Agree nor Disagree'=3 to 'Strongly Agree'=5 and 'Do Not Know'. The percentage of respondents who answered some level of Agree or Disagree is represented in table 4.1.7. Data from Question 12 is used to create the environmental management plan variable in the second section of this chapter, which indicates the facility's level of environmental management plan adoption.

Table 4.1.7 Percentage of Responses to Question12: For your facility, please indicate the extent of your agreement or disagreement with the following statements.

Level of Agreement from 1 = Strongly Disagree to 5 = Strongly Agree	1	2	3	4	5
Q12a. Our environmental goals guide operational decisions	17.4%	17.0%	34.6%	22.4%	8.72%
Q12b. Environmental responsibility is emphasized through well-defined environmental policies and procedures	19.8%	19.7%	30.0%	17.3%	13.1%
Q12c. Our environmental standards are more stringent than mandatory governmental requirements	21.9%	13.0%	35.9%	16.9%	12.3%

Q12d. We conduct environmental audits for our own performance goals, not just for compliance	30.2%	13.6%	28.9%	14.7%	12.6%
Q12e. Employees receive incentives for contributions to environmental performance	49.4%	16.4%	28.9%	4.3%	1.1%
Q12f. We use environmental cost accounting	51.5%	13.3%	26.2%	6.3%	2.8%
Q12g. We make continuous efforts to minimize environmental impacts	8.7%	4.5%	24.5%	32.7%	29.6%
Q12h. We require our suppliers to pursue environmentally friendly practices	30.8%	14.7%	32.9%	13.7%	8.0%
Q12i. Employees are conscious of the importance of minimizing negative environmental impacts	7.87%	9.5%	22.5%	37.2%	23.0%
Q12j. An adequate amount of training in environmental management is provided to all employees	20.5%	14.4%	32.8%	20.5%	11.8%
Q12k. Facility environmental achievements are given prominent coverage in facility annual reports	44.7%	12.3%	30.6%	7.1%	5.3%

Question 14 is 'For your facility, please indicate to what extent you agree or disagree with the following statements'. Six statements are provided that indicate the facility's current environmental actions. The percentage of respondents who answered question 14 in the range from 'Strongly Disagree'=1 to 'Strongly Agree'=5 are represented in table 4.1.8. The data contained in Question Q14 is used to create an environmental action index in section 4.2.

Table 4.1.8 Percentage of Responses to Question 14: For your facility, please indicate to what extent you agree or disagree with the following statements.

Where 1 = Strongly Disagree, 3= neither agree nor disagree, and 5 = Strongly Agree	1	2	3	4	5
Q14a. Pollution prevention is emphasized to	6.7%	9.5%	28.1%	29.2%	26.5%

improve environmental performance					
Q14b. Efforts have been made to reduce spills and leaks of environmental contaminants	2.5%	0.9%	12.6%	23.0%	61.0%
Q14c. We choose raw materials that minimize environmental impacts	7.4%	7.7%	39.1%	22.8%	23.0%
Q14d. We have modified our production systems to reduce waste and environmental impacts	5.8%	5.8%	26.6%	35.0%	26.7%
Q14e. We have modified our production to reduce environmental damage during production, consumption, and disposal	8.2%	7.9%	34.3%	27.9%	21.7%
Q14f. We have increased recycling and reduce landfilling of our solid waste	2.7%	4.1%	13.6%	29.3%	50.5%

Section three of the questionnaire looks at facility environmental performance specific to their industry. Questions in this section look at the current pollution levels at the facility. Respondents were asked to indicate levels of compliance with regulatory standards, the amount of pollution released from the facility, and the change in environmental performance during 2004. This information is used to create the dummy variable OVERCOMP in the next section, which is the dependent variable in Model 1.

Question Q15 asks responds to 'please indicate the level of compliance with regulatory standards for any of the following (types of pollution) that were regulated by a government agency'. Respondents were asked whether they were 'Working Towards Meeting Regulations', 'Meet Regulatory Standards', 'Do More than Regulation Requires', and 'Not Regulated at your Facility' for each regulated type of pollution. The types of industry specific pollution presented to respondents in this question are reported in tables 4.1.9 through 4.1.12. The data in Question Q15 is used to create a dummy variable for over-compliance of environmental regulations in the following section of this chapter.

Table 4.1.9 Percentage of Responses to Question 15 Accommodations: For your facility, please indicate the level of compliance with regulatory standards for any of the following that were regulated by a government agency during the 2004 calendar year.

Where 1 = Working towards meeting regulations, 2 = meet regulatory standards, 3 = do more than regulation requires, and 4 = not regulated at your facility	1	2	3	4
AQ15a. Water Pollution	1.5%	51.2%	19.9%	27.5%
AQ15b. Solid waste	1.5%	56.9%	15.4%	26.2%
AQ15c. Hazardous/toxic wastes	0.8%	55.0%	14.0%	39.2%
AQ15d. Volatile organic compounds (VOCs)	1.6%	46.5%	11.8%	40.2%
AQ25e. Other	2.56%	43.6%	7.7%	46.2%

Table 4.1.10 Percentage of Responses to Question 15 Construction: For the projects managed by your facility, please indicate the level of compliance with regulatory standards for any of the following that were regulated by a government agency during the 2004 calendar year.

Where 1 = Working towards meeting regulations, 2 = meet regulatory standards, 3 = do more than regulation requires, and 4 = not regulated at your facility	1	2	3	4
CQ15a. Water pollution		45.9%	9.8%	44.3%
CQ15b. Construction & demolition (C&D) wastes	2.4%	54.4%	24.0%	19.2%
CQ15c. Hazardous/toxic C&D wastes		59.7%	8.4%	31.9%
CQ15d. Projects constructed to "green" building or high-performance standards (beyond code)	4.8%	38.1%	17.5%	39.7%
CQ15e. Fugitive dust mitigation measures	4.8%	41.9%	8.1%	45.2%
CQ15f. Other	6.7%	13.3%	13.3%	66.7%

Table 4.1.11 Percentage of Responses to Question 15 Transportation: For your facility, please indicate the level of compliance with regulatory standards for any of

the following that were regulated by a government agency during the 2004 calendar year.

Where 1 = Working towards meeting regulations, 2 = meet regulatory standards, 3 = do more than regulation requires, and 4 = not regulated at your facility	1	2	3	4
TQ15a. Water pollution	5.9%	52.1%	16.8%	25.2%
TQ15b. Solid waste	1.7%	52.9%	20.2%	25.2%
TQ15c. Hazardous/toxic wastes	1.7%	52.5%	19.5%	26.3%
TQ15d. Hazardous air emissions	3.4%	40.2%	17.1%	39.3%
TQ15e. Other	2.9%	23.5%	8.8%	64.7%

Table 4.1.12 Percentage of Responses to Question 15 Manufacturing: For your facility, please indicate the level of compliance with regulatory standards for any of the following that were regulated by a government agency during the 2004 calendar year.

Where 1 = Working towards meeting regulations, 2 = meet regulatory standards, 3 = do more than regulation requires, and 4 = not regulated at your facility	1	2	3	4
MQ15a. Water pollution	0.4%	45.4%	26.7%	27.5%
MQ15b. Solid Waste	0.4%	43.8%	27.4%	28.5%
MQ15c. Hazardous/toxic wastes	0.7%	45.4%	28.3%	25.7%
MQ15d. Hazardous air emissions	1.5%	41.3%	20.8%	36.4%
MQ15e. Other		15.1%	15.1%	69.8%

Due to the low response rate to question 16 'Please indicate the approximate amount of each of the following (types of pollution)', the data contained within this question cannot be used as a measure of environmental performance. Instead, question 17 is used to create a variable for the change in environmental output in the following section of this chapter.

Question Q17 asks respondents to 'For your facility, please indicate the extent to which the following measures of environmental performance have changed over the

2004 calendar year'. Respondents can reply 'Increased Greatly >10%'=1, 'Increased Moderately 4% to 10%'=2, Increased Slightly 1% to 3%'=3, 'No Change 0%'=4, 'Decreased Slightly –1$ to –3%'=5, 'Decreased Moderately –4% to –10%'=6 and 'Decreased Greatly <-10%'=7, and 'Do Not Know'. Since Q17 is industry specific, only those output variables that are the same across all industries are included in the creation of the change in environmental output variable. Table 4.1.13 looks at Q17a, Q17b, Q17c, and Q17e1, which represent wastewater discharged, solid waste generated, hazardous or toxic waste generated, and carbon dioxide emitted. These variables are used to create the variable ENVPERF in section 2 of this chapter, which represents the change in environmental output over the calendar year 2004. Note that in the construction industry survey, the question for carbon dioxide emitted is Q17f. The variable Q17e1 is used to represent Q17e for the accommodations, manufacturing and transportation industries and Q17f for the construction industry. The percentages of responses to Question Q17 are reported in table 4.1.13 where the response with the highest percentage of responses is always 'No Change'. AQ17 is the accommodations industry, TQ17 is the transportation industry, CQ17 is the construction industry, and MQ17 represents the manufacturing industries.

Table 4.1.13 Percentage of Responses to Question 17 Accommodations: For your facility, please indicate the extent to which the following measures of environmental performance have changed over the 2004 calendar year.

Where 1= Increased Greatly, 4= No Change, and 7 = Decreased Greatly	1	2	3	4	5	6	7
AQ17A Waste Water Discharged		6.41%	15.4%	62.8%	10.3%	5.13%	
AQ17B Solid Waste Discharged		3.9%	11.5%	62.8%	11.5%	9.0%	1.3%
AQ17C Hazardous/Toxic Wastes Generated		1.6%		90.3%	1.6%	3.2%	3.2%
AQ17E Carbon Dioxide Emitted		1.7%	3.5%	91.4%	1.7%		1.7%

Table 4.1.14 Percentage of Responses to Question 17 Construction: For your facility, please indicate the extent to which the following measures of environmental performance have changed over the 2004 calendar year.

Where 1= Increased Greatly, 4= No Change, and 7 = Decreased Greatly	1	2	3	4	5	6	7
CQ17A Waste Water Discharged	6.4%	4.8%	7.9%	76.2%	1.6%		3.2%
CQ17B Solid Waste Discharged	6.6%	9.2%	13.2%	60.5%	9.2%	1.3%	
CQ17C Hazardous/Toxic Wastes Generated	2.7%	4.1%	10.8%	74.3%	4.1%	4.1%	
CQ17F Carbon Dioxide Emitted		4.9%	3.3%	85.3%	6.6%		

Table 4.1.15 Percentage of Responses to Question 17 Transportation: For your facility, please indicate the extent to which the following measures of environmental performance have changed over the 2004 calendar year.

Where 1= Increased Greatly, 4= No Change, and 7 = Decreased Greatly	1	2	3	4	5	6	7
TQ17A Waste Water Discharged		5.1%	5.1%	79.5%	6.4%	3.9%	
TQ17B Solid Waste Discharged	1.2%	4.9%	13.4%	74.9%	4.9%	1.2%	
TQ17C Hazardous/Toxic Wastes Generated			4.0%	88.2%	7.9		
TQ17E Carbon Dioxide Emitted	1.3%	1.3%	5.3%	82.9%	5.3%	2.6%	1.3%

Table 4.1.16 Percentage of Responses to Question 17 Manufacturing: For your facility, please indicate the extent to which the following measures of environmental performance have changed over the 2004 calendar year.

Where 1= Increased Greatly, 4= No Change, and 7 = Decreased Greatly	1	2	3	4	5	6	7
MQ17A Waste Water Discharged	2.4%	6.8%	4.9%	70.7%	9.3%	3.9%	2.0%
MQ17B Solid Waste Discharged	2.8%	5.6%	9.8%	54.7%	13.1%	7.0%	7.0%
MQ17C Hazardous/Toxic Wastes Generated		2.7%	4.9%	74.6%	7.0%	5.4%	5.4%
MQ17E Carbon Dioxide Emitted			6.2%	89.4%	3.1%	0.6%	0.6%

The final section of the Oregon Business Environmental Management Survey contains general information about the facility and parent company. General information about the facility includes whether the facility is owned by a parent company, if the facility has a research and development department, how many environmental inspections or penalties the facility has had, the age of the upper management staff, and the estimated annual total revenue of the facility, the closeness of the facility to consumers in retail markets and the number of competitors the facility has. General information about the parent company contained within the survey includes if the parent company (or facility if the facility is not owned by a parent company) is part of a multi-national company, whether the parent company is publicly traded or privately owned, and if the parent company has a research and development department.

