FINANCIAL PERFORMANCE, PRODUCTION COSTS, TRANSACTION COSTS, CAPABILITIES AND THE ADOPTION OF ENVIRONMENTAL SUSTAINABILITY PRACTICES

by

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DEDICATION

To my loving, supportive and patient wife.
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ABSTRACT

FINANCIAL PERFORMANCE, PRODUCTION COSTS, TRANSACTION COSTS, CAPABILITIES AND THE ADOPTION OF ENVIRONMENTAL SUSTAINABILITY PRACTICES

Brent C. Kurapatskie, Ph.D.
George Mason University, 2012
Dissertation Advisor: Dr. Nicole Darnall

Since the 1990s, scholars and business managers have devoted significant attention towards determining whether firms’ environmental sustainability practices (ESPs) are related to profitability (Klassen & McLaughin, 1996; Konar & Cohen, 1997; Laplante & Lanoie, 1994; Lanoie, Laplante & Roy, 1998; Russo & Fouts, 1997; Sharma & Vredenburg, 1998). These studies have shown that ESPs can improve internal efficiencies and drive down operating costs (Hart & Ahuja, 1996; Shrivastava, 1995), gain first mover advantage (Nehrt, 1996), and expand market prospects through innovation (Hart & Milstein, 1999). When taken together, ESPs can create enhanced pathways for competitive advantage (Hart, 1995; Hart & Milstein, 2003). As a consequence, there many are compelling reasons for firms to adopt ESPs.

However, there are at least three gaps in the research literature examining the relationship between firms’ ESPs and profitability. First, we know little about which
types of ESPs are associated with varying degrees of financial gain. Such knowledge is important to business managers since they are more likely to adopt specific sustainability activities if they are to be associated with greater financial advantages (Margolis & Walsh, 2003).

A second research gap relates to the fact that in spite of the benefits associated with adopting ESPs, many facilities forgo implementation due to costs (Nordhaus, 1992; Walley & Whitehead, 1994). Facilities adopting ESPs are expected to incur two types of costs: production costs and transaction costs (Alchain & Demsetz, 1972; Langlois & Foss, 1999; Walker & Weber, 1984; Williamson, 1979). As such, firms that face high costs when adopting ESPs are less likely to follow through. However, as of yet, this relationship has not been assessed empirically. Moreover, we have little understanding about how different types of costs relate to ESP adoption.

The third gap in the literature relates to the fact that we have little understanding of the moderating role that capabilities have on the relationship between business’ perceived economic cost savings and ESP adoption. Conventional literature suggests that costs will limit firms’ adoption of ESPs (Nordhaus, 1992; Rienhardt, 1999; Walley & Whitehead, 1994). However, prior research has shown firms’ capabilities can facilitate the adoption of ESPs by lowering costs (Hart, 1995; Hart & Ahuja, 1996; Sharma & Vredenberg, 1998). For instance, businesses that have previously adopted quality management systems are more likely to adopt sustainability practices such as environmental management systems, since both systems require similar knowledge, cross-functional communication and other tacit capabilities (Hersey, 1998; Scrimshire,
I posit that capabilities positively moderate the relationship between business’ perceived economic cost savings and ESP adoption, such that in their presence businesses may choose to adopt ESPs regardless of high costs.

I address each of these concerns in three essays. In the first essay, I examined which types of ESPs are associated with varying degrees of financial gain. This paper assessed the economic relationship between two types of ESPs—lower- and higher-order—derived from Hart & Milstein’s (2003) sustainability value framework using data as reported by 48 firms on the Dow Jones’ Sustainability Indexes (DJSI). My results suggest that both types of ESPs are associated with firms’ financial performance. However, the financial benefits associated with firms’ higher-order ESPs exceed the financial benefits related to firms’ lower-order ESPs. These findings offer an important initial piece of information to managers about the conditions in which it pays for firms to be green. Moreover, they represent some of the first empirical findings suggesting that the various ESPs specified by Hart & Milstein (2003) are related to firm financials in different ways.

In the second essay, I examined the relationship between production costs, transaction costs and ESP adoption using survey data from 65 U.S. manufacturing facilities. The data contain detailed information about the direct relationship between facilities’ adoption of ESPs and the production costs and transaction costs they accrued along the way. To examine this relationship I used a negative binomial regression analysis. The results of my analysis reveal that production and transaction costs are associated with facilities’ ESP adoption in that they follow a similar direction and trend.
However, anticipated production costs are more closely associated with ESP adoption than higher anticipated transaction costs.

In the third essay, I examined the moderating effect of capabilities on the relationship between perceived economic cost savings and ESP adoption. These relationships were examined using bivariate probit analysis and survey data for 4,013 manufacturing facilities operating in Canada, France, Germany, Hungary, Japan, Norway and the U.S. The results of my analysis indicate that complementary capabilities moderate the relationship between perceived economic costs and facilities’ ESP adoption even after controlling for self-selection effects related to ESP adoption decisions.

This research informs management strategy by expanding on accepted views about the relationship between green strategy and business performance. It offers evidence about which different types of ESPs are more closely related to those payoffs. By exploring how production costs and transaction costs are related to business’ green strategy, this study will offer a more in-depth and nuanced view of how anticipated costs are related to business’ implementation of ESPs. Additionally, this research offers evidence of the moderating effect of complementary capabilities on perceived economic cost savings, such that facilities may still choose to adopt ESPs even if doing so is costly. Combined, this research offers inferences for why businesses might forgo the adoption of green strategies, even though implementation of these strategies might benefit them financially.
CHAPTER ONE - INTRODUCTION

Since the 1990s, scholars and business managers have devoted significant attention towards determining whether firms’ environmental sustainability practices (ESPs) are related to profitability (Klassen & McLaughin, 1996; Konar & Cohen, 1997; Laplante & Lanoie, 1994; Lanoie, Laplante & Roy, 1998; Russo & Fouts, 1997; Sharma & Vredenburg, 1998). These studies have shown that ESPs can improve internal efficiencies and drive down operating costs (Hart & Ahuja, 1996; Shrivastava, 1995), gain first mover advantage (Nehrt, 1996), and expand market prospects through innovation (Hart & Milstein, 1999). When taken together, ESPs can create enhanced pathways for competitive advantage (Hart, 1995; Hart & Milstein, 2003). As a consequence, there many are compelling reasons for firms to adopt ESPs.

However, there are at least three gaps in the research literature examining the relationship between firms’ ESPs and profitability. First, we know little about which types of ESPs are associated with varying degrees of financial gain. Such knowledge is important to business managers since they are more likely to adopt specific sustainability activities if they are to be associated with greater financial advantages (Margolis & Walsh, 2003).

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I will address each of these concerns in three essays. In the first essay, I will examine which types of ESPs are associated with varying degrees of financial gain. This paper will assess the economic relationship between two types of ESPs—lower- and
higher-order—derived from Hart & Milstein’s (2003) sustainability value framework using data as reported by 48 firms on the Dow Jones’ Sustainability Indexes (DJSI). I will attempt to identify which types of ESPs are associated with firms’ financial performance in terms of direction and trend.

In the second essay, I will examine the relationship between production costs, transaction costs and ESP adoption using survey data from 65 U.S. manufacturing facilities. The data contain detailed information about the direct relationship between facilities’ ESP adoption and the production and transaction costs they accrued along the way. Using a negative binomial regression model, I will attempt to identify whether production costs or transaction costs are more likely to influence (and deter) ESP adoption by facilities.

In the third essay, I will examine the moderating effect of capabilities on the relationship between perceived economic cost savings and ESP adoption. To examine these relationships, I will use a bivariate probit analysis and survey data for 4,013 manufacturing facilities operating in Canada, France, Germany, Hungary, Japan, Norway and the U.S.

This research is anticipated to inform management strategy by expanding on accepted views about the relationship between green strategy and business performance. It will offer evidence about which different types of ESPs are more closely related to those payoffs. By exploring how production costs and transaction costs are related to business’ green strategy, and the moderating influence of capabilities, these studies will offer a more in-depth and nuanced view of how costs are related to business’
implementation of ESPs. Combined, this research offers inferences for why businesses might forgo the adoption of green strategies, even though implementation of these strategies might benefit them financially.
CHAPTER TWO - WHICH CORPORATE SUSTAINABILITY ACTIVITIES ARE ASSOCIATED WITH GREATER FINANCIAL PAYOFFS?¹

Since the 1990s, scholars and business managers have devoted significant attention towards determining whether firms’ proactive environmental sustainability practices (ESPs) are related to profitability (e.g. Darnall, 2009; Darnall, Jolley, & Ytterhus, 2007; Hart & Ahuja, 1996; Klassen & McLaughin, 1996; Lanoie, et. al., 1998; Laplante & Lanoie, 1994; Russo & Fouts, 1997; Stanwick & Stanwick, 2000). Following the general framework developed by Hart & Milstein (2003), these ESPs can be classified into four broad categories: pollution prevention, product stewardship, clean technology and community focus. I refer to pollution prevention and product stewardship as lower-ordered ESPs because Hart & Milstein (2003) suggest that both activities focus on developing incremental environmentally friendly process improvements for existing products and markets. By contrast, I consider clean technology and community focus to be higher-order ESPs because Hart & Milstein (2003) note that both activities emphasize creating radically innovative green process improvements that lead to new products and novel market opportunities.

While prior studies assessing the link between firms’ environmental and financial performance are well established, we know far less about what sorts of sustainability activities are associated with greater financial gain. Additionally, while the different

¹ This is a preprint of an article to appear in Business Strategy and the Environment©, 2012.
ESPs specified in Hart & Milstein’s (2003) framework are widely recognized, we lack empirical evidence regarding the extent to which lower- or higher-order sustainability activities are associated with firms’ bottom lines. Such knowledge is important to scholarly literature, but also to business managers since managers are more likely to adopt specific sustainability activities if they are to be associated with greater financial advantages (Margolis & Walsh, 2003).

This paper investigates the economic returns associated with the two types of ESPs derived from Hart & Milstein’s (2003) framework. It examines which of these ESPs are correlated more strongly with firms’ financial payoffs and whether there is a difference in the average level of financial benefits associated with both. My results suggest that both types of ESPs are associated with firms’ financial performance. However, the financial benefits associated with firms’ higher-order ESPs exceed the financial benefits related to firms’ lower-order ESPs. These findings offer an important initial piece of information to managers about the conditions in which it pays for firms to be green. Moreover, they represent some of the first empirical findings suggesting that the various ESPs specified by Hart & Milstein (2003) are related to firm financials in different ways.

Environmental Sustainability Practices and Firm Performance

Sustainability is defined as the ability of the current generation to meet its needs without compromising the ability of future generations to meet their own needs (WCED, 1987). Related to the firm, corporate sustainability is a business’s capacity to reduce or eliminate its impact to the natural environment (Hart, 1995) while satisfying the needs of
its existing (Delmas & Toffell, 2004) and future stakeholders (e.g., shareholders, employees, community groups, environmental nonprofits) (Dyllick & Hockerts, 2002). Companies can address stakeholder concerns by adopting a variety of environmental sustainability practices. An ESP is a project, program, or initiative that is designed to meet stakeholder-related goals, and is integrated into day-to-day management decisions. Implementing these practices allows firms to effectively address shareholder pressures to increase short-term earnings because economic activities are not sacrificed. However, firms that adopt ESPs also attend to needs of existing and future stakeholders because they simultaneously protect the environment and social integrity (Epstein, 2008).