4.2 Data Description and Variable Creation

The primary objective of this section is to analyze the motivations behind a facility's decision to voluntarily over-comply with environmental regulations, adopt an environmental management plan, take environmental action, and whether adoption of environmental management plans and actions leads to changes in environmental performance. To this end, appropriate measures of motivations, environmental management plans, environmentally friendly actions, and changes in environmental output must be constructed. To create these variables, the data is transformed using techniques including dummy variables and primary component analysis. First, we will examine the creation of dummy variables for both dependent and independent variables used in the regression analysis.

The dependent variable in Model 1 is OVERCOMP. This variable is developed using data from questions A15, C15, T15, and M15 and represents a facility that over-complies with government regulations. In these questions, which are described in the second section of this chapter, respondents indicated if they over-comply with government regulations for industry specific types of pollution. Using these data, a dummy variable is created, which equals 1 if the respondent indicates over-compliance of government regulations with one or more type of pollution and 0 otherwise.

The size of facility is measured using annual total revenue. Question Q28 is an open-ended question asking respondents to write in their estimated annual total revenue for 2004 in millions of dollars. Due to the variation in sizes of firms sampled, the answers are grouped into three categories, which correspond to small, medium and large facilities. The first category Q28A, captures facilities with an estimated annual total revenue of $25 million or less. Q28A is equal to one if the facility's estimated total revenue is in that category and zero otherwise. Q28B is equal to one if the facility has an estimated annual total revenue greater than $25 million and less than or equal to $100 million and zero otherwise. The final dummy variable, Q28C captures firms that have an annual total revenue greater than $100 million, in which case Q28C is equal to one and zero otherwise.

4.2.1 Annual Total Revenue

Annual Total Revenue	Variables Included
Q28A	Q28 < $25 Million
Q28B	$25 < Q28 < $101 Million
Q28C	Q28> $100 Million

In order to look at parent company ownership (or facility ownership if the facility is not owned by a parent company), dummy variables are created from Q22 that indicate if the parent company is publicly traded, privately owned, or other. If the parent company is publicly traded, Q22A is equal to one and 0 otherwise. If Q22B is equal to one it suggests that the parent company is privately owned otherwise Q22B is equal to zero. The last dummy variable Q22C, captures parent companies that are not publicly traded or privately owned but specify some other type of ownership.

Table 4.2.2 Ownership of Facility

Ownership of Facility	Variables Included
Q22A	Q22=1, Publicly Traded
Q22B	Q22=2, Privately Owned
Q22C	Q22=3, Other

Questions Q25, Q26, and Q27 are all open-ended questions that have a large variation in answers, so they are categorized in order to create useable variables for the regression analysis that follows in the next chapter. Question Q25 looks at how much competition the facility faces by asking respondents to write in the number of close competitors their facility has. The responses to Q25 range from zero to 1000 close competitors with an average response of just over 14. In order to examine if the competitiveness of the market is important for environmental action, performance and/or over-compliance, Q25 is split into three categories—one category for facilities belonging to a very competitive market, one for facilities facing about average or above amounts of competition, and one for firms facing relatively little competition. The first category, Q25A is equal to one if the facility has ten or fewer close competitors and zero otherwise. Q25B is equal to one if the facility faces more than ten but less than or equal to fifty close competitors in their market and zero otherwise. Q25C is equal to one if a facility has greater than 50 close competitors and zero otherwise.

Table 4.2.3 Competition in Market

Competitiveness of Market	Variables Included

Q25A	Q25 < 11 Close Competitors
Q25B	10 < Q25 < 51 Close Competitors
Q25C	lQ25 > 50 Close Competitors

Question Q26 looks at the number of times a facility was inspected by an environmental agency in 2004. The answers to this question range from zero to 100 with a most frequent reply of zero and an average of one. Since we are primarily interested in whether or not the facility had an environmental inspection, a dummy variable Q26NY, is created with a value of 1 if the facility had an environmental agency inspection in 2004 and zero otherwise.

Question Q27 reports the number of environmental penalties, lawsuits and/or sanctions for environmental management in 2004 the facility had. The answers to this question range from zero to ten with .04 as an average value. The variable created from Q27 is approached the same was as Q26 since we are primarily interested in if the facility received a penalty, lawsuit, and/or sanction in 2004. Therefore the dummy variable Q27NY is equal to one if the facility received a penalty, lawsuit, and/or sanction for environmental management in 2004 and zero otherwise.

Question Q29 reports the average age of upper management staff at the facility. There are five categories for respondents to select. Category one is 20 to 30-years-old, category two is 31 to 40-years-old, category three is 41 to 50-years old and category four is 51 to 60-years old. The fifth category is over 61 years old. In order to interpret the regression analysis results for Q29, the categories are combined and turned into dummy variables. AGE40 is equal to one if the average age of upper management at the facility is between 20 and 40-years old and zero otherwise. AGE60 is equal to one if the age of the facility's upper management is greater than 40 but less than or equal to sixty. Finally, AGE61 is equal to one if the average age of the facility's upper management is over 60-years old.

Table 4.2.4 Age of Upper Management

Age of Management	Variables Included

AGE40	Q29=1	30-30 years old
	Q29=2	31-40 years old
AGE60	Q29=3	41-50 years old
	Q29=4	51-60 years old
AGE61	Q29=5	Over 61 years old

In addition to using the survey data to create dummy variables for the regression analysis, we create motivational index variables out of questions Q3, Q4, Q5, Q7, and Q8 to be used in all three empirical models. In order to create these and additional index variables, Principal Component Analysis (PCA) is used with the SAS econometrics computer program. PCA linearly combines optimally weighted observed variables to create a new principle component variable (Kennedy, 2003). After the original variables are optimally weighted, a linear combination is formed resulting in coefficients on the optimally weighted variables, which are reported as PCA coefficients in table 4.2.6 through table 4.2.13 and tables 4.2.15 through 4.2.17. The individual observations in the new principle component variable are referred to as principle components.

In order to scale the index of principle components from zero to one—where zero suggests the variable is not a motivational force and one suggests the variable is a complete motivational force, we subtract the smallest data value from all of the new data values and then divided these values by the largest data value, which creates motivational factors scaled from zero to one. Using PCA also takes care of collinearity between the variables that create the PCA variable.

The motivational factors we create are COMPETIT, BARRIERS, INVESTOR, REGUALTO, MANAGEMEN, INTEREST, CONSUMER. We create the motivational factors based on the available data from the survey and the theoretical basis of this thesis. An example is consumer and interest group pressures reported in question Q3 create two different variables because it is theorized that consumer pressure will affect the facility's decision to create an environmental management system.

Table 4.2.5 Motivational Factors

Motivation Number	Motivational Factors	Variables Included
M1	COMPETIT	Q5a-Q5f
M2	BARRIERS	Q8a-Q8h
M3	INVESTOR	Q4a-Q4c
M4	REGULATO	Q4d-Q4h
M5	MANAGEME	Q7a-Q7f
M6	INTEREST	Q3d-Q3f
M7	CONSUMER	Q3a-Q3c

Question Q3 is used to create motivational factors CONSUMER and INTEREST, which look at pressure firms face from consumers and interest groups. The variables that make up CONSUMER are Q3A, Q3B, and Q3C. The mean values of the variables suggest that the average respondent thinks consumer pressure is only a minor influence in environmental management at their facility.

Table 4.2.6 Principle Component Analysis for CONSUMER

Variables	Mean	Std Dev	PCA Coefficient
Q3A	2.8189	1.4262	.4209
Q3B	2.3361	1.3424	.4030
Q3C	2.6835	1.3723	.3641

The three variables that are analyzed to create INTEREST are Q3D, Q3E and Q3F. The mean values of the variables are 2.2315, 1.7315, and 2.3810, respectively, which suggests that the average respondent is only moderately influenced in their environmental management decision by interest group pressures. The coefficients of the variables derived with PCA are .3986, .3712, and .4001, respectively, and the results are detailed in Table 4.2.7.

Table 4.2.7 Principle Component Analysis for INTEREST

Variables	Mean	Std Dev	PCA Coefficient
Q3D	2.2315	1.2566	0.3986
Q3E	1.7315	1.1323	0.3712
Q3F	2.3810	1.3565	0.4001

Question Q4 is used for motivational factors INVESTOR and REGULATO. The motivational factor variable INVESTOR is investor pressure on a facility, while REGULATO is the variable that addresses government regulations as a motivation. The variables that are analyzed to create the motivational factor INVESTOR are Q4A, Q4B, and Q4C with mean values of 3.3361, 2.2308, and 2.3796, respectively. This suggests that the average respondent believes investor pressure is a priority encouraging environmental management.

Table 4.2.8 Principle Component Analysis for INVESTOR

Variables	Mean	Std Dev	PCA Coefficient
Q4A	3.3361	1.4765	0.4084
Q4B	3.2308	1.4983	0.4197
Q4C	2.3796	1.4194	0.35

The variables Q4D through Q4H are used to create the motivational factor variable REGULATO. The mean values of the variables Q4D through Q4H are 4.0344, 3.1859, 3.2685, 2.9690, and 2.6730, respectively. The average respondent ranks 'complying with current government regulations' as a large priority in encouraging environmental management but 'preempting future environmental regulations by voluntarily reducing unregulated impacts' is only a moderate priority encouraging environmental management at their facility in the last 5 years.

Table 4.2.9 Principle Component Analysis for REGULATO

Variable	Mean	Std Dev	PCA Coefficient
Q4D	4.0344	1.2712	0.2057

Q4E	3.1859	1.4948	0.2421
Q4F	3.2685	1.3797	0.244
Q4G	2.969	1.4381	0.2467
Q4H	2.673	1.3733	0.2328

Motivational factor COMPETIT is created from Question Q5 and represents environmental pressure from competition. The variables included in COMPETIT are Q5A through Q5F. The mean values of the variables suggest that the average facility's environmental management is only slightly influenced by competitive pressures.

Table 4.2.10 Principle Component Analysis for COMPETIT

Variable	Mean	Std Dev	PCA Coefficient
Q5A	2.792	1.3766	0.2038
Q5B	2.5824	1.3881	0.2023
Q5C	2.4958	1.2886	0.2222
Q5D	2.9185	1.4474	0.1856
Q5E	2.4642	1.3401	0.2119
Q5F	2.7754	1.3208	0.2084

Question Q7 is used for motivational factor MANAGEME, which indicates the level of pressure from management for environmental management at the facility. The mean values of the variables Q7A through Q7F range from 3.0242 to 4.2612. This suggests that management staff creates environmental management pressure at facilities. The mean, standard deviation and PCA coefficient for each variable in MANAGEME are displayed in Table 4.1.11.

Table 4.2.11 Principle Component Analysis for MANAGEME

Variable	Mean	Std Dev	PCA Coefficient
Q7A	4.2612	0.9507	0.2146

Q7B	3.4291	1.1534	0.2232
Q7C	3.3945	1.0904	0.2267
Q7D	3.7215	1.0417	0.2285
Q7E	3.4066	1.0626	0.2097
Q7F	3.0242	0.9796	0.2160

The motivational factor BARRIERS is created using question Q8. The eight factors included in Question Q8 indicate barriers to adopting more environmentally friendly processes, products and/or services. The mean values suggest that the factors create a moderate barrier to a facility's decision to adopt more environmentally friendly practices.

Table 4.2.12 Principle Component Analysis for BARRIERS

Variable	Mean	Std Dev	PCA Coefficient
Q8A	3.6088	1.2674	0.1684
Q8B	2.7573	1.1886	0.1536
Q8C	3.2824	1.2745	0.1841
Q8D	3.1987	1.2389	0.1968
Q8E	3.0962	1.3267	0.1796
Q8F	3.7929	1.3725	0.1742
Q8G	2.3640	1.2528	0.1672
Q8H	2.3452	1.2656	0.1492

The seven motivational factors created by PCA are normalized between zero and one. A response value of zero suggests that the motivational factor does not motivate environmental management at the facility, and a value of one implies the facility is greatly motivated by the motivation. The average value of the MANAGEME principal component variable is .680735, which is the highest average value of the motivational factor. The large average value may be due the answer scale for Question Q17, which has a larger range than that of the questions used to create the other six motivational factors. Question Q17 is examined in detail in section 1 of this chapter. The number of observations and average value for the seven motivational factors are recorded in Table 4.2.13.

4.2.13 Principle Components for Motivational Factors

Principle Component Analysis Variable	Number of Observations	Average Value of Principal Component
COMPETIT	602	0.415085
BARRIERS	479	0.486121
INVESTOR	599	0.501447
REGULATO	588	0.554716
MANAGEME	579	0.680735
INTEREST	623	0.276014
CONSUMER	616	0.402187

Principle Component Analysis is also used to create the dependent variables for the 3 Stage Least Squares (3SLS) models. The variable ENVPLAN is developed from question Q12 and indicates the level of environmental management plan adoption by the respondent. The eleven components of Question Q12 have a mean value range of 1.91 to 3.61. This suggests that the average respondent disagrees the most with 'Employees receive incentives for contributions to environmental performance'. The average value of 3.61 for Q12G means that the respondents agree the most with 'We make continuous efforts to minimize environmental impacts' out of the environmental plan factors. These results along with the mean value, standard deviation, and PCA coefficient for all eleven factors of Q12A are reported in Table 4.2.14.

Table 4.2.14 Principle Component Analysis for ENVPLAN

Variable	Mean	Std Dev	PCA Coefficient
Q12A	2.8047	1.1809	0.1181

Q12B	2.7515	1.2766	0.1312
Q12C	2.7890	1.2811	0.1186
Q12D	2.5858	1.3652	0.1323
Q12E	1.9112	1.0167	0.1124
Q12F	1.9921	1.1455	0.1181
Q12G	3.6134	1.2062	0.1077
Q12H	2.4773	1.2420	0.1205
Q12I	3.4852	1.1817	0.1109
Q12J	2.8679	1.2591	0.1300
Q12K	2.1440	1.1949	0.1285

Question Q14 is used to create the variable ENVACTIO, which represents the level of environmentally friendly actions taken by the facility. Table 4.2.15 contains the average value, standard deviation and PCA coefficient for the six factors belonging to Question Q14.

Table 4.2.15 Principal Component Analysis for ENVACTIO

Variable	Mean	Std Dev	PCA Coefficient
Q14A	3.5893805	1.1689969	0.22590
Q14B	4.3840708	0.9202766	0.21168
Q14C	3.4566372	1.1362714	0.23431
Q14D	3.7115044	1.1140426	0.25553
Q14E	3.4619469	1.1565661	0.25128
Q14F	4.1982301	0.9980462	0.18864

ENVPERF is created from Question Q17 to indicate the level of change in environmental output by the facility. The mean of Q17A is 3.9638 suggesting that the average respondent increased release of waste-water, solid waste, hazardous waste, and/or carbon dioxide over the calendar year 2004. The mean of both Q17B and Q17E1 also suggest an increase in pollution. The variable Q17C, which represents the release of carbon dioxide by the facility has a mean value of 4.0890, which says that respondents have not changed or have slightly decreased their release of carbon dioxide over the 2004 calendar year. Table 4.2.16 details the mean value and standard deviation of the observed values of the variables and the resulting PCA coefficients.

Table 4.2.16 Principle Component Analysis for ENVPERF

Variable	Mean	Std Dev	PCA Coefficient
Q17A	3.9638	.84167	0.3861
Q17B	3.9877	.9797	0.4300
Q17C	4.0890	0.7241	0.2771
Q17E1	3.9847	0.4400	0.3326

Environmentally friendly actions include pollution prevention, waste reduction, and reducing natural resource use. The ENVPLAN, ENVACTIO and ENPERF variables are scaled from zero to one with one being no EMP, action or change in environmental output taken and one being all plans adopted, all actions taken or the greatest change in environmental output reduction.

Table 4.2.17 Principle Components for Dependent Variables

Principle Component Analysis Variable	Number of Observations	Average Value of Principle Component
ENVPLAN	507	0.41222
ENVACTIO	565	0.700863
ENVPERF	327	0.558864

The number of observations for the Principle Component variables is 507 for ENVPLAN, 565 for ENVACTIO and 327 for ENVPERF. The low number of observations for an environmental performance variable is a problem faced repeatedly in the survey. Though equation 17 has a higher response rate than other performance variables, the small number of observations makes the model analyzing ENVPERF less reliable than the other models.

The average value of the principle components is .41 for ENVPLAN, .7 for EVACTIO, and .56 for ENVPERF. This suggests that the average respondent does not have a high degree of EMP adopted at their facility but they do take a level of environmental action. The average respondent also reduced their emission of pollution, waste and/or use of natural resources over the 2004 calendar year.

CHAPTER 5

Empirical Models

Three empirical models are specified and estimated in this study. The first model is specified to examine the question why facilities over-comply with environmental regulations and standards. The second model is specified to address the question what motivates the degree of a facility's EMP adoption and whether the degree of EMP adoption affects the extent of environmental action taken by a facility. The third model is specified to look at whether the degree of EMP adoption and extent of environmental action taken by a facility have led to improvements in environmental outcomes. This chapter discusses the specification and estimation methods of the three models.

5.1 Model 1

The over-compliance conditioned (e3.11) developed in this study provides the theoretical basis for the empirical analysis of Model 1. In order to perform the empirical analysis of Model 1, we must empirically specify the theoretical model. The theoretical over-compliance condition is

$$sN > \frac{B'(sN) - 1 + P(sN)}{-P'(sN)}. \qquad \text{(e3.11)}$$

Rearranging the equation, we find,

$$sN + \frac{B'(sN) - 1 + P(sN)}{P'(sN)} > 0. \qquad \text{(e3.11a)}$$

In order to empirically specify the theory, we decompose the model into two components. Let $sN + \frac{B'(sN) - 1 + P(sN)}{P'(sN)} = Z'\gamma - \varepsilon$ where ε is a random error term, and $Z'\gamma$ is the non-random component of (e3.11a). The error term captures measurement error and factors unobserved in this study that affect the facility's over-compliance decision. The non-random component of (e3.11a) is specified as a linear function of motivational pressures, facility characteristics, and company characteristics. In the decomposed model, a facility will choose to over-comply with environmental regulations if

$$Z'\gamma - \varepsilon > 0.$$

Over-compliance is a dichotomous choice variable, so Model 1 is a discrete choice model where ε is assumed to follow a normal or logistic distribution in a discrete choice model (Kennedy, 2003). If we assume a logistic distribution, the probability that a facility over-complies with environmental regulations is derived as a logit model

$$\text{Prob}[Overcomp = 1] = \frac{e^{Z'\gamma}}{1 + e^{Z'\gamma}},$$

where Overcomp =1 indicates facility over-compliance of environmental regulations. If we assume a normal distribution, the probability that a facility over-complies with environmental regulations is represented as a probit model

$$\text{Prob}[Overcomp = 1] = \Phi(Z'\gamma),$$

where $\Phi()$ is the c.d.f. of the standard normal distribution.

where Overcomp is

OVERCOMP = level of facility's environmental output reduction effort

where γ contains

Q1 = facility has environmental issues

Q22A = parent company is publicly traded

Q22B = parent company is privately owned facility

Q24 = facility participates in retail markets

Q25A = facility has less than 10 close competitors in market

Q25B = facility has between 10 and 50 close competitors in market

Q28A =facility annual total revenue less than $25 million

Q28B = facility annual total revenue between $25 million and $100 million

COMPETIT = level of influence competition has on environmental management

BARRIERS = degree to which barriers inhibit increasing environmental processes, products and/or services

INVESTOR = degree of pressure investors have on encouraging environmental management

REGULATO = extent of the priority environmental regulations have on encouraging environmental management

MANAGEME = extent of management support for environmental protection and performance

CONSUMER = degree of influence consumer pressure has on environmental management

INTEREST = extent of influence environmental interest groups have on environmental management

The variables included in Model 1 are based on theory but limited by the data. In this study, the vector γ includes the following facility company, and motivational characteristics. Facility characteristics are captured through Q1, Q18, Q24, Q25A, Q25B, Q28A and Q28B, which indicate the presence of environmental issues at the facility, facility ownership by a parent company, facility's participation in retail markets, the amount of competition the facility faces, and size of the facility. Company characteristics are captured by Q22A and Q22B, which indicate ownership of the facility's parent company or the facility's ownership if the facility is not owned by a parent company.

The seven motivational factors are included to indicate motivational pressure. COMPETIT indicates the level of influence competition has on environmental management at the facility. The variable BARRIERS conveys the degree to which cost, time, employee and benefit barriers stand in the way of increasing the facility's environmental friendliness of the processes, products and/or services. INVESTOR measures the degree of priority investor pressure has on encouraging environmental management at the facility. The extent of the priority current and possible future environmental regulations have on encouraging environmental management at the facility is measured by REGULATO.

The motivational variable MANAGEME indicates the extent to which the facility's upper management believes in supporting environmental protection and increasing environmental performance. The degree of influence consumer pressure has on environmental management at the facility is measured with CONSUMER. INTEREST measures the extent of the influence environmental interest groups has on environmental management at the facility.

A detailed explanation of these variables is included found in chapter 4. In chapter 6, we use Model 1 to evaluate the effects of motivational pressure on a facility's decision to over-comply with environmental regulations and standards. This study includes both probit and logit model estimations of Model 1 using maximum likelihood estimation (MLE) methods. Model 1 is estimated two additional ways in order to check for robustness. The variables central to the theory of this work are left in all versions of the models, while firm characteristic and company variables are changed across the models. The regression results for Model 1 including the two additional versions are reported as both a binomial probit model and multinomial logit model in section 1 of chapter 6.

5.2 Model 2

Model 2 addresses the affects of motivational pressures on the degree of EMP adoption and whether the degree of EMP adoption influences the extent of environmental action taken by a facility. The general model is specified as:

$$ENVPLAN = \alpha_0^1 + \alpha_1^1 X^1 + \alpha_2^1 M + e^1$$

$$ENVACTIO = \alpha_0^2 + \alpha_1^2 X^2 + \alpha_2^2 ENVPLAN + \alpha_3^2 M + e^2$$

where

ENVPLAN = degree of EMP adoption

ENVACTIO = extent of environmental actions

X^1 = a vector of variables that affect degree of EMP adoption

X^2 = a vector of variables that affect extent of environmental action

M = a vector of motivational pressures

e^1, e^2 = error terms

where X^1 contains

Q1 = facility has environmental issues

Q6B = percentage of annual revenue spent on environmental management

Q21 = parent company is a multi-national corporation

Q26NY = inspection by environmental agency in 2004

Q27NY = penalty, lawsuit, and/or sanction for environmental management in 2004

Q28A =facility annual total revenue less than $25 million

Q28B = facility annual total revenue between $25 million and $100 million

AGE40 = average age of facility upper management 20-40 years-old

AGE60 = average age of facility upper management 40-60 years-old

where X^2 contains

Q1 = facility has environmental issues

Q22A = parent company is publicly traded

Q22B = parent company is privately owned

Q25A = facility has less than 10 close competitors in market

Q25B = facility has between 10 and 50 close competitors in market

Q26NY = inspection by environmental agency in 2004

Q28A =facility annual total revenue less than $25 million

Q28B = facility annual total revenue between $25 million and $100 million

ENVPLAN = degree of EMP adoption

where M contains

COMPETIT = level of influence competition has on environmental management

BARRIERS = degree to which barriers inhibit increasing environmental processes, products and/or services

INVESTOR = degree of pressure investors have on encouraging environmental management

REGULATO = extent of the priority environmental regulations have on encouraging environmental management

MANAGEME = extent of management support for environmental protection and performance

CONSUMER = degree of influence consumer pressure has on environmental management

INTEREST = extent of influence environmental interest groups have on environmental management

The variables included in Model 2 are based on theory and limited by the data. The same type of facility, company, and motivational factors that affect over-compliance are predicted to affect the degree of EMP adoption and the level of environmental action. Since the same factors are expected to influence both equations, the specific variables included in each equation are based on the researcher's discretion.

The variables in vector X^1 include Q1, Q6B, Q26NY, Q27NY, Q28A, Q28B, AGE40 and AGE60 to indicate facility specific variables that show the presence of environmental issues at the facility, current environmental spending, size of the facility, and age of facility management. Company characteristics are captured by Q21, which indicate multi-national companies. Motivational pressures at the facility are indicated by COMPETIT, BARRIERS, INVESTOR, REGULATO, MANAGEME, CONSUMER, and INTEREST.

Vector X^2 of Model 2 includes the variables Q1, Q25A, Q25B, Q26NY, Q28A and Q28B, which contain information about facility specifics to directly indicate the presence of environmental issues at the facility, the amount of competition the facility faces, and the size of the facility. The variables Q22A and Q22B are included as company characteristics to indicate ownership of the facility's parent company or the facility's ownership if the facility is not owned by a parent company.

The seven motivational factors influence equations 1 and 2 in Model 2. The variable COMPETIT indicates the level of influence competition has on environmental management at the facility, while BARRIERS conveys the degree to which cost, time, employee and benefit barriers stand in the way of increasing the facility's environmental friendliness of the processes, products and/or services.

The motivational variable INVESTOR measures the degree to which investors encourage environmental management at the facility. The extent of pressure environmental regulations have on encouraging environmental management at the facility is measured by REGULATO. MANAGEME indicates the extent of the facility's upper management beliefs on supporting environmental protection and increasing environmental performance. CONSUMER indicates the degree of influence consumer pressure has on environmental management at the facility. The extent of environmental interest groups' influence environmental management at the facility is INTEREST.