Hart and Milstein (2003) developed an organizing framework that rationalizes many corporate ESPs in a business-oriented way by examining the strategic approaches firms could take to be more competitive. These authors suggest that firms’ ESPs can be categorized based on whether they involve pollution prevention, product stewardship, clean technology or a community focus. Firms that implement activities in each of the four broad categories of sustainability can create shareholder value through positive financial performance (Hart & Milstein, 2003).

I elaborate on this general framework by considering firms day-to-day management decisions. This distinction is subtle, but important since competitive firms acting strategically should not be reacting on a day-to-day basis to stakeholder whims. I refer to pollution prevention and product stewardship as lower-order ESPs, and suggest that clean technology and community focus are higher-order ESPs. I discuss these issues and their relationship with firms’ financial performance below.
Lower-order Environmental Sustainability Practices

Lower-order ESPs focus on improving the sustainability of companies’ existing products and processes. These practices do so by encouraging the company’s employees and managers to engage in pollution prevention. Pollution prevention involves the reduction or elimination of pollution at the source (source reduction) instead of at the end-of-the-pipe or stack (Hart & Milstein, 2003). It occurs when raw materials, water, energy, and other resources are used more efficiently, when less harmful substances are substituted for hazardous ones, and when toxic substances are eliminated from the production process (Nehrt, 1996). Firms often implement pollution prevention as an initial ESP since it is believed to create cost savings faster than other types of sustainability activities (Christmann, 2000; Kabongo & Boiral, 2011).

For instance, by switching from solvent-based coatings to water-based coatings a company can improve the environment but also eliminate having to meet environmental approvals. As a consequence, this modification can speed up the time in which it takes to get a firm’s product to market. Additionally, it reduces the firm’s long-term liabilities related to hazardous waste disposal. However, pollution prevention can also reduce a firm’s non-regulated environmental impacts and save money. Minnesota Mining and Minerals’ (3M) energy conservation program is one example. Beginning in the year 2000, 3M challenged 150 company sites to reduce their annual energy consumption by 4 percent. The result for 3M has been a savings of more than $190 million (Darnall, 2008).

Undertaking pollution prevention can reduce a company’s long-term legal obligation to clean up contamination of air, soil, or water due to the intentional and unintentional discharge of harmful substances. For companies that avoid creating
pollution, many environmental regulations are no longer relevant to them. To the extent that companies can reduce their environmental impacts below regulatory thresholds and maintain them, they may no longer need to apply for costly operating permits or undergo expensive monitoring and reporting of specific environmental activities (Porter & van der Linde, 1995). Additionally, these companies can reduce the monetary and reputation risks associated with emission violations or the legal implications of non-compliance (Hart & Milstein, 2003).

In some instances, companies may accrue a net financial gain from their pollution prevention activities. For instance, when Leff-Marvin’s Cleaners, Inc., of Pittsburgh, Pennsylvania, replaced its old dry-cleaning equipment with new cold-water-chilled closed-loop systems that recycle perchloroethylene (PERC), it no longer had to apply for a state environmental permit. The company’s new equipment eliminated most of its regulated emissions and reduced its use of PERC from 200 gallons per month to 40 gallons per month (U.S. Environmental Protection Agency, 2011). Leff-Marvin’s realized a net savings and now has one less regulatory requirement, which also frees dedicated resources that would otherwise be allocated towards completing an additional environmental permit (U.S. Environmental Protection Agency, 2011).

Other lower-order ESPs engage external stakeholders in a way that encourage firms to look beyond their operational boundaries to individuals and organizations who are involved in the life cycle of their existing products or processes. For instance, in developing 3M’s product stewardship program, its Valley, Nebraska facility recognized an opportunity to reduce its supplier waste. By working with its supplier, shipments now
incorporate reusable packaging. The modification has reduced shipping waste at this single 3M facility by eight tons in the first year (Minnesota Mining and Minerals, 2008).

By engaging external stakeholders, lower-order ESPs also can assist firms by avoiding the inheritance of environmental risks from less environmentally conscious suppliers. The global automotive industry is an example of one sector that is collectively considering the environmental attributes of its suppliers to avoid unnecessary environmental risks (Klassen & Whybark, 1999). U.S. automakers require that their suppliers assess and continually improve their environmental performance. By reducing the risk of inheriting environmental problems, these companies are minimizing potential long-term environmental liabilities associated with their product inputs (Darnall, Jolley & Handfield, 2008).

**Higher-order Environmental Sustainability Practices**

Higher-order ESPs differ significantly from lower-order ESPs. Whereas lower-order ESPs lead to continuous incremental improvements in existing products, higher-order ESPs foster radical changes that are designed to unseat existing products and processes (Hart & Milstein, 2003) by developing products and processes for new markets. Such markets are characterized by their rapid pace of development (Hoskisson et. al., 2000), and are not well defined in terms of industry norms for production or customer preferences. Consequently, innovative firms can respond through a variety of novel product or equipment designs (Clark, 1985).

Companies that adopt higher-order ESPs embrace business models that disregard widely accepted industry routines and knowledge (Young & Tilley, 2006). They also
invest in innovative clean technologies in an effort to preempt competitors, and, in some instances, restructure their industry. For instance, when developing its hybrid locomotive technology, General Electric (GE) aspired to do for the locomotive transportation market what Toyota did for the automobile market. By establishing itself as an early market entrant in hybrid locomotive technology, GE hoped to preempt its competitors and confirm itself as a market leader in this area (General Electric, 2007).

Such efforts often require that companies have strong relationships with their employees and managers in addition to their supply chain in order to discover innovative solutions that render existing products and processes obsolete. They also build partnerships with external nontraditional stakeholders such as environmental groups, consumer groups, and other companies, to acquire new competencies, knowledge, and vision (London, Rondinelli & O’Neill, 2005). For example, Kraft Foods Inc. has partnered with the Rainforest Alliance and small coffee farmers in Central and South America to help train farmers in sustainable coffee production while paying them a fair wage. These efforts have benefited Kraft by securing a reliable source for 13 million pounds of sustainably grown coffee (Rainforest Alliance, 2006). Doing so has enabled the company to penetrate the burgeoning market for fair trade coffee. At the same time, the partnership has also enhanced the economic stability of rural farmers and improved their knowledge and use of sustainable farming practices.

Higher-order ESPs often have a broader focus in that they not only emphasize environmental concerns but also issues affecting communities and human well-being. Such a perspective generally necessitates that firms focus on systems thinking for the
strategic identification of value creation. Systems thinking requires that businesses comprehensively examine their operations and align them with the unmet needs of those in the local communities. These actions can create opportunities and growth over the long term (Hart & Milstein, 2003). As an example, DaimlerChrysler is exploring the new biotechnology market by using a community focus. It has partnered with NextEnergy to develop more economical means of producing soybean, corn, canola, and switchgrass for the evolving biodiesel and/or ethanol fuel markets. In so doing, DaimlerChrysler is utilizing land that was once an industrial dump site to grow its crops. Since the site is located near an economically disadvantaged community, its productive use can benefit those living in the surrounding area by creating a safer and cleaner environment (PR Newswire, 2007).

In other instances, higher-order ESPs involve utilizing volunteerism and community involvement to better develop new products and processes, to find and serve new markets, and to solve long-standing business problems that simultaneously benefit communities (Hessetal, 2002). For instance, Hindustan Unilever Limited (HUL) of Mumbai has implemented a program in which leadership trainees go through a rural stint and spend time working on numerous community volunteer projects that address the concerns of the rural populations in India (Hindustan Unilever Limited, 2009). The program facilitates employee interaction with the rural customer, thereby bringing HUL managers closer to these individuals’ social and economic challenges (Hindustan Unilever Limited, 2009). In undertaking its program, HUL recognized that existing products often fall short of meeting the economic and social needs of the poor. As a
benefit of the knowledge HUL gained from its volunteer activities, the company developed an environmentally friendly soap and shampoo bar. Affordably priced to meet the economic constraints of the poor, the product was created to benefit health and hygiene by reducing the transmission of diseases in poor communities (Hart & Sharma, 2004).

Which Environmental Sustainability Practices are Associated with Greater Performance?
In considering the relationship between the two broad types of ESPs (lower- and higher-order) and a firm’s financial performance, my position is that the financial benefits associated with a firm’s higher-order ESPs are more likely to exceed the financial benefits associated with its lower-order ESPs. My rationale draws on the fact that lower-order ESPs, by design, emphasize the incremental improvement of companies’ existing technologies and processes by eliminating excess waste in the production process. These activities reduce costs by way of enhanced efficiencies and risk avoidance associated with avoiding environmental non-compliances, supplier waste, and long-term environmental liabilities. However, the marginal benefits of these activities are also limited because they involve practices that are more easily replicated by competitors. For instance, to reduce virgin materials in product feedstock, companies may negotiate alternative contract agreements with suppliers. However, competitor companies can imitate these agreements with some ease. Similarly, firms that reuse their production materials can reduce their internal inefficiencies related to the manufacture of their existing products. However, significant knowledge about best environmental practices has been distributed widely among manufacturing firms. Additionally, governments
worldwide have assembled information about best environmental practices and made them available publicly. Because of their replicability, the financial gains associated with undertaking lower-order ESPs are restricted to internal efficiency improvements and risk avoidance rather than competitive advantage opportunities that can come from operating on the frontier of new product development.

By contrast, companies that utilize higher-order ESPs radically improve their production processes and develop products poised for new markets. Because of the focus on new product innovation, the financial gains that are associated with implementing these ESPs are not restricted by efficiency concerns and industry best practices, but rather their ability to reshape markets. This strategic approach is more likely to yield greater financial benefits for three reasons. The first reason relates to the fact that higher-order ESPs are more idiosyncratic, and require significant organizational commitment related to acquiring new skills and creatively destroying existing product portfolios (Hart & Milstein, 2003). To achieve this sort of commitment, firms must foster or create knowledge among their employees. Employee knowledge is a strong determinant of a firm’s financial gain (Kogut & Zander, 1997; Markides & Williamson, 1997; Prahalad & Hamel, 1990). Because of the tacit nature of the knowledge and capabilities required to radically improve a firm’s production processes and develop products for new market entry, firms that adopt higher-order ESPs are more likely to benefit financially than firms that develop lower-order ESPs.

The second reason why higher order-sustainability activities are more likely to be associated with greater financial performance relates to first-mover advantages. If
successful, firms that undertake higher-order ESPs are more likely to be first-movers among competitors in their quest for new market innovations (Hart & Milstein, 2003). This advantage carries over into consumer and buyer markets where firms that develop innovative green products can obtain greater visibility for their business practices. Doing so can position them as industry leaders, which can help them to increase their market share.