The recursive equations system is tested for simultaneity using the Hausman specification error test. Since the error term in the first equation significantly affects the dependent variable in the second equation, the model will be estimated by three stage least-squares (3SLS) (Greene, 1993). This suggests that the extent of environmental action is influenced by the same company, facility and motivational conditions that affect the degree of EMP adoption. If we treat the level of EMP adoption as exogenous and use ordinary least squares (OLS) to estimate both equations, the estimated model coefficients will be biased because the error term in the degree of EMP adoption equation may also affect the level of environmental action model (Wu et al., 2000). Therefore, three-stage least squares (3SLS) is used to estimate Model 2.

The three-stage least squares model is estimated in three stages. In the first stage, the predicted value of the dependent variable in the first equation is calculated using ordinary least squares (OLS). In the second step, the structural equations' errors are estimated using the predicted value found in step one. The resulting errors are then used to find the structural equations' errors contemporaneous variance-covariance matrix. In the final stage, generalized least squares (GLS) is applied to the whole model, which includes the two identified equations in Model 2 (Kennedy, 191).

ENVPLAN, ENVACTIO, and the motivational variables are created using principal component analysis (PCA) in chapter 4. In chapter 6, we use Model 2 to evaluate the effects of motivational pressure on a facility's degree of EMP adoption, and the affects of a facility's degree of EMP adoption on the extent of environmental action taken by the facility. Multiple versions of Model 2 are created in order to check for robustness of the model. One of these additional versions referred to as Model 2.2, is reported along side Model 2 in chapter 6.

5.3 Model 3

Model 3 contains three equations. The first equation looks at the effects of motivational pressure on the degree of EMP adoption. Equation two examines motivational pressures and degree of EMP adoption on the extent of environmental action taken by the facility. In the final equation, the level of change in environmental performance is a function of the degree of EMP adoption and the extent of environmental action taken by the facility.

$$ENVPLAN = \alpha_0^1 + \alpha_1^1 X^1 + \alpha_2^1 M + e^1$$

$$ENVACTIO = \alpha_0^2 + \alpha_1^2 X^2 + \alpha_2^2 ENVPLAN + \alpha_3^2 M + e^2$$

$$ENVPERF = \alpha_0^3 + \alpha_1^3 X^3 + \alpha_2^3 ENVPLAN + \alpha_3^3 ENVACTIO + e^3$$

where

ENVPLAN = degree of EMP adoption

ENVACTIO = extent of environmental action

ENVPERF = level of change in environmental output

X^1 = a vector of variables that affect degree of EMP adoption

X^2 = a vector of variables that affect extent of environmental action

X^3 = a vector of variables that affect the level of change in environmental output

M = a vector of motivational pressures

e^1, e^2, e^3 = error terms

where X^3 contains

Q6A = percentage of annual revenue spent on environmental management in 2003

Q18 = ownership by a parent company

Q21 = parent company is a multi-national corporation

Q22A = parent company is publicly traded

Q22B = parent company is privately owned

Q23A = facility has research & development department

Q23B = parent company has research & development department

Q24 = facility sells directly to consumers

ENVPLAN = degree of EMP adoption

ENVACTIO = extent of environmental action

The variables in vectors X^1, X^2 and M of Model 3 are identical to those in Model 2. Vector X^3 includes Q6A, Q18, Q23A, Q23B and Q24 as facility specific information indicating past environmental management spending, facility ownership by a parent company, research and development department at the facility, and facility participation in retail markets. Company characteristics are included with the variables Q21, Q22A, Q22B and Q23B conveying the parent company is a multi-national corporation, parent company ownership, and parent company has a research and development department. In addition, the motivational pressures, facility characteristics, and company characteristics variables in vectors X^1, X^2 and M indirectly affect vector X^3 through ENVPLAN and ENVACTIO.

Both ENVPLAN and ENVACTIO are included in equation 3 of Model 3 because it is probable that the list of environmental actions used in this study does not include all possible environmental actions. An EMP may lead to an environmental action that affects environmental output but that is not included in our list of environmental actions. Therefore the EMP will directly affect environmental output in this model, so the variable is included in the ENVPERF equation. In addition, the correlation between ENVPLAN and ENVACTIO is .64, so we can include both variables in equation 3 of Model 3.

The recursive equation system is estimated simultaneously since the Hausman Specification Test suggests that the error terms in the first and second equations significantly affect the dependent variable in the third equation. If we treat the dependent variables ENVPLAN and ENVACTIO in equations 1 and 2 of Model 3 as exogenous variables and then use ordinary least squares (OLS) to estimate the level of change in environmental performance equation, the resulting coefficients will be biased because the error terms in equations 1 and 2 may affect the level of change in environmental performance equation (Wu et al., 2000). Therefore, three-stage least squares is used to estimate Model 3.

All three dependent variables as well as the seven motivational variables are created in chapter 4 of this study. The Survey and Data Design chapter contains a description of these variables with the other variables in vectors X^1, X^2, and X^3 used in Model 3. Multiple versions of Model 3 are estimated in order to check for robustness. The variables central to theory are included all versions of the models, while firm characteristic and company variables are varied across the models. Two versions of Model 3 are included in the Regression Results and Analysis chapter.

CHAPTER 6

Estimation Results

The three empirical models developed in Chapter 5 are analyzed in this chapter. The first model looks at the motivational pressures that encourage over-compliance of environmental regulations. In the second model, we examine the motivational pressures that affect the degree of EMP adoption and the affect of the degree of EMP adoption on the extent of environmental action taken by the facility. The third model includes the two steps in the second model in addition to looking at the affects of the degree of EMP adoption and the level of environmental action on the level of the change in environmental output. This chapter discusses the estimation results for these three models.

6.1 Model 1 Results

Model 1 is specified as both a Logit and a Probit model. Three versions of the model are included in the results to check for robustness of the model. The results of the five model specifications are reported in Table 6.1.1. The coefficients are recorded first followed by the standard error in parenthesis. The Probit model coefficient and standard error are reported initially followed by the Logit model coefficient and standard error. One, two, and three stars indicate significance at the 10%, 5%, and 1% significance levels, respectively. The model is analyzed in Lindep/NLOGIT with the following results.

Table 6.1.1 Regression Analysis Results for Model 1

	Model 1		Model 1.2		Model 1.3	
Variable	Probit	Logit	Probit	Logit	Probit	Logit
Constant	-2.441*** (.8706)	-4.016*** (1.460)	-2.159*** (.6668)	-3.488*** (1.148)	-1.687*** (.5580)	-2.762*** (.9606)
Q1	.2235 (.1668)	.3794 (.2750)	.2189 (.1658)	.3642 (.2726)		

Q18	.0709 (.2306)	1.373 (.3788)	-.0194 (.1928)	-.0230 (.3153)		
Q22A	.2868 (.4218)	.5213 (.7072)				
Q22B	.3581 (.3523)	.6451 (.5988)				
Q24	.1052 (.1610)	.1542 (.2677)	.1142 (.1594)	.1740 (.2643)		
Q25A	-.1787 (.4007)	-.3232 (.6493)				
Q25B	.1691 (.4334)	.2714 (.7003)				
Q28A	.4511 (.4991)	.6745 (.8442)	.4448 (.4745)	.7236 (.8248)	.4125 (.4727)	.6694 (.8180)
Q28B	.9066 (.5607)	1.439 (.9446)	.9442* (.5369)	1.562* (.9247)	.9131* (.5298)	1.497* (.9070)
COMPETIT	.6252 (.4694)	1.009 (.7735)	.5623 (.4641)	.8891 (.7611)	.6281 (.4439)	.9935 (.7287)
BARRIERS	-.8063** (.3671)	-1.399** (.6281)	-.7254** (.3629)	-1.228** (.6149)	-.5918* (.3434)	-1.007* (.5746)
INVESTOR	-.4650 (.3639)	-.7472 (.6043)	-.4773 (.3604)	-.7661 (.5971)	-.4376 (.3415)	-.7073 (.5658)
REGULATO	1.118*** (.3590)	1.813*** (.6053)	1.144*** (.3550)	1.849*** (.5961)	.9914*** (.3397)	1.602*** (.5697)
MANAGEME	.6103 (.5329)	1.062 (.9016)	.6729 (.5284)	1.154 (.8883)	.7240 (.4780)	1.227 (.8090)
CONSUMER	.2585 (.3745)	.4479 (.6149)	.2160 (.3707)	.3695 (.6096)	.1742 (.3576)	.3053 (5856)
INTEREST	.1446 (.3770)	.2789 (.6164)	.1459 (.3740)	.2743 (.6116)	.1591 (.3602)	.2885 (.5870)

Correct Prediction	70.06%	70.70%	69.43%	69.43%	66.97%	67.27%
Log Likelihood Function	-181.61	-181.55	-183.48	-183.61	-198.91	-199.02
LM Stat	.1541	.9648	.1998	.2396	.1279	.0765

Note: one, two and three asterisks indicate statistical significance at the 10%, 5% and 1% levels respectively

Note: standard error is in parenthesis

The discussion of estimation results below are based on the Probit model in Model 1 in Table 6.1.1. The variable Q1 represents concern for environmental issues at the facility. The value of the coefficient is .2235. This suggests that if the respondent has concern over environmental issues at their facility, they are more likely to over-comply with environmental regulations by twenty-one percent. This intuitive result is insignificant at the 10% level.

The coefficient on Q18 is .0709, which suggests that if a facility is owned by a parent company, they are seven percent more likely to over-comply with environmental regulations. Though this result is anticipated but is not statistically significant at the 10% significance level. Both Q22A and Q22B have a positive affect on over-compliance with coefficients of .2868 and .3581 respectively. The coefficients suggest that if the facility's parent company is privately owned, the facility over-complies more and a facility that has a parent company that is publicly traded over-complies more than a facility with a parent company that is neither publicly traded nor privately owned but specified some other type of ownership. Both results do not significantly affect the probability that a facility will over-comply with environmental regulations.

The coefficient on variable Q25A is negative, and the coefficient on Q25B is positive. This suggests that a facility that with ten or less close competitors is less likely to over-comply with environmental regulations than a facility that has greater than fifty close competitors. A facility that has more than ten but less than or equal to 50 close competitors is more likely to over-comply with environmental regulations than a facility that has greater than fifty close competitors. The variables Q25A and Q25B are insignificant at the 10% significance level.

Question Q24 indicates whether the facility sells their products and/or services directly to retail consumers. The coefficient on Q24 is .1052 suggesting that facilities selling directly to retail consumers over-comply with environmental regulations more than facilities that are not in retail sales. The result does not significantly affect the probability that a facility will over-comply with environmental regulations.

Variables Q28A and Q28B are used to measure the size of the facility. The coefficients are .4511 and .9066 respectively. A facility that makes twenty-five million dollars or less in annual total revenue over-complies more and a facility that makes more than twenty-five dollars but less than or equal to one hundred million dollars in annual total revenue over-complies more than a facility that makes over one-hundred million dollars in annual total revenue. The p-variables Q28A and Q28B are not statistically significant at the 10% level. While neither result is statistically significant at the 10% significance level, Q28B is more significant that Q28A suggesting that firm size does affect over-compliance.

The next seven variables to be discussed are the environmental management motivational variables. The first of these is COMPETIT. The coefficient on COMPETIT is .6252 suggesting that facilities that have the most pressure from competition over-comply with environmental standards more than facilities that have no competitive pressures. COMPETIT is expected to have a positive influence though this result is not statistically significant in the model. The environmental management motivation variable BARRIERS has a coefficient of -.8063 and is statistically significant at the 5% significance level. This suggests that facilities with the highest level barriers to increasing the environmentally friendliness of the facility's process, products, and/or services over-comply with environmental standards less than facilities that have no barriers present. BARRIERS is predicted to discourage over-compliance, and therefore have a negative coefficient as the result confirms.

The coefficient on INVESTOR is -.4650. This suggests that facilities with environmental pressure from investors to reduce environmental risks and liabilities or protect the facility's value are less likely to over-comply. This result is constant across the five over-compliance models but has the opposite sign as expected suggesting possible measurement error. The result is not statistically significant at the 10% significance level.

The variable REGULATO is the most significant motivational variable. The result is statistically significant at the 1% significance level. The coefficient on REGULATO is 1.118. This suggests that the probability that a facility with high current and/or future environmental regulation pressures are significantly more likely to over-comply than facilities with no regulatory pressure. This is an expected result saying that government policy can encourage facilities to over-comply with current environmental regulations.