In addition to the revenue associated with the sale of innovative green products, greater visibility provides a stronger foundation for the creation of intangible benefits via enhanced organizational reputation (Porter & van der Linde, 1995). This is the third reason why I anticipate that the relationship between firms’ financial performance and their higher-order ESPs are more likely to be stronger than for firms that undertake lower-order ESPs. Companies that develop a green reputation can enjoy stronger community support for the firm’s day-to-day operations and development plans. They also have the potential for greater goodwill with environmental regulators (Darnall, Potoski & Prakash, 2010). Each of these intangible benefits may improve a company’s shareholder value (Hart & Milstein, 2003).

For all these reasons, I hypothesize that the correlation between a firm’s financial benefits and its number of higher-order sustainability activities is stronger than the correlation between its financial benefits and its number of lower-order sustainability activities. Moreover, the average level of firms’ financial gains associated with their higher-order sustainability activities will be higher than the gains associated with their lower-order sustainability activities.
Hypothesis 1: The correlation between a firm’s financial benefits and its number of higher-order sustainability activities is stronger than the correlation between its financial benefits and its number of lower-order sustainability activities.

Hypothesis 2: The mean level of financial benefits associated with a firm’s higher-order sustainability activities is greater than the mean level of financial benefits related to its lower-order sustainability activities.

Methodology
To test my research hypotheses, I assessed firms identified in Dow Jones’ Sustainability Indexes (DJSI). The DJSI is a “best-in-class” index, which recognizes the cleanest firms in specific industries as opposed to identifying an industry’s overall sustainability or distinguishing which industries are cleaner than others. All DJSI firms are large publicly traded companies that are recognized as being sustainability leaders (DJSI, 2008). To be included on the index, Dow Jones uses a variety of sustainability criteria, such as whether or not a company has a climate change strategy, the extent of a business’ energy consumption, and information related to its corporate governance and human resources management. Firms that do not qualify for inclusion in the DJSI index are small companies, privately held businesses, and large enterprises that may adopt ESPs but fail to report them in their external publications. These exclusions somewhat limit my ability to generalize the results of this study to a broader array of businesses. Nonetheless, the DJSI is one of the most comprehensive and globally recognized indices that track U.S. firms’ ESPs.
For my analysis, I relied on what was the most recent year the DJSI companies made its sustainability data publicly available - either 2006 or 2007. At that time, there was between an 18 to 24 month lag in when companies collected their sustainability data and when DJSI firms reported these data publicly via their corporate sustainability reports. Data collection for this paper occurred between December 2008 and March 2009. As such, the sustainability reports were comparable to the DJSI data. By focusing on U.S. manufacturing firms, I was able to ensure that my sample was subject to the same minimum federal environmental regulations. Within the U.S., Dow Jones included 51 companies on its list, and of these, 48 were classified as manufacturing (NAICS 31-33) firms. These companies represent approximately 11% of all DJSI companies.

**Dependent Variables**

To examine my hypotheses, I utilized firms’ reported value of financial benefits associated with their sustainability activities. The data were extracted from firms’ sustainability reports. Since the data are self-reported, firms may have a bias towards providing socially desirable information and withholding undesirable information. However, each of the publicly traded firms in our sample are required to disclose extensive financial information in their annual reports using Generally Accepted Accounting Principles, and provide independently audited financial statements to the U.S. Securities and Exchange Commission. So while there may have been some variation in firms’ estimation procedures related to their estimations of the monetary benefits of their ESPs, I anticipate that firms utilized their existing standards and conventions to collect these financial data.
Within their sustainability reports, firms described the financial benefits related to their sustainability efforts at the practice level. For each ESP, I documented the value of its associated financial benefit. I then categorized each firm’s respective benefit based on whether it was associated with a lower- and/or higher-order ESPs. If benefits were reported over a multiple year span, the average benefit per year was calculated. Since companies have numerous incentives to disclose high-quality information about their activities (Singhvi & Desai, 1971), in instances where firms did not report a financial benefit associated with a respective sustainability activity, I assumed that the actual value was $0.

Financial benefits data were recorded for each firm at the practice level and summed to arrive at each firm’s total benefits associated with its lower- and higher-order ESPs. Each firm therefore had the potential of having two financial benefit values. These two measures form my dependent variables.

**Independent Variables**

The independent variables were the sum of each firm’s lower-ordered ESPs, and the sum of each firm’s higher-ordered ESPs. To account for firms’ different types of ESPs, I drew on information within companies’ sustainability report. Using the framework developed by Hart & Milstein (2003) individual ESPs were assigned to one of four categories—pollution prevention, product stewardship, innovative technologies and community-focus—based on the following definitions:
• Pollution prevention relates to improving the internal environmental efficiency of a company’s existing products and processes—that is, reducing waste from current operations—thereby reducing the amount of pollution generated at its source.

• Product stewardship extends beyond organizational boundaries to include the product’s life cycle—from raw material access, through production processes, to product use and the disposal of spent products. It involves integrating the firm’s value chain stakeholders, such as suppliers and customers, into business development with the ultimate goal of reducing the firm’s environmental impacts of existing products and processes.

• Clean technology and innovation refers to internal business innovations that “leapfrog” widely accepted industry routines and knowledge. Such innovations depart from pollution prevention in that they extend beyond the company’s existing products and services to the development of radically new products and business models.

• Community focus involves developing new products and business models that address the unmet needs of the economically disadvantaged, while presenting opportunities for firms to define a compelling trajectory for future growth. In some instances, such a strategy involves recognizing that existing products fall short of meeting the economic, social, and environmental needs of the poor. In other instances, a community-focused strategy involves developing products for new markets in a way that simultaneously improves the conditions of the poor. To achieve these outcomes, firms with a community focus collaborate with external community stakeholders previously overlooked or ignored by firms (e.g., radical environmentalists, and the urban and rural
poor), to help them steer towards radical innovation of new products and unconventional models for market growth.

Once my classification was completed, I randomly sampled 50 of firms’ 633 sustainability activities and asked an independent reviewer to categorize them in an effort to increase the reliability of my classification. In 49 of 50 cases (98%) the categorization was consistent. I then classified firms’ ESPs based on whether they met the definition of ‘lower-ordered’ or ‘higher-ordered’. I excluded several types of ESPs from the study that firms had reported in their sustainability reports. The first type relates to employee diversity programs, because their existence is driven primarily by equal opportunity laws rather than voluntary efforts. Second, I excluded activities associated with nuclear power generation, because nuclear power generation necessarily produces environmentally damaging wastes for which there are no technical solutions. Finally, I omitted philanthropic activities since they do not change a company’s internal production practices (Rondinelli & London, 2003) and therefore have little relationship to a business’ products and processes.

**Empirics**

To empirically assess the association between firms’ reported financial benefits and their total number of reported lower-order ESPs, I relied on Spearman’s rank correlation. Similarly, I used Spearman’s rank correlation to determine association between firms’ reported financial benefits and their total number of their higher-order ESPs. Spearman’s rank correlation is a nonparametric measure of statistical association that does not make assumptions about the distribution of the variables of interest (Chen &
Popovich, 2002). The resulting statistic, $r_s$, can have values between -1.00 and 1.00. If a correlation reliably differs from zero, it will be statistically significant, suggesting that the relationship between the two variables is not due to chance (Chen & Popovich, 2002). In general, variables with correlation coefficients in the order of 0.10 are considered “small” relationships, those of 0.30 are considered “medium” relationships, and those of 0.50 are considered “large” relationships (Cohen, 1988). To determine whether the correlation between firms’ reported financial benefits and their lower- and higher-ordered ESPs differed statistically, I utilized a difference in correlations test described by Howell (2007) to assess whether the paired correlations were likely to represent a real difference in the population.

To examine Hypothesis 2, I began by calculating the financial benefits related to the sum of each firm’s lower-order ESPs. For instance, if a firm implemented 10 lower-order practices, I summed the financial benefits associated across that suite. I also summed the firm’s suite of higher-order ESPs. Similar values were then calculated for the remaining 47 firms. All firms’ financial benefits related to their lower-order ESPs were then summed and divided by our sample size to arrive at firms’ total average financial benefits. A similar procedure was performed for firms’ higher-order ESPs. I utilized a dependent t-test for paired samples to determine whether firms’ total average financial benefits differed across the two categories of sustainability activities. A dependent paired t-test compares the difference between two means (with different variances) within the same sample (Howell, 2007). This test is robust even if the distribution is skewed, as long as the sample size has at least 40 observations (Moore, 2004).
However, there is a possibility that a firm may derive more financial benefits from its ESPs simply because it adopts more of them. As such, I followed up this analysis by assessing each firm’s average level of financial benefits per lower-ordered ESP to determine whether it differed significantly from its average level of financial benefits per higher-ordered ESP. For instance, if a firm implemented a suite of 10 lower-order ESPs, I calculated the mean level of financial benefits associated with that suite, before doing the same for the firm’s higher-order ESPs. Similar values were then calculated for the remaining 47 firms.

Firms’ mean level of financial benefits associated with their ESPs were then summed, before arriving at a grand average of firms’ financial benefits per lower-order and higher-order ESPs for the sample. I then used a dependent t-test to compare whether the average benefits associated with each firm’s lower-ordered ESPs differed from the benefits related to their higher-ordered ESPs. One-tailed tests are reported for our mean comparisons, since Hypothesis 2 specifies direction (Moore, 2004).

**Results**

Figure 1 describes the 633 ESPs that U.S. DJSI manufacturing firms undertook. More than half (53%) of all ESPs related to pollution prevention, and more than a quarter (28%) were related to product stewardship. Lower-order ESPs therefore accounted for 81% of all sustainability activities in the sample. By contrast, only 19% of firms’ ESPs (less than one in five) were classified as either clean technology (15%) or community focus (4%). Figure 2 provides examples of the types of ESPs that the firms in my sample
implemented and how they were categorized. About 75% of all ESPs recorded for the study are included in Figure 2.

![Figure 1. Firm's Environmental Sustainability Practices](image)

Table 1 includes descriptive statistics for my sample. My unit of analysis is the firm, and the 48 firms in my sample implemented an average of 13 ESPs (both lower- and higher-order). Depending on the firm, this total average ranged from 1 to 44 practices.
All 48 sample firms adopted lower-order ESPs, and 43 (89.6%) of them also adopted higher-order ESPs. Firms’ average monetary benefits associated with all their ESPs were $186 million, and total benefits ranged from $0 to $2,847 million.