The variables MANAGEME, CONSUMER and INTEREST encourage over-compliance as was predicted, but they are all statistically insignificant. The coefficient on MANAGEME is .6103 suggesting that if the management staff pressures the facility to improve environmental performance and protection efforts, that facility is more likely to over-comply than a facility without any pressure from management. If a large amount of consumer pressure exists at a facility, that facility over-complies more than a facility with no pressure from consumers. Consumers were predicted to be a highly significant source of pressure encouraging facilities to over-comply with environmental standards. CONSUMER is insignificant possibly because the industries sampled are removed from retail markets. The variable INTEREST has a coefficient of .1446 suggesting that if interest groups intensely pressure a facility to be environmentally friendly, that facility is more likely to over-comply with environmental standards than facilities that do not face any interest group pressure.

In order to test the variables for robustness, two additional models are created that include the motivational variables with different variations of facility specification variables. Model 1.2 is the largest of these models. It is similar to Model 1 except does not include variable Q22A, Q22B, Q25A and Q25B. The only change in significance is Q28B becomes statistically significant at the 10% significance level. The only change in direction of a variable is Q18 becomes negative though small and insignificant. The rest of the variables have similar magnitudes to Model 1 with the same direction of impact. Model 1.3 includes only the motivational variables, Q28A, and Q28B. The coefficients found from the regression analysis have the same direction, magnitude and significance as the same variables in Model 1 and Model 1.2.

The environmental management plan motivational variables are the key elements we are concerned with in this model. The variable BARRIERS is consistently statistically significant throughout all five model though the coefficient values are larger in the logit model than the probit model. Due to the similarity of this variable across Model 1, we can assume that the presence of BARRIERS at a facility significantly decreases the chance that the facility will over-comply with environmental regulations. The other environmental management system motivation variable that is significant across all models is REGULAO. The coefficient is positive and close to one in all five models. This suggests that environmental government regulations play a key part in encouraging firms to over-comply with current environmental policies.

The chance of a correct prediction of over-compliance using this model is 70.1%. Since over-compliance is a discrete choice variable, the chance of a correct prediction without this model is 50%. Therefore, using this model improves the probability of a correct prediction by 20.1%. The correct prediction rate is between 67% and 71% across all three version of Model 1.

Due to the cross-sectional nature of the data used in this study, all five models are tested for heteroscedasticity. In order to accomplish this in a Logit or Probit model, a Lagrange Multiplier (LM) test is used (Greene, 1993). Where the null hypothesis is homoscedasticity and the alternative hypothesis is heteroscedasticity. The null hypothesis is rejected if the observed LM statistic is greater than the chi-squared test statistic. Models 1 through 5 do not have significant heteroscedasticity, so we fail to reject the null hypothesis of homoscedasticity.

6.2 Model 2 Results

Model 2 examines the affects of motivational factors on the degree of EMP adoption and the affect of EMP adoption on the extent of environmental action taken by the facility. Table 6.2.1 presents the regression results for two versions of Model 2. Model 2.1 is the empirical model developed in chapter 4, and Model 2.2 is included to test for robustness. Though multiple versions of Model 2 were analyzed to test the model for robustness, only Model 2.2 is reported here. The coefficients and standard errors are reported for both. The stars on the coefficient value indicate the significance level. The models are run using OLS with predicted values to test for Heteroscedasticity with a Breusch-Pagan Chi-Squared LM test, which is reported in Table 6.2.1. There is no significant heteroscedasticity at the 5% significance level. In order to test for simultaneity of the equations system, the Hausman test was run. This tests the null hypothesis of no simultaneity against the alternative hypothesis of simultaneity. The null hypothesis of no simultaneity is rejected at the 1% statistical significance level, so the equations are estimated simultaneously using 3SLS.

Table 6.2.1 Regression Results for Model 2

Equation 1	Model 2		Model 2.2	
Variable	Coefficient	Standard Error	Coefficient	Standard Error
Constant	-.0366	.0891	-.0397	.0864
Q1	.0352	.0226	.0291	.0224
Q6B	.0071	.0085	.0089	.0079
Q21	.0499	.0328	.0374	.0316
Q26NY	.0234	.0219	.0243	.0217
Q27NY	.0133	.0617	.0065	.0572
Q28A	.0180	.0543	.0043	.0541
Q28B	-.0345	.0626	-.0476	.0624
AGE40[1]	-.1354**	.0582	-.1160**	.0541
AGE60	-.1234**	.0521	-.1047**	.0484
COMPETIT	.1432**	.0631	.1397**	.0584
BARRIERS	-.1039**	.0461	-.0885**	.0427
INVESTOR	.1432***	.0472	.1110***	.0437
REGULATO	.0660	.0492	.1207***	.0455
MANAGEME	.4623***	.0657	.4459***	.0617
INTEREST	.0770	.0505	.0429	.0467

CONSUMER	-.0583	.0510	-.0139	.0471
LM Statistic	20.8711		20.7711	

Equation 2	Model 2		Model 2.2	
Variables	Coefficient	Standard Error	Coefficient	Standard Error
Constant	.0972**	.0972	.2998***	.0971
Q1	.0002	.0230	.0026	.0241
Q22A	-.0325	.0635	-.0331	.0583
Q22B	-.0419	.0456	-.0448	.0459
Q25A	.0769	.0519	.0414	.0537
Q25B	.0672	.0558	.0414	.0581
Q26NY	.0564***	.0218	.0427*	.0228
Q28A	.0168	.0525	.0461	.0583
Q28B	.0363	.0628	.0878	.0677
ENVPLAN	.4762*	.2542	.7779***	.0710
COMPETIT	.0359	.0731		
BARRIERS	.0158	.0514		
INVESTOR	-.0411	.0559		
REGULATO	.1792***	.0506		
MANAGEME	.0972	.1256		
INTEREST	-.0834	.0537		
CONSUMER	.1190**	.0507		
LM Statistic	25.8928		14.9734	
Hausman Test	.3392***		.3344***	

Note: one, two and three asterisks indicate statistical significance at the 10%, 5% and 1% levels respectively

This discussion focuses on Model 2.1, which is developed in chapter 4 of this study. Only two of the facility characteristic variables are significant at the ten percent significance level though two other variables are close. The significant variables at the 10% significance level are AGE40 and AGE 60 with coefficients of -.1354 and -.1234 respectively. This suggests that a facility with a management staff with an average age between 20 and 40 have less of an EMP than a facility with an average management age of over 60. A facility that has an average management age of over 40 but less than or equal to 60 has less of an EMP than a facility with a management staff that has an average age of over 60. Variable Q1 is significant at the 12% significance level, and variable Q21 is significant at the 13% significance level. The coefficients are .0352 and .0499 respectively.

Though all seven of the motivational factors are significant at the 25% significance level, only four motivational factors are significant at the ten percent level. They are COMPETIT, BARRIERS, INVESTOR, and MANAGEME. Facilities with competitive pressures and facilities that face investor pressures have a coefficient of .14, so they have higher EMP adoption. Facilities that experience barrier pressures to EMP adoption have a do not adopt an EMP, while facilities that experience pressures from management have a high level of EMP adoption. The direction of the magnitude of the four significant motivational variables are as predicted.

The three insignificant motivational variables in equation one are REGULATO, INTEREST, and CONSUMER. The coefficient on regulatory is .0660 and is significant at the 18% level. This suggests that facilities facing high regulatory pressure have a higher degree of EMP adoption. The affect of interest group pressure on the degree of EMP adoption is likewise small and positive, and INTEREST is significant at the 13% level. Consumer pressure is the least significant motivational variable in equation 1 of Model 2. The result for consumer pressure is counter-intuitive, and may be accounted for by measurement error.

The second equation of Model 2 includes only one facility characteristic variable that is significant at the ten percent level in addition to the constant term. This suggests that facilities that have had an environmental inspection in 2004 have a greater degree of environmental action. Two motivational factors are significant at the 5% significance level. They are REGULATO and CONSUMER with coefficients of .1792 and .1190 respectively. A facility with regulatory pressures including the threat of future environmental regulations has a higher level of environmentally action, and a facility facing consumer pressure also has a higher level of environmentally friendly action than facilities without such pressure. The direction of influence of consumer pressure, interest group pressure investor pressure and barrier pressure switches direction from equation 1 in Model 2 suggesting possible measurement error. Investor pressure, barrier pressure and interest group pressure have the opposite sign as expected.

The variable ENVPLAN is significant at the 10% significance level. A facility with a high degree of EMP adoption has a higher degree of environmental action than a facility that has no degree of EMP adoption. The four motivational variables that significantly affect the degree of EMP adoption in equation one of Model 2 indirectly affect environmental action taken by the facility. Therefore all of the motivational variables except for interest group pressure indirectly or directly affect the level of environmental action taken by a facility.

The intuitive result that a higher EMP adoption level results in taking greater environmentally friendly actions was expected. One interesting result is that regulatory pressure does not significantly affect the degree of EMP adoption but does affect the level of environmental action taken by a facility. One explanation is that the majority of the motivational factor REGULATO is based on future environmental regulations. Since future environmental regulations have not been created with specific target pollution levels, it is not probable that a facility will have created an EMP to deal with such issues. Therefore, REGULATO will not significantly influence adoption of an EMP, but it will affect environmental actions taken by the facility. This result does not hold in Model 2.2 when the motivational factors do not directly affect ENVACTIO as is illustrated in Table 6.2.1.

The variable CONSUMER is the only other motivational factor that directly affects ENVACTIO. It was expected that consumer pressure would affect both variables. The unexpected result can be explained through the factors that create the motivational variable. The environmental management factors relate to two aspects—customer demand and WTP for environmentally friendly product/service output and customer goodwill gained through environmentally friendly actions. Both aspects relate closely to actions taken by the facility instead of EMP created by the facility.

This suggests that the motivational factor variable CONSUMER, will influence environmental action but not the creation of an EMP.

The significance of the variables remains similar across models. The only variable that changes from insignificant to significant across models is regulatory pressure as was discussed previously in this section. Since little changes between the models as variables are dropped and added, we can conclude that the model is robust.

6.3 Model 3 Results

Model 3 follows Model 2 closely with the addition of a third equation to examine changes in environmental output, ENVPERF. As was discussed before, the number of observations for ENVPERF is 305 versus 507 and 565 for ENVPLAN and ENVACTIO, respectively. We include Model 3 because we are interested in the effects of environmental action on environmental output, but the low number of observations for ENVACTIO makes these results less reliable than those found in Model 2.

Table 6.3.1 presents the regression results for Model 3. The coefficients and standard errors are reported for each variable. One, two and three stars represent the ten, five, and one percent significance levels respectively. The Breusch-Pagan Chi-Squared Statistic is reported, which is used to test for heteroscedasticity. Since the statistic is less than the chi-squared test statistic, we fail to reject the null hypothesis of homoscedasticity at the 5% significance level suggesting that there is no significant heteroscedasticity in the model. In order to test the model for simultaneity, the Hausman specification test is used. The Hausman test statistics in Model 3 are statistically significant at the 15% level except for the Hausman test statistic 2 in equation 3 of Model 3. Due to the significance of the all but one of the test statistics, the null hypothesis of no simultaneity is rejected, and the model is estimated simultaneously using 3SLS.

Table 6.3.1 Regression Analysis Results for Model 3

Equation 1	Model 3		Model 3.2	
Variable	Coefficient	Standard Error	Coefficient	Standard Error

Constant	-.0732	.1346	-.0614	.1314
Q1	-.0155	.0281	-.0156	.0279
Q6B	.0252**	.0112	.0194*	.0105
Q21	.0325	.0426	.0263	.0410
Q26NY	.0380	.0267	.0480*	.0265
Q27NY	-.0266	.0632	.0130	.0603
Q28A	.0170	.0747	-.0090	.0743
Q28B	-.0721	.0843	-.1015	.0838
AGE40	-.0616	.0976	-.0348	.0933
AGE60	-.0563	.0898	-.0414	.0859
COMPETIT	.1136	.0806	.1282*	.0770
BARRIERS	-.1315**	.0574	-.1288**	.0549
INVESTOR	.1542***	.0615	.1258**	.0588
REGULATO	.1370**	.0612	.1530***	.0582
MANAGEME	.4817***	.0793	.4883***	.0763
INTEREST	.0355	.0624	.0055	.0592
CONSUMER	-.0351	.0630	-.0002	.0600
LM Statistic	20.8711		20.8711	

Equation 2	Model 3		Model 3.2	
Variable	Coefficient	Standard Error	Coefficient	Standard Error
Constant	.2817**	.1261	.3118***	.1177
Q1	.0092	.0256	.0134	.0267
Q22A	.0132	.0846	.0103	.0796
Q22B	-.0246	.0679	-.0367	.0665
Q25A	.0762	.0583	.0541	.0579
Q25B	.0261	.0645	.0897	.0642
Q26NY	.0550*	.0304	.0183	.0260
Q28A	-.0776	.0728	-.0209	.0746

Q28B	-.0261	.0837	.1175	.0843
ENVPLAN	.5216*	.3008	.8153***	.0802
COMPETIT	.0695	.0882		
BARRIERS	-.0049	.0664		
INVESTOR	-.0437	.0694		
REGULATO	.0822	.0712		
MANAGEME	.1644	.1628		
INTEREST	-.0805	.0621		
CONSUMER	.0938	.0604		
Hausman Test	.3392***		.3344***	
LM Statistic	25.8928		14.9734	

Equation 3	Model 3		Model 3.2	
Variable	Coefficient	Standard Error	Coefficient	Standard Error
Constant	.5634***	.1977	.6391***	.1920
Q18	.0948***	.0381	0947***	.0371
Q6A	-.0057	.0099	-.0044	.0094
Q21	.0051	.0569	.0119	.0555
Q22A	-.1730**	.0818	-.1797**	.0817
Q22B	-.1531**	.0695	-.1594**	.0692
Q23A	.0155	.0321	.0102	.0316
Q23B	.0453	.0523	.0459	.0502
Q24	-.0163	.0247	.0104	.0238
ENVPLAN	.3889*	.2104	.5239***	.1995
ENVACTIO	-.3879	.2421	-.5584***	.2264
Hausman Test 1	.0765		.2482	
Hausman Test 2	.1154		.1049	
LM Statistic	9.3109		15.2074	

Note: one, two and three asterisks indicate statistical significance at the 10%, 5% and 1% levels respectively

Note: Hausman Test 1 refers to the error term from equation 1

Note: Hausman Test 2 refers to the error term from equation 2

The regression results for equation one of Model 3 have five significant variables at the 10% significance level. They are Q6B, BARRIERS, INVESTOR, REGULATO, and MANAGEME with coefficients of .2519, -.1315, .1543, .1370, and .4817, respectively. This suggests that facilities that spent a higher percentage on environmental management have a higher EMP adoption level. This result is expected since firms that spend more on environmental management in the past would have an incentive to create an environmental management plan to deal with the high costs of environmental management at the facility. Facilities that experience barrier pressures have a negative EMP adoption level, while facilities that face investor pressure have a higher EMP adoption level. If regulatory pressures occur at the facility, that facility has a higher EMP adoption level, and if there is environmental pressure from the managerial staff, the facility has a higher EMP adoption level. The direction of influence the four significant motivational variables have on degree of EMP adoption is consistent with theory. Though they are insignificant, competitive pressures and interest group pressures have the predicted sign. The affect consumer pressure has on degree of EMP adoption is counter-intuitive but consistent with Model 2.

The second equation in Model 3 has two significant variables including Q26NY and ENVPLAN in addition to the constant term. While none of the motivational factors are significant, CONSUMER is significant at the twelve percent level and has a positive coefficient, which is also consistent with the results in Model 2. Facilities that had an environmental inspection in 2004 take greater environmental actions than those facilities that had no environmental inspections. If a facility has adopted an EMP, that facility takes greater environmental actions. This result is expected and intuitive. Since the variable ENVPLAN is significant, the independent variables in equation one indirectly affect the level of environmental actions.

The final equation in Model 3 examines changes in environmental output by the facility. The coefficient on the constant is .5634 and is significant at the 1% significance level. The variables Q18, Q22A and Q22B are significant 1%, 5% and 5% levels respectively. Facilities that are owned by a parent company have reduced pollution and/or use of natural resources over the 2004 calendar year more than facilities that are not owned by a parent company. Facilities with publicly traded parent companies reduced their environmental output in 2004 by less than facilities that are neither publicly traded nor privately owned.

The variable ENVPLAN is significant at the 10% significance level in equation three of Model 3. The significance of this variable suggests that the variables in equations one indirectly affect ENVPERF. It also suggests that facilities that create and EMP reduced environmental output by more than facilities that do not have an EMP in place, which is an expected result. The variable ENVACTIO is significant at the 11% level. The surprising result is the coefficient of -.3879 on ENVACTIO. This suggests that facilities that take environmental actions have lower environmental output reduction levels than facilities that did not take environmental action over the 2004 calendar year. This result is not intuitive and goes against the expectations of this study. One explanation for the counter-intuitive result is that facilities have already taken environmental action and reduced environmental output before the 2004 calendar year. If they continue to take the same environmental action holding all else is equal, their level of environmental output stays constant. Even though they continue to take environmental action to stay at the reduced levels of environmental output, the level of change in environmental output is zero.

In order to test for robustness, multiple variations of the model are used. In these variations, variables are added and taken away from the original model. One additional version of Model 3 is reported in table 6.3.1. There is little change in significant variables among these models suggesting that the model is robust.

CHAPTER 7

Policy Analysis and Discussion

This chapter discusses policy implications of the regression analysis results. More specifically, we discuss how a policymaker can encourage voluntary over-compliance of environmental regulations. We then focus on how a policymaker can encourage a facility's environmental actions through EMP adoption. Finally, we examine how policymakers can encourage facilities to decrease pollution through environmental action and the development of an EMP.

7.1 Encouraging Voluntary Over-Compliance

Policy makers are attracted to voluntary policies as a tool for environmental management because of their potential low implementation costs. Model 1 in chapter 4 is developed to look firm's motivations to voluntarily over-comply with environmental regulations. The factors that are found to significantly affect over-compliance of environmental regulations are barriers to increasing the environmental friendliness of a facility's processes, products, and/or services and regulatory pressures from current and possible future environmental regulations. Government agencies have the ability to manipulate these motivations to encourage over-compliance of environmental regulations.

There are many barriers to increasing environmental friendliness in the production process, products, and/or services. This study focuses on eight barriers in four categories that appear in the survey. The first barrier category is costs, which are a barrier in the form of high upfront costs and high day-to-day costs. A second barrier is time as both significant upfront time commitment and the risk of downtime or interruptions during implementation. Employees can also be barriers if knowledgeable staff is not available and/or employees are not rewarded for any contribution to environmental performance. Unknown future benefits from creating an EMP can create a barrier to adopting an EMP. Facilities may choose not to adopt an EMP if contributions to environmental performance are not included in performance appraisals. One way an environmental policymaker can encourage over-compliance of environmental regulations is to remove some of these barriers.

High upfront investment expenses for increasing the environmentally friendliness of the facility's process, products, and/or services discourages over-compliance of environmental regulations. In order to remove this barrier, a policymaker can create an incentive for facilities to invest in environmentally friendly technology. Subsidies and tax breaks are two types of incentives that may encourage facilities to invest in environmentally friendly production equipment leading to over-compliance of environmental regulations.

To create obvious future benefits for increasing environmentally friendliness in the facility's processes, products, and/or services, policymakers can threaten the possibility of future environmental regulations. Since the facility will have to comply with more stringent regulations in the future, they may choose to over-comply in the present as long as other barriers do not prevent over-compliance. In addition, the policymaker can provide subsidies to facilities that purchase environmentally friendly equipment.

The staff at a facility can act as a barrier to increasing environmental friendly production practices if they are not knowledgeable on the subject or rewarded for contributing to environmental performance. One way for an environmental policymaker to remove this barrier to educate employees on environmental friendly practices. The policymaker can provide employees with educational literature on the subject or make classes available for employees. To avoid turning education into a high upfront cost barrier, the government agency may choose to provide the educational courses at little or no cost to the facility. Providing education to employees can remove the second employee barrier to increasing environmentally friendly production. Educating management staff about the benefits of environmentally friendly processes can encourage them to create rewards for employees who contribute to environmental performance.

The second significant motivational factor is regulatory pressure. The survey suggests five pressures that encourage environmental management. Pressure from current environmental regulations includes compliance with regulations, taking environmentally friendly actions to reduce regulatory inspections, and making it easier to get environmental permits. Future environmental pressures include being prepared to meet anticipated environmental regulations, preempting future regulations by voluntarily reducing regulated pollution beyond regulation levels, and preempting future regulations by reducing unregulated impacts. Policymakers can encourage over-compliance of current environmental regulations by manipulating these environmental motivational pressures.

The anticipation of future regulations can motivate facilities to over-comply with current regulations. Policymakers can use this motivation to their advantage by publicizing anticipated regulations well before they are enacted. This technique can be applied for both currently regulated and unregulated pollutants that are the subject of future environmental policy. The regulatory motivational pressure can be used by government policymakers to encourage over-compliance of environmental regulations.

7.2 Encouraging Environmental Action through the EMP Adoption

Since the degree of EMP adoption significantly affects the level of environmental action taken by the facility, policymakers can manipulate the motivational factors that significantly affect the EMP adoption in order to encourage facilities to take environmental action. The significant motivational factors influencing the degree of EMP adoption are competitive environmental management pressures, barriers to increasing the environmentally friendliness of process, products and/or services, the priority of investor desire to reduce environmental risks/liabilities or protect the facility's value in encouraging environmental management, and management beliefs on increasing environmental protection and performance. In addition to encourage the EMP adoption, the priority of current and future environmental regulations in encouraging environmental management and consumer influence on environmental management significantly affect the level of environmental action taken by the facility. Therefore policymakers can choose to manipulate regulatory and consumer pressures as well as the EMP adoption to encourage facilities to take environmental action.

Section 7.1 of this chapter discusses methods policymakers can use to reduce the barriers to increasing the environmentally friendliness of the process, products, and/or services. Environmental policymakers can create managerial pressure on a facility's decision to adopt an EMP through education. Providing managers with literature on the importance of environmentally friendly management may encourage them to increase their facility's degree of EMP adoption. In addition, policymakers can create classes to educate managers. Government agencies that provide classes to managers interested in environmental management techniques may increase the degree of EMP adoption at facilities, which will then affect the level of environmental action taken by the facility.

The presence of competitive pressure for environmental management increases the degree of EMP adoption at facilities. The influence of competition on environmental management can be used by government agencies to encourage EMP adoption by publicly recognizing those firms that adopt EMPs through labeling and other programs. With public recognition, a facility may gain competitive advantages by participating in an EMP, which will force its competition to adopt EMPs.

Investor pressure for environmental management increases a facility's degree of EMP adoption. Policymakers can target investor pressure for environmental management by increasing penalties for non-compliance of environmental regulations. This will increase the cost to a facility for taking environmental risks, which will increase investor and lenders' desire to reduce environmental risks and liabilities. Investor and lender desire to reduce environmental risks and liabilities makes up most of the investor pressure, so increasing their desire to decrease environmental risks and liabilities will create greater investor environmental management pressure. Raising penalties for environmental non-compliance can increase investor environmental pressure indirectly increasing the level of environmental action taken by a facility through the degree of EMP adoption.

The motivational variables that directly affect the level of environmental action taken by a facility are current and possible future environmental regulations and consumer pressure for environmental management. Policymakers may choose to target either motivational variables as well as the EMP adoption to increase the level of environmental action taken by a facility. Section 7.1 in this chapter discusses methods policymakers can use to increase the presence of the motivational factor REGULATO.

Policymakers can create consumer pressure by educating the public about the importance of buying products and/or services produced in an environmentally friendly manner. This can be accomplished by creating informative literature for consumers about environmentally friendly products. In order to make it easier for consumers to purchase products produced in an environmentally friendly manner, government agencies can encourage facilities to label products produced following specific environmental guidelines or standards. Policymakers could create labeling standards in order to make sure labeling is a reliable environmental purchasing guide for consumers. Another tool policymakers can use to create consumer pressure for facilities to adopt environmentally friendly practices is publishing environmental records. This would allow consumers access to a company's environmental records, which creates an incentive for facilities to behave in an environmentally friendly manner.

In order to directly or indirectly increase a facility's level of environmental action, policymakers can target six motivational factors. The motivational factors that directly encourage environmental action are the priority of current and future environmental regulation on environmental management and consumer influence on environmental management. The four motivational factors that indirectly encourage environmental action by increasing the degree of EMP adoption are competitive pressure on environmental management, barriers to increasing the environmentally friendliness of the process, products, and/or services, the priority of investor/lender desire to reduce environmental risks and protect/enhance facility value, and management beliefs on increasing environmental performance and protection. To be most effective, policymakers may choose to target multiple motivational factors at the same time. For example, a policymaker can target both management beliefs on increasing environmental performance/protection and barriers to increasing the environmentally friendliness of the process, products, and/or services by creating a two part educational program for managers that discusses the techniques to create an environmentally friendly processes, products, and/or services and the benefits of adoption. In addition to removing a barrier to environmental management adoption, educating managers about the importance of environmentally friendly production will encourage them to support environmental management at their facility.