<table>
<thead>
<tr>
<th>Descriptive Item</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum Value</th>
<th>Maximum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of ESPs per firm</td>
<td>13</td>
<td>9</td>
<td>1</td>
<td>44</td>
</tr>
<tr>
<td>Number of lower-order ESPs per firm</td>
<td>11</td>
<td>8</td>
<td>1</td>
<td>39</td>
</tr>
<tr>
<td>Number of higher-order ESPs per firm</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>19</td>
</tr>
<tr>
<td>Firms’ total financial benefits across all ESPs*</td>
<td>$ 86 $ 647</td>
<td>$ 0</td>
<td>$2,847</td>
<td></td>
</tr>
<tr>
<td>Benefits related to the sum of each firm’s lower-order ESPs</td>
<td>$ 69 $ 173</td>
<td>$ 0</td>
<td>$1,197</td>
<td></td>
</tr>
<tr>
<td>Benefits related to the sum of each firm’s higher-order ESPs</td>
<td>$ 117 $ 240</td>
<td>$ 0</td>
<td>$1,650</td>
<td></td>
</tr>
<tr>
<td>Firms’ financial benefits per ESP*</td>
<td>$ 3  $ 14</td>
<td>$ 0</td>
<td>$ 100</td>
<td></td>
</tr>
<tr>
<td>Benefits per each lower-order ESP</td>
<td>$ 20 $ 71</td>
<td>$ 0</td>
<td>$ 413</td>
<td></td>
</tr>
</tbody>
</table>

In examining which types of sustainability activities were more strongly associated with firms’ financial gains, I found that 29.64% (.2964; p=0.0408, see Table 2) of the variability in firms’ benefits was associated with the variability in the number of their lower-ordered ESPs. The associated p-value indicates that there was a 95.92% probability that this occurrence was not due to chance. With respect to firms’ higher-order ESPs, 35.56% (.3556; p=0.0131) of the variability in firms’ financial benefits was associated with the variability in the number of these ESPs. Moreover, the associated p-value indicates that there was a 98.69% probability that this occurrence was not due to coincidence. However, the difference in the correlation between the lower- and higher-order activities was 5.92%, and not significant statistically. As such, I did not find evidence in support of Hypothesis 1.
Table 2. Firms’ Environmental Activities and Financial Performance

<table>
<thead>
<tr>
<th>Dependent Variable – Financial Benefits</th>
<th>Independent Variable</th>
<th>n</th>
<th>Spearman’s Rank Correlation</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefits related to the sum of each firm’s lower-order ESPs</td>
<td>Number of lower-order ESPs</td>
<td>48</td>
<td>29.64%</td>
<td>0.0408</td>
</tr>
<tr>
<td>Benefits related to the sum of each firm’s higher-order ESPs</td>
<td>Number of higher-order ESPs</td>
<td>48</td>
<td>35.56%</td>
<td>0.0131</td>
</tr>
</tbody>
</table>

In performing my first dependent paired t-test, firms’ mean benefits related to the sum of their lower-ordered activities were $69 million (see Table 3). By contrast, firms’ benefits related to the sum of their higher-ordered activities were $117 million. Following the dependent paired t-test methodology the mean and standard error of the difference between lower- and higher-order benefits were calculated. Dividing the mean difference ($48 million) by the difference in standard errors yielded a test statistic of 1.703, which was statistically significant at p=0.0475 (df=47). These findings indicate that the average benefits associated with each firm’s higher-ordered ESPs differed significantly from the average benefits associated with their lower-ordered ESPs.

Table 3. Difference in Firms’ Financial Benefits related to their Lower- and Higher-order ESPs

<table>
<thead>
<tr>
<th>Financial Benefits Measure</th>
<th>Mean</th>
<th>Difference</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Benefits related to the sum of each firm’s lower-order ESPs</td>
<td>$69</td>
<td>$48</td>
<td>1.703</td>
<td>0.0475</td>
</tr>
<tr>
<td>• Benefits related to the sum of each firm’s higher-order ESPs</td>
<td>$117</td>
<td>$18</td>
<td>1.940</td>
<td>0.0290</td>
</tr>
</tbody>
</table>

Since firms that have numerous sustainability activities may generate more financial benefits by virtue of the number of projects they adopt, Table 3 also examines the benefits related to each individual activity. I compared each firm’s difference in mean benefits per lower-ordered ESP with their mean financial benefits per higher-ordered ESPs.
Each firm’s mean level of benefits reported per higher-ordered ESP was $20 million. Similarly, each firm’s mean value of benefits per lower-ordered ESP was $3 million. The results of my dependent paired t-test indicated that the difference ($18 million) in the mean values were statistically significant at p=0.0290 (t=1.940; df=47).

Figure 2 offers a graphical representation of my statistical findings. It plots (on a logarithmic scale) firms’ number of lower- and higher-ordered ESPs by their reported benefits. The image illustrates that the general association between lower- and higher-order ESPs is quite similar in that there appears to be a positive relationship with a similar upward trend. However, the benefits associated with each type of ESP differs significantly in that to obtain a certain level of benefit, the firms in this sample did so with fewer higher-order ESP. That is, firms that had $20 million of benefits associated with their ESPs might have implemented only one higher-order ESP, while others might have implemented 6.7 lower-order ESPs.
Combined, these findings offer evidence that fails to support Hypothesis 1, which states that the correlation between firms’ financial benefits and their number of higher-order ESPs is stronger than the correlation between firms’ financial benefits and their number of lower-order ESPs. However, I do find evidence that the mean level of financial gains associated with each firm’s higher-order ESPs is higher than the mean level of financial gains associated with their lower-order ESPs (Hypothesis 2). So while the two types of ESPs have a similar association with financial performance, the magnitude of this association appears to differ.

**Discussion**

In spite of the importance that Hart and Milstein’s (2003) sustainability value framework has had in the field of management strategy, as yet it has not been operationalized in terms of how firms’ different types of sustainability activities are related to their financial performance. Additionally, while many scholars have suggested
that there is an association between firms’ adoption lower- and higher-order ESPs and their financial performance, empirical support has been lacking. This study offers initial evidence for the notion that firms’ ESPs of numerous sorts are related to their financial performance, and the strength of the association between financial performance and the number of lower- and higher-order ESPs they adopt is quite similar in terms of direction and trend. However, firms that adopt higher-order ESPs have a higher average level of financial benefit associated with undertaking these activities.

These findings are important for four reasons. First, from a managerial perspective, firms may elect to focus solely on developing lower-order ESPs. However, to achieve the same level of average financial benefits associated with higher-order ESPs, they may need to implement more of them. A rationale for why the benefits associated with higher-order ESPs may be greater (an average of $18 million more per practice) might relate to the fact that these practices are designed to unseat existing products and processes and preempt competitors (Hart & Milstein, 2003). Such practices necessitate layers of embedded capabilities (Darnall & Edwards, 2006) and strong relationships with external stakeholders (London, Rondinelli, & O’Neill, 2005), in addition to greater coordination among employees and managers. Firms that develop these capabilities must also foster or create knowledge among their employees. Since this sort of knowledge is related to a company’s financial performance (Kogut & Zander, 1997; Markides & Williamson, 1997; Prahalad & Hamel, 1990), firms that are successful at their innovative efforts are positioned to be first-movers among competitors in their quest for new market innovations (Hart & Milstein, 2003). First-mover advantage can advantage firms by
enhancing revenues with the sale of innovative green products, improving their visibility, and the intangible benefits related to improved reputation.

Second, knowledge that higher-order ESPs are associated with greater financial gains is important because managers often struggle to determine to what extent they should implement ESPs within their companies. Because firms commonly believe that higher-order ESPs are more risky or costly to implement, managers may be less likely to adopt them. However, my results suggest that higher-order ESPs are associated with a higher average level of financial performance than lower-order ESPs. These results support strategic arguments about risk/reward relationships that risky higher-order practices are related with higher financial rewards. Understanding these distinctions may offer managers the needed support to reach further with respect to their companies’ sustainability practices, especially for firms that are developing their long-term sustainability strategies. While my results may be skewed towards successful activities, since firms may be less likely to discuss failures in public forums (Singhvi & Desai, 1971), I expect that this reporting bias would apply systematically across all sorts of ESPs. As such, meaningful knowledge can still be gained by making empirical comparisons across lower- and higher-order ESPs.

The third contribution of this study is that it offers companies evidence of the merits of classifying their existing ESPs in a systematic way. Fewer than one in five of ESPs that each firm implemented were considered to be higher-order. Since DJSI firms are recognized as being sustainability leaders, I anticipate that fewer non-DJSI firms are adopting ESPs, especially those that are higher-order. By classifying their existing ESPs
based on whether they are lower- or higher-order, firms may develop a better understanding of their existing sustainability focus, which can allow them to make strategic adjustments that may benefit them to a greater degree over time.

The fourth contribution of this research relates to public policy. Many policy efforts, fashioned in the form of a voluntary environmental program (VEP), are designed to encourage companies to pursue a proactive environmental strategy. In the U.S. alone, there are more than 200 VEPs that operate at the federal level (Carmin, Darnall & Mil-Homens, 2003). However, most of these VEPs are designed to encourage firms to expand their lower-order ESPs in large part because program managers fear that having more stringent program requirements may discourage additional participants in their programs (Darnall & Carmin, 2005). The results of my research suggest that a firm’s higher-order ESPs are associated with greater financial returns. An opportunity therefore may exist for regulators to use VEPs to encourage more far-reaching ESPs among participant companies. Such VEPs may involve offering firms incentives to collaborate with other firms, nonprofits, or government research laboratories with the goal of bolstering their innovative capacity to address issues related to poverty reduction or clean technology development or poverty reduction. Additionally, regulators may also consider creating competitions to encourage greater development of higher-order ESPs.

Related to future research, recent studies have suggested that companies typically choose to implement lower-order ESPs since they might be able to generate cost savings or revenue faster than other types of ESPs (Christmann, 2000), whereas higher-order ESPs may benefit firms over a longer time horizon (Hart, 2007). These studies and others
(e.g., Hart & Ahuja, 1996) have suggested that there may be a potential lag in firms’ financial benefits due to their sustainability efforts. Future research therefore would benefit from undertaking a more longitudinal analysis to examine how different types of ESPs are related with financial performance over time. My expectation is that the financial benefits derived from higher-order ESPs might accrue at a greater and more sustained rate over time than those derived from lower-order ESPs because of their focus on new markets. If so, a more compelling case can be made for companies to develop far-reaching sustainability programs.

Similarly, prospective scholarship would benefit by examining the threshold in which adopting additional ESPs increases a firm’s marginal costs. Such an assessment may be of particular interest to business managers in helping them to understand the extent to which they should pursue lower- or higher-order ESPs. Along the way we may find there is a point of diminishing return on corporate sustainability activities that differs across industries. Finally, future work would benefit by improving upon this analysis in a way that accounts for other effects that might explain the relationship between firms’ ESPs and their financial performance. Such an analysis would require access to a much larger dataset of firms to simultaneously control for firms’ self-selection of their sustainability activities, and data related to control and instrumental variables. While collecting these sorts of data can be costly, the results of our analysis offer some initial justification for undertaking a broader study.
Conclusion

In sum, this research extends prior studies that examine the broader connections between ESPs and financial performance. It offers some of the first empirical evidence suggesting that the different ESPs specified Hart & Milstein (2003) are related to firms’ financial performance in different ways. More specifically, I assess the extent to which ESPs involving incremental modifications (lower-order) and ESPs involving more significant modifications (higher-order) in product and process development are associated with similar financial gains. I reveal that lower- and higher-order ESPs are similarly associated with firms’ financial performance in that they follow a similar direction and trend. However, the average level of financial benefits related with firms’ higher-order ESPs is greater than the average level of financial benefits related with their lower-order ESPs. My results suggest that companies which reach further by developing higher-order ESPs may be able to reap greater financial benefits, while improving the natural environment. These findings offer another important piece of information to managers and researchers about the possible conditions in which it might pay for firms to be green.
CHAPTER THREE - PRODUCTION COSTS, TRANSACTION COSTS AND THE DECISION TO ADOPT ENVIRONMENTAL SUSTAINABILITY PRACTICES

Many studies have highlighted the benefits of adopting environmental sustainability practices (ESPs) (e.g., Hart, 1995; Hart & Ahuja, 1996; Hart & Milstein, 2003; Christmann, 2000; Klassen & McLaughlin, 1996; Prahalad & Hamel, 1990; Russo & Fouts, 1997; Sharma & Vredenberg, 1998) which suggests all facilities should adopt ESPs. However, in spite of the benefits associated with adopting ESPs, many facilities forgo implementation. One reason is costs (Nordhaus, 1992; Walley & Whitehead, 1994), and especially production costs and transaction costs (Alchain & Demsetz, 1972; Langlois & Foss, 1999; Walker & Weber, 1984; Williamson, 1979).

Related to organizations and the natural environment, production costs are the expenses that accrue from the acquisition of resources (Shrivastava, 1995; Thompson, 1999) and employees’ time and efforts to manage ESP implementation (Delmas & Marcus, 2004; McCann et al., 2005). Transaction costs are the expenses that accrue during a facility’s early steps of gathering information and identifying resources for ESP implementation (Thompson, 1999; McCann et al., 2005). Transaction costs also occur during the negotiating and/or bargaining for resources (Milgrom & Roberts, 1990) and/or monitoring related activities to prevent ecosystem degradation as prescribed by environmental regulation or as part of a permit to discharge (McCann, et al., 2005).
Prior scholarship has examined production costs indirectly by discussing how ESPs can reduce labor, materials and utility costs (Nehrt, 1996; Porter & van der Linde, 1995b; Shrivastava, 1995). However, production costs are also likely to influence ESP adoption. Moreover, few researchers have assessed the relationship between transaction costs and facilities’ environmental strategies. Rather, general transaction costs have been associated with a facilities development or selection of its environmental policy (Delmas & Marcus, 2004; McCann, et al., 2005; Vatn, 2005) and facilities’ decisions to use marketable permits for pollution control (Delmas & Marcus, 2004; Montero, 1998; Netusil & Braden, 2001; Woerdman, 2001). To date, little research has closely examined how transaction costs influence ESP adoption. While the effects of economic costs are widely recognized, we lack empirical evidence regarding the extent to which production costs and transaction costs are associated with facilities’ ESP adoption.

My position is that production costs and transaction costs are expected to influence ESP adoption. That is facilities that incur greater production costs and transaction costs are more likely to adopt fewer ESPs. Additionally, I posit that when compared to transaction costs, production costs have a stronger relationship with ESP adoption since they represent the first step in the adoption process (Stavins, 1995) and they are likely to involve significant facility expenses (USEPA, 2000). Moreover, production costs directly impact the amount of funds available for ESP adoption such that facilities will strive to acquire resources quickly or at a lower cost than their competitors (Porter, 1980). Finally, compared to production costs, transaction costs may be considered as another form of sales tax (Alchain & Demsetz, 1972; Jacobides & Winter,
2005). When facilities account for the total cost of goods or services, transaction costs represent the time and effort undertaken to identify the goods and services (Alchain & Demsetz, 1972) not the actual purchase price (Walker & Weber, 1984). As such, transaction costs represent only a small percentage of a facility’s total cost to adopt ESPs.

Understanding the relationship between production costs, transaction costs and ESPs is important for many reasons. First, it extends Walley & Whitehead’s (1994) seminal work suggesting that resistance by facility managers to adopt ESPs is likely due to the cost. It expands these ideas by critically (and empirically) examining how different types of costs are associated with facilities’ ESP adoption. Second, knowledge that costs are associated with the adoption of fewer ESPs is important because many managers often struggle to determine to how they can implement ESPs within their facility. This information may help managers to efficiently allocate funds while maintaining the delicate balance of protecting the environment and enhancing financial performance.

This paper examines the relationship between facility production and transaction costs and the adoption of ESPs. To examine this relationship I used a negative binomial regression analysis and survey data for 65 manufacturing facilities operating in the U.S. The results of my analysis reveal that production and transaction costs are associated with facilities’ ESP adoption in that both costs follow a similar direction and trend. However, the association of production costs with ESP adoption is greater than the association of transaction costs with ESP adoption.
**Environmental Sustainability Practices**

Environmental sustainability practices (ESPs) are projects, programs, or initiatives that are designed to protect the environment and society and are integrated into day-to-day operations and management decisions. They also include voluntary activities that move facilities beyond compliance with existing environmental regulatory requirements (Sharma & Vredenberg, 1998). These practices require extensive employee coordination across multiple units within the organization and across different organizational levels (Hart, 1995). Engaging employees in this way can more readily lead to new product ideas (Shrivastava, 1995) and to the redefinition or redesign of products and operations (Hart & Milstein, 1999). Examples include investments in new technologies and management practices that reduce environmental impacts (Shrivastava, 1995; Sharma & Vredenburg, 1998). By implementing ESPs, facilities can identify how their production activities interact with the environment, and how they can conserve energy and natural resources and minimize the environmental load of their business activities (Shrivastava, 1995).

ESPs can also enhance a facility’s financial performance in that they can increase operational efficiency (Hart & Ahuja, 1996). They do so by continuously reducing a facility’s pollution and enhancing resource conservation (Hart, 1995). Through activities such as benchmarking and accounting procedures, ESPs help to establish environmental performance goals (Nash & Ehrenfeld, 1997) which help reduce costs (Khanna & Damon, 1999). For instance, Hart & Ahuja (1996) show that reducing emissions can significantly improve a facility’s financial performance within one or two years after initiation. In addition, facilities which reduce their toxic releases have been shown accrue
greater financial gains (Khanna & Damon, 1999). In still other instances, ESPs (and specifically environmental management systems (EMSs)) have been shown to enhance facilities’ financial performance by way of reducing negative environmental impacts, lessening reporting burdens and reducing the costs associated with compliance (Darnall, Gallagher, Andrews & Amaral, 2000). ESPs can also help facilities differentiate their products or processes along environmental lines (Reinhardt, 1998), by enhancing reputation, expanding market demand and increasing financial performance (Hart & Milstein, 2003; Khanna & Damon, 1999). Finally, facilities that announce their investment in ESPs can accrue above average market valuations (Sharma & Vredenburg, 1998).

Given the association between ESPs and improved financial performance, we might expect that all facilities are on the path to becoming green. However, in reality, there is much variation in facilities’ adoption of ESPs.

**Anticipated Production and Transaction Costs and Facilities’ ESP Adoption**

One reason for the variation in facilities’ adoption of ESPs may relate to the cost of ESP adoption. That is, production and transaction costs may be important factors that inhibit organizations from implementing ESPs (Nordhaus, 1992; Rienhardt, 1999; Walley & Whitehead, 1994).

Historically, production costs focus on the manufacturing aspects of the firm whereas transaction costs focus on the exchange aspects (Langlois & Foss, 1999). Production costs are expenses that include direct and indirect labor, materials, and utilities (Walker & Weber, 1984). Related to the natural environment, production costs
include the acquisition of resources (Shrivastava, 1995; Thompson, 1999) and employees’ time and efforts implementing ESPs (Delmas & Marcus, 2004; McCann et al., 2005). They influence business decisions associated with internal production processes such as the adoption of new technologies or the substitution of raw materials (Alchain & Demsetz, 1972; Milgrom & Roberts, 1990). However, production costs do not explain inter-firm contractual relationships or the boundaries of the firm (Langlois, 1998). As such, many scholars have identified transaction costs—costs that stand separate from and in addition to ordinary production costs (Coase, 1937; Williamson, 1975).

Transaction costs are the expenses related to organizing production through the identification, negotiation, and monitoring of resources (Coase, 1937; Williamson, 1975). Many scholars have argued that transaction costs can help explain facilities’ behavior related to vertical and horizontal organization (Teece, 1982; Williamson, 1983) and changes in strategy over time (Safizadeh, Field & Ritzman, 2008; Teece, 1982). Whereas production costs emphasize the substitution of like resources based on price, transaction costs emphasize efficient operations by way of determining whether functions should be internalized or sought elsewhere (Langlois, 1998). Given their differences in relative emphasis, each type of cost is expected to influence facilities to pursue varying strategies. As such, when assessing one type of cost the other must be also considered (Madhok, 1996; Riordan & Williamson, 1985).

Related to organizations and the natural environment, few researchers have assessed the relationship between production and transaction costs together with ESP
adoption. Rather, production costs (on their own) have been associated with facilities’ decisions to invest in new environmental compliance technology (Nehrt, 1996; Shrivastava, 1995). Additionally, changes in production costs (post implementation) have been used to argue that ESPs can increase efficiency, protect the environment, save money and generate cost advantages (Hart & Ahuja, 1996; Klassen & McLaughlin, 1996). Similarly, transaction costs (on their own) have been linked to facilities’ development or selection of environmental policy (Baldursson & von der Fehr, 2004; McCann, et al., 2005; Schneider & Volkert, 1999; Venkatachalam, 2008; Vatn, 2005; Zhao & Kling, 2003) and firms’ decisions to use marketable permits for pollution control (Montero, 1998; Netusil & Braden, 2001; Woerdman, 2001).

I suggest that both production and transaction costs are associated with the adoption ESPs at the facility level. However, managers may perceive the influence of these costs on ESP adoption differently. Managers are defined as “any individual who can affect the achievement of the organization’s objectives” (Burgelman, 1991; Leonard-Barton & Deschamps, 1988). Management theory is rooted in the practical concerns for managers—how they can be more effective at reducing costs and enhancing performance (Wooldridge & Floyd, 1990; 1997). Managers think about strategy selection and past performance (Boeker, 1997) which serve as critical signals for anticipated costs and future financial performance (Wooldridge & Floyd, 1997). After assessing which costs are salient (Boeker, 1997; Burgelman, 1991; Wooldridge & Floyd, 1990), managerial perceptions of anticipated costs subsequently establish how a facilities’ ESP adoption strategy will be influenced (Cordano & Frieze, 2000; Delmas & Toffel, 2004; Henriches
& Sadorsky, 1999). Because of their central role, managerial perceptions of anticipated costs are the focus of this paper.

Production Costs and Facilities’ ESP Adoption

Related to the natural environment, production costs include the acquisition of resources (Thompson, 1999), in addition to employees’ time and efforts to manage the implementation of EPSs (McCann et al., 2005). They influence business decisions associated with internal production processes such as the adoption of new technologies or the substitution of raw materials (Alchain & Demsetz, 1972; Milgrom & Roberts, 1990). Taken together, two production costs—acquisition and implementation— are especially relevant to ESP adoption.