7.3 Decreasing Pollution via Environmental Plans and Actions

Model 3 in chapter 6 of this study examines how adopting an EMP and taking environmentally friendly actions affect changes in environmental output. Since environmental policymakers are interested in reducing pollution and waste, the results from the regression analysis provide information for designing policies that encourage environmental performance. In order to analyze the effects EMP adoption and environmental action have on changes in environmental performance, we must first look at the motivational factors that encourage adoption of an EMP. The motivational factors and EMP adoption that affect the implementation of environmentally friendly actions will also be examined before exploring the effects of these variables on changes in environmental output.

Four motivational variables that significantly encourage EMP adoption are barrier pressure to increasing the environmentally friendliness of the process, products, and/or services, the priority of investor desire to reduce environmental risks/liabilities or enhance the facility's value in encouraging environmental management, the priority of current and future regulatory pressure in encouraging environmental management, and management beliefs on increasing environmental performance and process. Policies government agencies can create using the motivational factors barrier pressure to increasing the environmentally friendliness of the process, products, and/or services and the priority of current and future regulatory pressure in encouraging environmental management are discussed in section 7.1 of this chapter, while policies targeting the priority of investor desire to reduce environmental risks/liabilities or enhance the facility's value in encouraging environmental management and management beliefs on increasing environmental performance and process are discussed in section 7.2 of this chapter. Facilities that have an environmental management plan in place are significantly more likely to reduce their environmental output than those firms that do not. Techniques to encourage the adoption of an EMP are discussed above.

CHAPTER 8

Summary and Conclusion

This study develops theoretical and empirical models to analyze business decisions for voluntary environmental management in Oregon. The theoretical model analyzes the interaction of facility, parent company and industry level environmental decisions based on three major assumptions. First, facilities choose a parent company that will maximize their profits. Second, parent companies set their levels of emission reduction spending based on maximizing company welfare, and the company level of emission reduction spending dictates the required level of emission reductions for the facilities within the parent company. Third, an environmental authority for the industry creates a pollution standard dictating the necessary level of companies' emission reduction spending, which is chosen to maximize social welfare. The result is that a parent company will choose to increase emission reduction spending above the industry level when the number of facilities belonging to the parent company is greater than the ratio of marginal company benefits to marginal facility benefits. Under this condition, facilities will over-comply with industry level environmental regulations.

Three empirical models are estimated to examine facilities decisions for environmental management. The first empirical model is specified based on the theoretical model and examines facilities motivations to over-comply with environmental regulations. The model is estimated as both a probit and logit model. The second empirical model studies a facility's decision to take environmental action based on the degree environmental management plan (EMP) adoption. The recursive equations system is estimated simultaneously. The third empirical model examines the changes in environmental outputs based on the EMP adoption and environmental action taken by a facility. This model has three equations that are estimated simultaneously. The equations in both the second and third empirical models are estimated simultaneously using a three-stage least squares estimation technique and the data gathered between October 2005 and March 2006 through the Oregon Business Environmental Management Survey.

Results from Model 1 suggest that regulatory pressures from future and current environmental regulations and barriers to adopt environmental friendly process, products, and/or services are the most significant factors affecting facility's decision to over-comply with environmental regulations. Regulatory pressures are significant at the 1% level. The coefficient suggests that facilities facing high current and/or future regulatory pressures are significantly more likely to over-comply with environmental regulations than facilities facing no pressure from environmental regulations. The variable measuring the barriers to adopt environmental friendly process, products, and/or services is significant at the 5% significance level. Facilities facing the barriers are significantly less likely to over-comply with environmental standards than facilities that do not encounter the barriers. Though they are not statistically significant, four other motivational factors affect over-compliance as predicted by the theory. The four variables are competitive pressure for environmental management, management pressure to increase environmental performance or protection, consumer pressure on environmental management, and interest group pressure on environmental management.

Model 2 is a recursive equations system model with two equations that are estimated simultaneously. In the first equation we look at the affects of motivational pressures on the degree of EMP adoption. The second equation looks at the affects of EMP adoption and motivational factors on the level of environmental action taken by the facility. The motivational factors that significantly affect the degree of EMP adoption are competitive pressures, cost and other barriers, investor pressures, and management pressures. The significant motivational variables that affect the level of environmental action taken by the facility are regulatory pressures and consumer pressures. The adoption of EMPs also significantly affects environmental action, so the motivational factors affecting EMP adoption indirectly affect environmental action.

Model 3 is a simultaneous equations system with three equations. In addition to the EMP adoption and action equations, a third equation is added to the system to investigate the affect of EMP adoption and environmental actions on environmental performance. The results suggest that both the EMP adoption and environmental actions significantly affect the environmental performance, but the coefficient on the environmental action variable is negative. The affect of EMP adoption on environmental performance is consistent with theory. One possible explanation for the unexpected coefficient on the environmental action variable is that environmental actions taken in the past (2003) may have eliminated the opportunity to improve the current environmental performance.

The results of Model 1, Model 2 and Model 3 provide insight into the design of effective environmental policy. The variable Barriers is significant in deterring over-compliance in Model 1 and the degree of EMP adoption in both Model 2 and Model 3. Policymakers can create environmental policies targeting this motivational factor to reduce the barriers to environmental over-compliance and to the creation of an EMP. This can be accomplished through for example, subsidies or tax breaks for facilities that purchase equipments to make their production processes more environmentally friendly. Another option is to provide free training to facilities interested in increasing their environmental processes, products and/or services.

Regulatory pressure is significant in Model 1, Model 2, and Model 3 making it a target for environmental policy. One option available for policymakers is to publicize future regulations well in advance of enacting the policy. This will encourage facilities to comply with the proposed regulation before they are enacted, which will encourage facilities to create EMPs, take environmental actions, and decrease environmental impacts. This option is especially appealing because the cost to accomplish this may be low.

This study could be expanded in several directions. Due to the low response rate to question on the amounts of pollutants and wastes released by the facilities, percent changes in the environmental outputs are used to measure environmental improvements. The changes do not provide information on environmental outputs. This may limit the usefulness of the regression results in Model 3. The limitations of this study create many opportunities for future research.

Only specific questions contain the time frame for respondents. The limited use of time frames in questions especially those questions in the environmental practices section, is a limiting factor of this study. Both ENVPLAN and ENVACTIO do not contain information on the time of adoption or actions. As we discussed before, the regression results indicate that environmental action has a negative impact on environmental improvements. One explanation for this unexpected result is that the environmental action variable may reflect past actions taken by the facility, which may limit the opportunities to improve the current environmental performance.

The theoretical model applied to private industry in this study can be applied to other areas of research with environmental concerns. For example, it could be used to look at a company's decision to locate in a particular state within a nation. In this model, states compete for companies where an environmental policymaker in each state sets environmental standards for that state. In addition, an environmental policymaker selects a level of emission control for the nation, which is based on maximizing social welfare. The theoretical model developed in this study can be adapted to explain a state's decision to increase environmental standards above the national levels.

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Appendices

APPENDIX A

Equation e3.5

$$\frac{\partial n_1}{\partial k_j}+\frac{\partial n_2}{\partial k_j}+...+\frac{\partial n_j}{\partial k_j}+...+\frac{\partial n_J}{\partial k_j}=(C-1)\cdot\frac{\partial n_i}{\partial k_j}+1\cdot\frac{\partial n_j}{\partial k_j}=0 \qquad \text{(Ae3.1)}$$

$$\frac{\partial \pi}{\partial k_j}=P'\frac{\partial n_i}{\partial k_j} \text{ for } n_i \qquad \text{(Ae3.2)}$$

$$\frac{\partial \pi}{\partial k_j}=P'\frac{\partial n_j}{\partial k_j}-1 \text{ for } n_j \qquad \text{(Ae3.3)}$$

$$\frac{\partial n_i}{\partial k_j}=\frac{1}{P'}\cdot\frac{\partial \pi}{\partial k_j} \qquad \text{(Ae3.2a)}$$

$$\frac{\partial n_j}{dk_j}=\frac{1}{P'}\cdot\left(1+\frac{\partial \pi}{\partial k_k}\right) \qquad \text{(Ae3.3a)}$$

To find $\frac{\partial \pi}{\partial k_j}$, we will use equations Ae3.1, Ae3.2a and Ae3.3a:

$$(C-1)\cdot\frac{1}{P'}\cdot\frac{\partial \pi}{\partial k_j}+1\cdot\frac{1}{P'}\cdot\left(1+\frac{\partial \pi}{\partial k_j}\right)=0$$

$$(C-1)\cdot\frac{\partial \pi}{\partial k_j}+\left(1+\frac{\partial \pi}{\partial k_j}\right)=0$$

$$C\cdot\frac{\partial \pi}{\partial k_j}-\frac{\partial \pi}{\partial k_j}+1+\frac{\partial \pi}{\partial k_j}=0$$

$$C\cdot\frac{\partial \pi}{\partial k_j}+1=0$$

$$\frac{\partial \pi}{\partial k_j}=\frac{-1}{C}=-s \qquad \text{(e3.3)}$$

To find $\frac{\partial n_j}{\partial k_j}$, we will use equations e3.3 and Ae3.2a:

$$\frac{\partial n_j}{\partial k_j} = \frac{1}{P'} \cdot \left(1 - \frac{1}{J}\right)$$

$$\frac{\partial n_j}{\partial k_j} = \frac{(C-1)}{CP'} = \frac{(1-s)}{P'} \qquad \text{(e3.4)}$$

To find $\frac{\partial n_i}{\partial k_j}$, we will use equations e3.3 and Ae3.3a:

$$\frac{\partial n_i}{\partial k_j} = \frac{1}{P'} \cdot \frac{\partial \pi}{\partial k_j}$$

$$\frac{\partial n_i}{\partial k_j} = \frac{1}{P'} \cdot \frac{-1}{C}$$

$$\frac{\partial n_i}{\partial k_j} = \frac{-s}{P'} \qquad \text{(e3.5)}$$

APPENDIX B

Equation e3.9

To find equation e3.9 we will use the social optimum values found from equation e3.6, and equations e3.8, e3.3, and e3.4.

$$B'\left(\frac{\partial n_j}{\partial k_j}\right)-e'\left[-n_j+(1-k_j)\cdot\frac{\partial n_j}{\partial k_j}\right]+\frac{\partial n_j}{\partial k_j}\cdot\pi+n_j\cdot\frac{\partial \pi}{\partial k_j} \qquad \text{(e3.8)}$$

$$B'\left(\frac{1-s}{P'}\right)-\left[-sN+(1-k^*)\cdot\left(\frac{1-s}{P'}\right)\right]+\left(\frac{1-s}{P'}\right)\cdot\pi-s^2N$$

$$\frac{B'(1-s)}{P'}+sN-\frac{(1-k^*)(1-s)}{P'}+\left(\frac{1-s}{P'}\right)\cdot\pi-s^2N$$

$$(1-s)\frac{B'}{P'}+(1-s)\frac{(-1+k^*)}{P'}+(1-s)\cdot\frac{\pi}{P'}+(1-s)sN$$

$$(1-s)\left[\frac{B'+k^*-1+\pi}{P'}+sN\right]$$

$$(1-s)\left[\frac{B'(sN)-1+P(sN)}{P'(sN)}+sN\right] \qquad \text{(e3.9)}$$

APPENDIX C

Oregon Business Environmental Management Survey Accommodations

Section I. Facility Environmental Management

Q1. Are environmental issues a significant concern for your facility?

A facility is typically a single physical location at the address where this survey was received or the location designated on the cover.

1 No **Skip to Question 3**

2 Yes

Q2. If yes, please list one or two of the most significant environmental concerns for your facility.