Acquisition

Acquisition costs accrue during a facility’s early steps of purchasing resources that are needed to adopt both regulatory compliance practices (Thompson, 1999; McCann et al., 2005), and ESPs. Most notably, acquisition costs include the direct expenses paid for raw materials and labor used in manufacturing (Jordan & Harris, 1920) in addition to the purchase of equipment (Christmann, 2000). Many facilities search for opportunities to reduce acquisition costs (Riordan & Williamson, 1985). Related to ESPs, manufacturing facilities often desire to substitute less harmful substances for hazardous ones, but may be unable to do so due to the cost premium for environmentally-friendly materials (Epstein, 2008; Kotchen, 2006; Walley & Whitehead, 1994). Frequently, environmentally friendly raw materials are costlier, which limits facilities’ willingness to purchase them (Epstein,
When faced with greater raw material substitution costs, these facilities are therefore likely to adopt fewer ESPs.

Additionally, the integration of less harmful substances into operations often requires the redesign of existing manufacturing processes (Porter & van der Linde, 1995b). In response, some facilities may need to acquire more employees to manage the newly redesigned manufacturing process (Christmann, 2000). However, the acquisition of new employees requires that funds be available to pay their salaries and benefits (Jordan & Harris, 1920). Moreover, the time and effort undertaken to solicit, interview and hire new employees can generate a significant amount of additional acquisition costs (Milgrom & Roberts, 1990). As such, facilities with limited funds may face a trade-off between either maintaining current levels of productivity or acquiring employees (Stavins, 1995) to manage new ESPs.

Finally, acquisition costs also relate to the expenses associated with the purchase of equipment that traps, stores, treats and disposes of pollution (Christmann, 2000; Hart & Ahuja, 1996). ESPs that trap, store, treat and dispose of pollution may be prescribed by environmental regulation or as part of a permit to discharge. Since many facilities are motivated to adhere to regulations in what they believe are the least expensive manner (Epstein, 2008), this may result in the adoption of fewer ESPs. Moreover, many ESPs are associated with innovative technologies (Nehrt, 1996; Porter & van der Linde, 1995b; Shrivastava, 1995). The acquisition costs associated with new or innovative technology is anticipated to be higher than conventional technology, since the purchase price often includes the new research or new information undertaken by the manufacturer. For
example, facilities increasingly have the option to purchase green electricity from renewable resources with a price premium that applies to all or part of their electricity consumption (Kotchen, 2006). However, many facilities may simply not have enough resources to pay for green electricity. Since new technology has a price premium which limits its diffusion (Reinganum, 1981) and can reduce ESP adoption. As such, higher anticipated acquisition costs are expected to discourage ESP adoption.

**Implementation**

The second type of production cost relates to implementation. Implementation costs are the time and effort undertaken by employees for the adoption of ESPs (McCann & Easter, 1999; Thompson, 1999). These costs are associated with the shutting down and retooling a production line to adopt ESPs (Delmas & Marcus, 2004). Moreover, the adoption of many ESPs involve modifying a facility’s existing processes in an effort to protect the natural environment (Shrivastava, 1995) and training employees to undertake these strategic shifts. Facilities that lack adequate resources to train employees internally are expected to incur greater implementation costs associated with ESP adoption (Zutshi & Sohal, 2004) since these facilities will likely require external assistance from consultants (Darnall & Edwards, 2006). As such, higher anticipated implementation costs are expected to discourage greater ESP adoption.

For these reasons, I suggest that higher anticipated production costs are associated with the adoption of ESPs such that facilities will adopt fewer ESPs.
**Hypothesis 1:** Higher anticipated production costs are associated with facilities’ decision to adopt fewer environmental sustainability practices.

**Transaction Costs and Facilities’ ESP Adoption**

Transaction costs are the expenses that accrue from the exchange of goods or services (Coase, 1937; Cheung, 1969; Williamson, 1975). They commonly include the cost of identifying resources, negotiating agreements, and monitoring and measuring performance (Boerner & Macher, 2005; Cheung, 1969; Williamson, 1975). Transaction costs are expected to influence the extent to which a facility adopts ESP (Nordhaus, 1992; Rienhardt, 1999; Stavins, 1995; Walley & Whitehead, 1994). For example, facilities may have to identify and interview new employees as part of the adoption of ESPs which is expected to increase overall time and effort. Moreover, facilities may have to monitor and measure performance as part of a permit to discharge which can require a significant amount of time and effort, especially if an ESP is complex (Delmas & Marcus, 2004). Combined, these three aspects of transaction costs – identification, negotiation and monitoring – are likely to discourage ESP adoption.

**Identification**

Transaction costs accrue during a facility’s early steps of information gathering and identifying resources, which are needed to both comply with environmental regulations (Thompson, 1999; McCann et al., 2005) and adopt ESPs. Resources include all assets, capabilities, organizational processes, attributes, information, knowledge, etc. controlled by a facility that enable it to conceive of and implement strategies to improve
efficiency and effectiveness (Daft, 1983). Facilities that are able to identify relevant resources quickly and effectively are expected to have lower identification costs (Hofer & Schendel, 1978). Specifically, relevant employee experience and knowledge can reduce the time and effort needed for ESP adoption (Hart & Milstein, 2003) since they may have first-hand knowledge of operations, production practices and other available resources (Hofer & Schendel, 1978; Kogut & Zander, 1996). Leveraging employees’ detailed knowledge can also quickly uncover excess resources, whereas facilities without such knowledge may have to use an extensive interview process for identifying other resources (Hofer & Schendel, 1978; Kogut & Zander, 1996). Facilities that anticipate higher identification costs (in the form of additional time and effort) since available resources cannot be located quickly, are expected to adopt of fewer ESPs.

Negotiation

Facilities’ negotiation costs are the additional time and effort to bargain for resources and include wages paid to attorneys (Milgrom & Roberts, 1990) when finalizing agreements (Haddock & McChensey, 1991). Facilities without qualified attorneys typically outsource this activity (Jacobides & Winter, 2005; Kogut & Zander, 1996; Leiblein & Miller, 2003). However, outsourcing of attorneys can increase transaction costs since additional time and effort is needed to negotiate terms of agreement with the outside law firm (Prahalad & Hamel, 1990; Kogut & Zander, 1996). Negotiation costs also accrue when facilities are found in violation of environmental regulations. These costs relate to the exceptional amount of time involved during the
litigation process (Milgrom & Roberts, 1990). Facilities that incur greater negotiation costs, may therefore have fewer resources available for ESP adoption. As such, the facility is anticipated to adopt fewer ESPs.

**Monitoring**

Monitoring costs include the purchase of costly equipment that disposes of pollution (Christmann, 2000; Hart & Ahuja, 1996). These costs can be high since monitoring performance may be continuous (Hart, 1995), requiring a significant amount of time and effort, especially if an ESP is complex (Delmas & Marcus, 2004). Also, some ESPs encourage continuous environmental improvement which requires the recording and documentation of routine processes and periodic auditing (Netherwood, 1998). This can be very costly since facilities have to undertake extensive internal evaluations, employee training and develop corrective action plans (Darnall & Edwards, 2006). Facilities with limited resources are expected to face trade-offs associated with use of employees’ time and effort to monitor performance which could be otherwise used to adopt more ESPs. As such, these facilities are expected to adopt fewer ESPs due to higher anticipated monitoring costs.

For these reasons, there is a general belief that facilities with higher anticipated transaction costs are expected to adopt fewer ESPs.

**Hypothesis 2: Higher anticipated transaction costs are associated with facilities’ adoption of fewer environmental sustainability practices.**
Which type of costs—Production or Transaction—is most influential?

In considering the two broader types of costs, my position is that anticipated production costs are likely to be more influential than anticipated transaction costs in facilities’ ESP adoption decision. Three factors support this view. First, production costs directly impact the amount of funds available for ESP adoption such that facilities will strive to acquire resources quickly or at a lower cost than their competitors (Porter, 1980; Walker & Weber, 1984). For example, the purchase price of resources represents some of the largest expenses incurred by facilities (USEPA, 2000). As such, facilities which fail to acquire resources quickly or inexpensively are likely to have lower profit margins than their competitors (Riordan & Williamson, 1985). This situation limits the amount of available capital that could be used to make environmental improvements within the organization (Hart, 1995). Whereas, all facilities must accrue some transaction costs identifying resources (Hofer & Schendel, 1978; Kogut & Zander, 1996) for ESP adoption. More importantly, any reduction in transaction costs (e.g. the time and effort identifying resources) is smaller than the reduction of acquisition costs when purchasing inexpensive resources (Walker & Weber, 1984). As such, the failure to acquire inexpensive resources is anticipated to reduce the amount of available funds to a greater extent and drive facilities to adopt fewer ESPs.

The second reason why anticipated production costs are more closely related to adoption of fewer ESPs is due to facilities’ manufacturing process choices. For instance, facilities that chose not to use environmentally-friendly resources may increase the amount of time, energy, raw materials or waste generated from manufacturing (Shrivastava, 1995). By choosing to use non-renewable resources, the facility may be
forced to purchase costly pollution prevention equipment (Hart, 1995; Hart & Ahuja, 1996) that would not be otherwise necessary had they acquired environmentally-friendly resources. These facilities are more likely to have high production costs and fewer available funds to adopt ESPs. Whereas, all facilities must spend some time and effort (e.g. transaction costs) acquiring resources (Coase, 1937; Cheung, 1969; Williamson, 1975) for manufacturing regardless of their management proficiency. As such, facilities with poor management may not be able to adopt ESPs since most available funds are directed towards the mitigation of current operations.

Additionally, transaction costs are somewhat similar to a sales tax (Alchain & Demsetz, 1972; Jacobides & Winter, 2005) in that they represent a small percentage of a facility’s total cost to acquire a good or service. However, unlike a sales tax, transaction costs may be managed by the facility and reduced over time. For example, transaction costs are dependent on the nature of the exchanges but they may be minimized if a facility increases the frequency of exchanges or reduces their acquisition of specialized resources (Williamson, 1979). These actions may also decrease the amount of employees’ time and effort needed to identify, negotiate and monitor specialized resources which can be used productively for other value-added activities (Hart, 1995; Hart & Ahuja, 1996). By contrast, production costs involve the significant outlay of capital expenditures for the acquisition of goods or services (Walker & Weber, 1984). These costs are determined by entities external to the facility and must be negotiated with the seller in order to be reduced. Since acquisition costs generally comprise the majority of total costs to a facility (Walker & Weber, 1984), they are more likely to involve a
significant outlay of capital. Given production costs’ comparative role in contributing to
total cost to the facility, they are anticipated to reduce the adoption of ESPs.

However, facilities may anticipate the influence of these costs on ESP adoption
differently. This is important because, even if similar costs were incurred by two similar
facilities, these two facilities might well anticipate future costs differently (Delmas &
Toffel, 2004). For example, facilities that view environmental management as an
important business function are most likely to view anticipated costs as an essential part
of ESP adoption. Whereas, facilities that tend to use the environmental regulatory
framework as their benchmark may anticipate costs at a different level than competitors
(Henriques & Sadorsky, 1999). Additionally, managers in facilities whose reputations
have suffered from pollution accidents may be more sensitive environmental issues and
anticipate costs differently (Delmas & Toffel, 2004). The source from which managers
obtain their information can influence their perception of anticipated adoption costs as
well (Sharma & Henriques, 2005). As such, anticipated costs for ESP adoption is
expected to vary across facilities.