Q3. Please indicate the extent each of the following factors has influenced environmental management at your facility in the last 5 years. *(Please check only ONE box for each factor.)*

	No Influence				**Great Influence**	**Do Not Know**
	1	**2**	**3**	**4**	**5**	**D**
a. Customer desire for environmentally friendly products and services	1	2	3	4	5	D
b. Customer willingness to pay higher prices for environmentally friendly products/services....	1	2	3	4	5	D
c. Ability to earn public recognition and customer goodwill with environmentally friendly actions ..	1	2	3	4	5	D
d. Environmental interest groups' perception that environmental protection is a critical issue	1	2	3	4	5	D
e. Preventing boycotts or other adverse actions by environmental interest groups	1	2	3	4	5	D
f. Promoting an environmentally friendly image to environmental interest groups..........................	1	2	3	4	5	D

Q4. For your facility, please indicate the priority of each of the following factors in encouraging environmental management in the last 5 years. *(Please check only ONE box for each factor).*

	No Priority 1	2	3	4	Great Priority 5	Do Not Know D
a. Satisfying **investor (owner)** desires to reduce environmental risks and liabilities........................	1	2	3	4	5	D
b. Protecting or enhancing the value of the facility or parent firm for **investors (owners)**.................	1	2	3	4	5	D
c. Satisfying **lenders'** desires to reduce environmental risks and liabilities........................	1	2	3	4	5	D
d. Complying with current government environmental regulations..................................	1	2	3	4	5	D
e. Taking environmentally friendly actions to reduce regulatory inspections and make it easier to get environmental permits	1	2	3	4	5	D
f. Being better prepared for meeting anticipated environmental regulations	1	2	3	4	5	D
g. Preempting future environmental regulations by voluntarily reducing **regulated** pollution beyond compliance levels (for example, air particulate emissions)	1	2	3	4	5	D
h. Preempting future environmental regulations by voluntarily reducing **unregulated** impacts (for example, carbon dioxide)	1	2	3	4	5	D

Q5. Please indicate the extent that each of the following factors has influenced environmental management at your facility in the last 5 years. *(Please check only ONE box for each factor.)*

	No Influence 1	2	3	4	Great Influence 5	Do Not Know D
a. Investing in cleaner products and services differentiates our products or our facility............	1	2	3	4	5	D
b. Improving environmental performance helps us keep up with competitors.	1	2	3	4	5	D
c. Environmentally friendly actions result in product or process innovations............................	1	2	3	4	5	D
d. Environmentally friendly actions can reduce costs	1	2	3	4	5	D
e. Being environmentally responsible attracts quality employees and reduces employee turnover..........	1	2	3	4	5	D
f. Being environmentally responsible improves employee morale, motivation and productivity....	1	2	3	4	5	D

Q6. Please indicate the percentage of your facility's annual revenue spent on environmental management (for example, energy and water conservation, recycling, pollution reduction, compliance inspections, audits,etc.) **for the 2003 and 2004 calendar years.** *(Please check only ONE box for each year.)*

	Less than 1%	1% up to 2%	2% up to 3%	3% up to 5%	5% up to 10%	10% up to 20%	More than 20%
2004 Calendar Year	1	2	3	4	5	6	7
2003 Calendar Year	1	2	3	4	5	6	7

Q7. For your facility, please indicate the extent of your agreement or disagreement with the following statements. *(Please check only ONE box for each statement.)*

	Strongly Disagree 1	2	3	4	Strongly Agree 5	Do Not Know D
a. Facility upper management believes it has a moral responsibility to protect the environment.	1	2	3	4	5	D
b. Facility upper management supports protecting the environment even if substantial costs are incurred	1	2	3	4	5	D
c. Facility upper management believes that improvements in environmental performance will improve long-term financial performance.	1	2	3	4	5	D
d. Facility upper management believes that customers and other stakeholders care about the environmental impacts of its products..................	1	2	3	4	5	D
e. Facility upper management believes that advances in technology can solve environmental problems while increasing profits at the same time....................	1	2	3	4	5	D
f. Facility upper management believes that the facility should help conserve society's limited natural resources	1	2	3	4	5	D

Q8. For your facility, please indicate the extent to which the following factors are barriers to increasing the environmental friendliness of your processes, products, and/or services. *(Please check only ONE box for each factor.)*

	No Barrier 1	2	3	4	Large Barrier 5	Do Not Know D
a. High upfront investment expense	1	2	3	4	5	D
b. Availability of knowledgeable staff	1	2	3	4	5	D
c. High day-to-day costs......................................	1	2	3	4	5	D

d. Significant upfront time commitment	1	2	3	4	5	D
e. Uncertain future benefits.	1	2	3	4	5	D
f. Risk of downtime or delivery interruptions during implementation	1	2	3	4	5	D
g. Contributions to environmental performance are not included in performance appraisals............	1	2	3	4	5	D
h. Employees are not rewarded for contributions to environmental performance	1	2	3	4	5	D

Section II. Facility Environmental Practices

Q9. Please indicate the types of employee involvement in environmental management at your facility. *(Check ALL types that apply.)*

A. Dedicated environmental staff (For example, environmental, health, and safety managers, compliance specialists, etc.) _________ **Total** number of full time equivalents (FTEs) in dedicated environmental positions (Count an employee who works half time on environmental management as 0.50 FTE, etc.)

B. Other staff with official environmental responsibilities (For example, production managers with official responsibility for environmental audits)

C. Staff who participate in environmental management on a voluntary basis (For example, employees who volunteer for environmental audits)

D. Environmental management is the responsibility of all employees

E. Other ____

Q10. Who is primarily responsible for the majority of environmental decisions, including which environmental practices to implement, at your facility? *(Please check only ONE box.)*

1 Owner

2 President or CEO

3 Vice President **Title or Area of responsibility:**

4 Director **Title or Area of responsibility:**

5 Executive Committee

6 Plant Manager/Facility Manager

7 Environmental Heath and Safety Manager

8 Other Environmental Manager (compliance, sustainability, etc.)

Title or Area of responsibility:

9 Other *(Please specify)*

Q11. For your facility, please indicate whether or not the following environmentally friendly practices have been implemented, and if yes, the year of implementation. *(Please check only ONE box for each practice.)*

	No	Yes	Year Implemented
a. Well-defined environmental goals	1	2	______________
b. Documented environmental policy	1	2	______________
c. Green purchasing policy	1	2	______________
d. Environmental standards for suppliers	1	2	______________
e. Environmental audits at regular intervals	1	2	______________
f. Internal environmental standards	1	2	______________
g. Cost accounting to identify environmental problems and costs	1	2	______________
h. Periodic publishing of environmental information in reports made available to the public	1	2	______________
i. Environmental training for employees	1	2	______________
j. Compensation to employees for their contributions to environmental performance	1	2	______________
k. ISO 14001 certification	1	2	______________

Q12. For your facility, please indicate the extent of your agreement or disagreement with the following statements. *(Please check only ONE box for each statement.)*

Strongly Disagree				Strongly Agree	Do Not Know
1	**2**	**3**	**4**	**5**	**D**

a. Our environmental goals guide operational decisions	1	2	3	4	5	D
b. Environmental responsibility is emphasized through well-defined environmental policies and procedures	1	2	3	4	5	D
c. Our environmental standards are more stringent than mandatory requirements	1	2	3	4	5	D
d. We conduct environmental audits for our own performance goals, not just for compliance	1	2	3	4	5	D
e. Employees receive incentives for contributions to environmental performance	1	2	3	4	5	D
f. We use environmental cost accounting	1	2	3	4	5	D
g. We make continuous efforts to minimize environmental impacts	1	2	3	4	5	D
h. We require our suppliers to pursue environmentally friendly practices	1	2	3	4	5	D
i. Employees are conscious of the importance of minimizing negative environmental impacts	1	2	3	4	5	D
j. An adequate amount of training in environmental management is provided to all employees	1	2	3	4	5	D
k. Facility environmental achievements are given prominent coverage in facility annual reports	1	2	3	4	5	D

Q13. Does your facility participate in any voluntary programs designed to improve environmental performance or construct projects according to voluntary environmental standards? *(For example, ECOTEL ® Certification, Green Globe, the Oregon Natural Step Network, ENERGY STAR ® for Hotels, WasteWise, etc.)*

1 No

2 Yes **Which programs:**

Q14. For your facility, please indicate to what extent you agree or disagree with the following statements. *(Please check only ONE box for each statement.)*

	Strongly Disagree 1	2	3	4	Strongly Agree 5	Do Not Know D
a. Pollution prevention is emphasized to improve environmental performance	1	2	3	4	5	D
b. Efforts have been made to reduce spills and leaks of environmental contaminants	1	2	3	4	5	D
c. We choose raw materials that minimize environmental impacts	1	2	3	4	5	D
d. We have modified our production systems to reduce waste and environmental impacts	1	2	3	4	5	D
e. We have modified our products to reduce environmental damage during production, consumption, and disposal.	1	2	3	4	5	D
f. We have increased recycling and reduced landfilling of our solid waste	1	2	3	4	5	D

Section III. Facility Environmental Performance

Q15. For your facility, please indicate the level of compliance with regulatory standards for any of the following that were regulated by a government agency during the 2004 calendar year. *(Please check only ONE box for each standard.)*

	Working Towards Meeting Regulation 1	Meet Regulatory Standards 2	Do More than Regulation Requires 3	Not Regulated at your Facility 4
a. Water pollution	1	2	3	4
b. Solid waste	1	2	3	4
c. Hazardous/toxic wastes	1	2	3	4

d. Volatile organic compounds (VOCs)	1	2	3	4
e. Other..	1	2	3	4
(Please specify)				

Q16. Please indicate the approximate amount of each of the following over the 2004 calendar year for your facility.

	Amount
a. Waste water discharged..	________Million Gallons
b. Solid waste landfilled	________Tons
c. Hazardous/toxic wastes generated..................................	________Tons
d. Volatile organic compounds (VOCs)	________Tons
e. Carbon dioxide emitted	________Tons
f. Percentage of recyclable waste that was recycled	________Percent
g. Electricity use	________Kilowatts
h. Natural gas use	________Therms (100,000 Btus)

Q17. For your facility, please indicate the extent to which the following measures of environmental performance have changed over the 2004 calendar year. *(Please check only ONE box for each measure.)*

	Increased Greatly (> 10%) **1**	Increased Moderately (4 to 10%) **2**	Increased Slightly (1 to 3%) **3**	No Change (0) **4**	Decreased Slightly (-1 to -3%) **5**	Decreased Moderately (-4 to - 10%) **6**	Decreased Greatly (<-10%) **7**	Do Not Know **D**
a. Waste water discharged......................	1	2	3	4	5	6	7	D
b. Solid waste landfilled	1	2	3	4	5	6	7	D
c. Hazardous/toxic wastes generated	1	2	3	4	5	6	7	D
d. Volatile organic compounds (VOCs)...	1	2	3	4	5	6	7	D
e. Carbon dioxide emitted	1	2	3	4	5	6	7	D
f. Recycling of recyclable waste	1	2	3	4	5	6	7	D
g. Electricity use..................................	1	2	3	4	5	6	7	D

i. Natural gas use.............................. 1 2 3 4 5 6 7 D

Comments:

Section IV. General Information

Q18. Is your facility owned by a parent company?

1 No **Skip to Question 21**

2 Yes

Q19. If yes to Q18, what is the name of the parent company, and where is it located?

Q20. If yes to Q18, please mark the extent of your agreement or disagreement with the following statements. *(Please check only ONE box for each statement.)*

	Strongly Disagree 1	2	3	4	Strongly Agree 5	Do Not Know D
a. The parent company strongly encourages facility participation in voluntary environmental programs.. ..	1	2	3	4	5	D
b. The parent company provides incentives and assistance for environmentally friendly practices and technologies..............	1	2	3	4	5	D
c. The parent company has an environmental policy/standard that applies to all facilities..	1	2	3	4	5	D
d. The parent company allows facilities to make environmental investments needed to go beyond compliance	1	2	3	4	5	D

Q21. Is your facility (or parent company) a multi-national corporation?

1 No

2 Yes

Q22. Is your facility (or parent company) publicly traded or privately owned?

(Please check only ONE box.)

1 Publicly traded

2 Privately owned

3 Other *(please specify)*

Q23. Does your facility or parent company have its own Research & Development department? *(Please check ALL that apply.)*

A. Yes, facility has a Research & Development department.

B. Yes, parent company has Research & Development department.

C. No, neither facility nor parent company has Research and Development department.

Q24. Does your facility primarily produce a good/service sold directly to customers in retail markets?

1 No

2 Yes

Q25. Approximately how many close competitors does your facility have?

Number of close competitors

Q26. How many times was your facility inspected by an environmental agency during 2004?

Number of times facility inspected in 2004

Q27. How many penalties, third-party lawsuits or other sanctions for environmental management did your
facility have during 2004?

Number of environmental penalties, other sanctions or third party lawsuits in 2004

Q28. What were the estimated annual total revenues of your facility during the

2004 calendar year?

(In million $)

Q29. What is the average age of facility upper management personnel (senior managers/directors and above)? *(Please check only ONE box.)*

1 20-30 years old

2 31-40 years old

3 41-50 years old

4 51-60 years old

5 Over 61 years old

Q30. We have asked you about a wide range of potential influences on environmental management at your facility. Considering both motivations and barriers, please list the three most important influences on your facility in descending order of importance.

1.

2.

3.

Q31. No single questionnaire can adequately cover all points relevant to environmental management by diverse Oregon firms. We welcome any additional comments, or elaboration on the answers to any of the questions. *(Please note the question number if appropriate.)*

Q32. If anyone else contributed to completing the survey, please list their positions/titles:

Q33. Finally, please let us know if you would like to see a report of the study findings.

1 Yes, please email the website for the report.

Email address:

2 Yes, please send a hard copy.

Address (if different from the address this survey was sent to):

3 No, thanks.

Thank you very much for completing the survey!

Please return your completed questionnaire to:

Social & Economic Sciences Research Center

Washington State University

PO Box 641801

Pullman, WA 99164-1801