Regardless of these differences, both anticipated production and transaction costs
of ESP adoption are expected to influence a facility’s manager decision. However, I
hypothesize that higher anticipated production costs are more closely associated with
facilities’ decision to adopt fewer ESPs when compared to transaction costs.

*Hypothesis 3: Compared to transaction costs, higher anticipated production
costs are more closely associated with the number of ESPs a facility decides to adopt.*
Methodology

Data: To evaluate these hypotheses, I used data from the National Database of Environmental Management Systems (NDEMS). NDEMS contains survey data for all facilities that participated in a voluntary, nation-wide EMS pilot program sponsored jointly by the Multi-state Working Group on Environmental Performance and EPA. Unlike government regulation, which imposes requirements on organizations from the outside, an EMS consists of a regulatory structure that arises from within the organization (Coglianese & Nash, 2001) and therefore is considered an environmental sustainability practice. EMSs consist of an environmental policy, as well as a set of evaluation processes that require firms to assess their environmental impacts, establish goals, implement environmental goals, monitor goal attainment, and undergo management review (Lamprecht, 1997; Netherwood, 1998). At the most basic level an EMS can help organizations assure that their management practices conform to environmental regulations. However, the EMS structure assists enterprises to scrutinize their internal operations, engage employees in environmental issues, continually monitor their progress, achieve greater efficiencies, and create opportunities for improving their strategic value, because they depend upon intensive employee involvement (Lawler, 1986; Hart 1995; Cole, 1991).

NDEMS was designed to include data on EMS implementation from 75 pilot facilities using identical data collection protocols for each. The data were collected by way of survey, and include environmental information from publicly-traded, and privately-owned facilities within the manufacturing industry (SIC codes 30-39) in...
addition to government municipalities. To ensure consistency and accuracy of responses, the survey contained strong prompts and detailed instructions for each question. Furthermore, the administrator of the survey met with each facility to provide on-site instruction for completing the survey. Additionally, the administrator closely reviewed each survey and when responses were incomplete or unclear they would contact the facility directly to resolve. Also, local and state authorities worked closely with facilities to ensure complete and accurate responses. The NDEMS database contains historical information about each facility’s pre-EMS activities, environmental performance, compliance, pollution prevention, and economic performance. The database also contains information on facilities’ industrial and demographic characteristics.

The pilot facilities were recruited by the ten participating state environmental agencies and received varying amounts of technical assistance from them. Because all NDEMS facilities were volunteers, they are not representative of all manufacturing facilities, but do offer rich insights about the relationship between production and transaction costs and comprehensiveness in ESP adoption. The results are therefore limited to facilities that are more likely to collaborate with state and federal environmental authorities, and facilities with stronger environmental performance.

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2 Generally, government municipalities operate under not-for-profit status, but they are still subject to environmental regulations and may be incur criminal or civil penalties due lack of compliance. For example, they may incur production costs such as acquisition costs for new technology and transaction costs such as monitoring and measuring costs as part of a permit to discharge. Additionally, they may incur negotiation costs due to criminal or civil penalties. In this regard, they can be considered similar to those facilities which operate under for-profit status.
**Dependent Variable**

To measure facilities’ ESPs, I used the total number of EMS processes adopted by each facility as the dependent variable for my analysis. This measure was created from an NDEMS survey question which asked: “Please indicate which of the following processes of an environmental management system you facility currently employs.” Facility managers replied “Yes” or “No” to each of the following fifteen EMS processes:

- Development of an environmental policy
- Identification of environmental aspects and impacts
- Identification of legal (regulatory) and other requirements
- Establishment of environmental objectives and targets
- Setting of time frame for achieving objective and targets
- Planning a method for achieving objective and targets
- Training employees
- Receiving communication from external parties
- Documenting communication from external parties
- Responding to external parties
- Development of EMS manual
- Monitoring and measuring significant environmental impacts
- Conducting internal audits
- Hiring external auditors
- Top management review
Following Khanna (2001) and Darnall, Henriques & Sadorsky (2010), each facility’s responses were summed. For example, if a facility reported that it had adopted three processes (e.g. developed an environmental policy, trained employees and responded to external parties) they received a total score of three ESP practices. The highest possible score a facility could receive was 15 based on the total number of possible ESP practices listed within the survey. Of the 80 facilities participating in the pilot program, 71 (89%) facilities provided survey responses with scores ranging from one to 15 ESP practices adopted. However, only 65 were fully complete and used for this analysis. On average, facilities in the study implemented between 5 and 6 EMS processes (Table 4).
### Table 4. Correlation Coefficients and Descriptive Statistics

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*Statistically significant at p<.10; **statistically significant at p<.05; ***statistically significant at p<.01

Notes: n = 65
**Independent Variables**

Facilities’ anticipated production and transaction costs were assessed by relying on NDEMS survey data. Prior to adopting their ESPs managers were asked to “identify and briefly describe the indicators that you are currently using to measure economic performance of your existing environmental management program”. These measures included personnel costs, equipment costs, permit fees, operating costs, contracting costs, consulting costs, disposal costs, fines and penalties. They also included cost reductions associated with (but not limited to) materials use reductions, insurance rate decreases, and regulatory inspection decreases.

In general, using existing costs to anticipate future costs can be a useful tool when evaluating new business opportunities (Grinblatt & Titman, 2002; Stickney & Weil, 2000). As such, managers seeking to forecast future financial performance often utilize existing cost information (Palepu & Healy, 2008) since it involves a relatively small set of assumptions (Grinblatt & Titman, 2002). Managers identified 199 costs prior to adoption of their ESP practices. Using the following definitions, these costs were categorized into: production costs or transaction costs.

- Production costs are the aggregate expenses, including direct and indirect labor, materials, and utilities that are incurred by a facility (Walker & Weber, 1984). Related to the natural environment, production costs include the acquisition of resources (Shrivastava, 1995; Thompson, 1999) and employees’ time and efforts to manage ESP implementation (Delmas & Marcus, 2004; McCann et al., 2005).
Transaction costs are the expenses that accrue from the exchange of goods or services (Coase, 1937;  Cheung, 1969; Williamson, 1975). They occur during a facility’s early steps of information gathering and identifying resources for ESP implementation (Thompson, 1999; McCann et al., 2005); negotiating and/or bargaining for resources (Milgrom & Roberts, 1990) and or monitoring and measuring-related activities to prevent ecosystem degradation as prescribed by environmental regulation or as part of a permit to discharge (McCann, et al., 2005).

Figure 4 describes the 186 costs measures used in the analysis. Thirteen of the 199 costs reported were removed from the analysis since they could not be classified into one of the above cost categories.

To increase the reliability of my classification, the same definitions were given to an independent reviewer who categorized each of the 199 responses as being either production costs or transaction costs. In 190 of 199 cases (95%) the categorization was consistent. To reconcile discrepancies the independent reviewer and I discussed the classification cost examples until agreement was reached. Doing so increased the inter-rater reliability of my measure, and any bias associated by my initial cost classification.

Production costs accounted for 81% of all costs in the sample. By contrast, 19% of facilities costs were related to transaction costs. Figure 4 provides examples of the types of costs used by the facilities and how they were categorized. About 75% of all economic performance measures recorded by facilities in the study are included in the table.

These included information on changes in credit ratings or local employment rates and were provided by a government organization.
Control Variables: Since NDEMS contains information on a diverse set of organizations operating within multiple manufacturing and government sectors, it was important to control for potential heterogeneities. Size was measured by determining how many full-time workers within each organization that were covered by the EMS during the year 2000.

To control for industry effects, facilities were assigned to one of four industry dummy categories: utilities, clean manufacturing, dirty manufacturing and government. Relying on existing taxonomies of U.S. manufacturing sectors (Mani & Wheeler, 1997; Gallagher & Ackerman, 2000), “dirty” manufacturing industries were classified as pulp and paper, chemical, petroleum refining, primary metal and basic metal industries. “Clean” manufacturing sectors consisted of fabricated metal products, industrial machinery, electronics, transportation equipment, instrumentation, and textile sectors. The small NDEMS sample limited the creation of more precise industry dummies.
Since facilities with strong historical environmental performance are more likely to adopt ESPs (Darnall, Gallagher, Andrews & Amaral, 2000), I relied on data derived from an NDEMS survey question that asked facility managers to “identify and describe the indicators you use to measure the environmental performance of your facility.” Facility’s number of indicators was summed to produce a total number of environmental performance indicators.

Other research has shown that parent companies influence their facilities to adopt ESPs in that they often provide technical or financial support to the facility which reduces the cost of ESP adoption (Darnall & Edwards, 2006). Parent company influences were accounted for by using NDEMS survey data that asked managers whether their facility “was part of a larger business or government organization?” Facility responses were coded 1 = “Yes”, 0 = “No”.

Since, organizations operating in a competitive or global market are more likely to adopt ESPs in order to be recognized as being green or environment-friendly, I included a set of dummies variables to account for facilities’ market scope. Specifically, I relied on NDEMS survey data that asked managers “Does your organization market its products in countries other than the United States?” Facility responses were coded 1 = “Yes”, 0 = “No”.

Finally, I accounted for whether or not the facility had been in noncompliance with any environmental regulations since they might choose to adopt EMS as a part of their agreement with local regulatory agencies. Facility responses were coded 1 = “Yes”, 0 = “No”.
**Empirics**

A negative binomial regression model was used to determine whether or not the independent variables predicted facilities’ number of ESP practices. A negative binomial model was selected since the dependent variable is continuous over a bounded set of positive values, with a maximum value of 15. In such instances, linear regression would not be appropriate since it would also estimate negative fitted values and values beyond the maximum. In addition, a test between the variance and the mean of the dependent variable suggested overdispersion in the data. Overdispersion occurs when the variance is greater than the mean (Cameron & Trivedi, 1998). In the presence of overdispersion, a Poisson regression model also is not suitable (Long, 1997). Given that the negative binomial model is a generalized linear model (unlike the Poisson model) the assumption that the mean equals the variance is relaxed, making it the best candidate for this analysis.

Normally, the coefficients produced by negative binomial regression models are the logs of the expected counts which are difficult to interpret (Coxe, West & Aiken, 2009). As such, the results were automatically converted to incidence-rate ratios (IRR). When converted, the results from negative binomial regression model can then be interpreted in same manner as the coefficients from an ordinary least-squares regression model (Hamilton, 2009). The transformation affects how the results are displayed, but not the test statistic or p-values (Hamilton, 2009).

To determine the goodness of fit, I relied on McFadden’s pseudo-$R^2$ statistic. Traditionally, the $R^2$ value is often used as a goodness-of-fit measure in ordinary-least square models, but the equivalent does not exist for negative binomial regression models since estimates from the regression are maximum likelihood estimates arrived through an
iterative process and are not calculated to minimize variance (Long, 1997; Veall & Zimmermann, 1994). The McFadden pseudo-$R^2$ value represents the log likelihood of the intercept model treated as a total sum of squares and the log likelihood of the full model treated as the sum of squared errors (Veall & Zimmermann, 1992). The ratio of the likelihoods suggests the level of improvement over the intercept model offered by the full model, meaning a small pseudo-$R^2$ value indicates that the model is a better fit (Veall & Zimmermann, 1992; 1994).

To estimate the range of values the dependent variable may take based on the independent variables, I relied on a stochastic simulation program. The program draws simulations of the main and ancillary parameters from their asymptotic sampling distribution, in most cases a multivariate normal with mean equal to the vector of parameter estimates and variance equal to the variance-covariance matrix of estimates (King, Tomz & Wittenberg, 2000). By default the program draws $M = 1000$ sets of simulated parameters and converts them into quantities, such as predicted values, expected values, or first differences (King, Tomz & Wittenberg, 2000). The simulation program was used to estimate the minimum, mean and maximum values of the dependent variable by setting the parameters of the independent variable to their minimum, mean and maximum values respectively.

**Results**

The estimated IRRs for ESP practices are presented in Table 5. Model 1 predicts the adoption of ESPs and includes the control variables only and is included for comparison purpose. The chi-square statistic was statistically significant ($p<0.01$) for
Model 1 with a pseudo-R$_2$ value of 0.1473. As shown in Model 1, both industry type ($p<0.05$) and market scope are significantly ($p<0.10$) associated with the number of ESPs. Moreover, the number of compliance violations for a facility were significant ($p<0.05$) and associated with the number of ESPs adopted by facilities.

### Table 5. Predicting the adoption of environmental sustainability practices†

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IRR</td>
<td>Std. Error</td>
</tr>
<tr>
<td>Size – Medium</td>
<td>1.003</td>
<td>0.327</td>
</tr>
<tr>
<td>Size – Large</td>
<td>1.542</td>
<td>0.673</td>
</tr>
<tr>
<td>Manufacturing Ind - Clean</td>
<td>2.159*</td>
<td>0.974</td>
</tr>
<tr>
<td>Manufacturing Ind - Dirty</td>
<td>1.106</td>
<td>0.524</td>
</tr>
<tr>
<td>Manufacturing Ind – Govt.</td>
<td>2.436*</td>
<td>1.351</td>
</tr>
<tr>
<td>Environmental Measures</td>
<td>1.021*</td>
<td>0.014</td>
</tr>
<tr>
<td>Parent Organization</td>
<td>-0.765</td>
<td>0.287</td>
</tr>
<tr>
<td>Foreign Market</td>
<td>2.253**</td>
<td>0.878</td>
</tr>
<tr>
<td>Noncompliance Violations</td>
<td>-0.902**</td>
<td>0.046</td>
</tr>
<tr>
<td>Production costs</td>
<td>-1.900***</td>
<td>0.525</td>
</tr>
<tr>
<td>Transaction costs</td>
<td>-0.358***</td>
<td>0.139</td>
</tr>
</tbody>
</table>

†Excluded industry dummy is the utilities industry.
*Statistically significant at $p<.10$; **statistically significant at $p<.05$; ***statistically significant at $p<.01$

Model 2 predicts the adoption of ESPs but also includes the results of the full model which includes control variables, production and transaction costs. The model’s chi-square statistic was statistically significant ($p<0.01$) with a pseudo-R$_2$ value of 0.0755 which is lower than the pseudo-R$_2$ value of Model 1(a small pseudo-R$_2$ value indicates that Model 2 is a better fit (Veall & Zimmermann, 1992; 1994)). Additionally, the Wald chi-square statistic across the models was statistically significant ($p<0.01$). In examining the IRRs in Model 2, the results show that facilities which reported their
economic performance by way of production costs and/or transaction costs were likely to adopt fewer ESPs \( (p < 0.10) \). That is, facilities with lower production and transaction costs are likely to adopt more ESPs. Specifically, facilities that reported production costs were twice \( (1.900) \) as likely to adopt fewer ESPs \( (p < 0.10) \). In contrast, facilities that reported transaction costs were slightly less likely \( (0.358) \) to adopt fewer ESPs \( (p < 0.01) \). These findings offer support for Hypotheses 1 and 2 which suggests that facilities which incur higher anticipated production or transaction costs are more likely to adopt fewer ESPs.

Related to the control variables in Model 2, environmental performance measures had a strong negative relationship with facilities’ adoption of more ESPs, suggesting that an increase in the number of environmental performance measures is associated with a decrease in the numbers of ESPs adopted \( (p < 0.05) \). Additionally, facilities which market their products overseas were likely to adopt more ESPs \( (p < 0.05) \). Moreover, the number of compliance violations were significant \( (p < 0.05) \) and influential on the number of ESPs adopted by a facility. However, facilities with a parent organization or facilities that had more than 300 employees were not likely to adopt more EMS processes \( (p > 0.10) \). Finally, facilities which operate in a ‘clean’ industry or facilities that are government-owned are likely to adopt more EMS processes \( (p < 0.05) \).

To determine whether anticipated production costs are associated with facilities’ decision to adopt fewer ESPs than anticipated transaction costs, I utilized a paired t-test of the IRR statistics in Model 2. In performing the paired t-test (Table 6), facilities which reported production costs were expected to adopt fewer ESPs by a factor of 1.90 (Table 5). By comparison, facilities which reported transaction costs were expected to adopt
fewer ESPs by a factor of 0.358. Following the paired t-test methodology the difference between the means for production costs and transaction costs was calculated. Dividing the mean difference by the difference in standard errors yielded a test statistic of 5.0680, which was statistically significant at $p=0.000$ ($df=64$). These findings indicate that ESP adoption associated with higher anticipated production costs differed significantly from higher anticipated transaction costs. These findings offer support for Hypothesis 3 which states that higher anticipated production costs are more closely associated with facilities’ decision to adopt fewer ESPs when compared to higher anticipated transaction costs.

Table 6. Paired T-Test Results for Production and Transaction Costs

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Error</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production costs</td>
<td>1.508</td>
<td>0.283</td>
<td>2.285</td>
</tr>
<tr>
<td>Transaction costs</td>
<td>0.554</td>
<td>0.209</td>
<td>1.689</td>
</tr>
</tbody>
</table>

Observations: 65
Degrees of Freedom: 64
$t$-statistic: 5.068
Probability: 0.000

Finally, facilities are expected to adopt approximately 1.23 EMS processes on average, when they incur production and transaction costs based on the results of the stochastic simulation (Table 7). As shown, facilities which incur more production and transaction costs are expected to adopt fewer EMS processes (0.907). By contrast, facilities which incur fewer production and transaction costs are expected to adopt more EMS processes (1.424).
Table 7. Estimated Number of EMS Processes Adopted by Facilities

<table>
<thead>
<tr>
<th>Estimated Number of EMS Processes Adopted†</th>
<th>Mean</th>
<th>Std. Error</th>
<th>95% Conf. Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>0.907</td>
<td>0.633</td>
<td>0.221</td>
</tr>
<tr>
<td>Mean</td>
<td>1.233</td>
<td>0.638</td>
<td>0.410</td>
</tr>
<tr>
<td>Maximum</td>
<td>1.424</td>
<td>0.704</td>
<td>0.502</td>
</tr>
</tbody>
</table>

†Based on 1000 simulations

Discussion

In practice many facilities still forego ESP adoption despite research suggesting their numerous benefits (Hart, 1995; Hart & Ahuja, 1996; Hart & Milstein, 2003; Christmann, 2000; Klassen & McLaughlin, 1996; Prahalad & Hamel, 1990; Russo & Fouts, 1997; Sharma & Vredenberg, 1998). This study offers initial evidence for the notion that both production and transaction costs are associated negatively with facilities’ ESP adoption. However, higher anticipated production costs – as compared to higher anticipated transaction costs – are more strongly associated with facilities’ adoption of fewer ESPs.

My findings are important to management scholarship for three reasons. First, it extends Walley & Whitehead’s (1994) seminal work suggesting that resistance by facility managers to adopt ESPs is likely due to the anticipated cost. It expands these ideas by critically (and empirically) examining how different types of costs are associated with facilities’ ESP adoption. My findings indicate that both production and transaction costs are significantly associated with facilities’ ESP adoption. However, my results suggest that higher anticipated production costs were more closely associated with ESP adoption when compared to higher anticipated transaction costs. One rationale for these findings may relate to the idea that facilities’ production costs involve financial outlays for
employee time and the acquisition of resources, which according to Hart (1995) are fundamental building blocks for ESP adoption. These costs also represent some of the largest expenses for facilities (USEPA, 2000), and may explain why higher anticipated production costs more strongly related to the reasons why facilities forgo ESP adoption.

The second contribution of this research is that the findings fuel the basic debate surrounding facilities’ motivation for ESP adoption. Most prior studies have focused on identifying ESP benefits (Sharma & Vredenberg, 1998; Shrivastva, 1995) which have been used as the primary argument for convincing facilities’ to adopt ESPs. However, in practice many facilities forgo adoption in spite of potential benefits. This essay adds more balance to the discussion by examining the costs associated with ESP adoption. By offering greater nuance to what is meant by costs (e.g. production and transaction costs), this research suggests why many facilities do not adopt ESPs. My analysis offers some initial justification that anticipated costs may be great motivating force when facilities are deciding whether to adopt ESPs. As such, it may be necessary to revisit the notion that both anticipated costs and potential benefits need to be considered when adopting ESPs.

The fourth contribution of this research relates to public policy. Current policies and practices encourage adoption by reporting associated ESP benefits. For example, U.S. EPA’s Sustainable Materials Management (SMM) program builds on the familiar concept of Reduce, Reuse, Recycle, and encourages a systemic approach to reduce materials use and their associated environmental impacts over their entire life cycle. Facilities that join the SMM program are anticipated to generate benefits in the form of more efficient use of energy, water and materials, reduced volume and toxicity of waste
and possible financial gains. This approach, suggests that the ESP benefits experienced by one facility will be experienced by all other facilities who adopt ESPs. However, in practice separate facilities rarely experience the same level of benefits from the same ESP (Walley & Whitehead, 1994). My research suggests anticipated production costs and transaction costs may be a differentiating factor in the adoption of ESPs. As such, policy makers should take a more pragmatic approach for encouraging adoption by enacting new knowledge-sharing programs to reduce facilities’ ESP adoption costs.

Additionally, many voluntary-based environmental programs encourage ESP adoption by way of information sharing, government-funded grants or technical assistance (Darnall, 2003). However, the effectiveness of these resources to help with the adoption process has been unclear. This research offers important evidence that informs that debate. Its findings support the notion that when compared to anticipated transaction costs, anticipated production costs are more strongly associated with less ESP adoption. As such, facilities may be more likely to adopt ESPs by way of participation in VEPs if they can help reduce their overall costs, but especially their production costs. For example, VEPs could offer tax credits for new technologies and ‘green’ jobs or subsidies for the use of renewable natural resources.

Related to future research, recent studies have suggested that companies typically choose to adopt ESPs since they might be able to generate revenue (Hart, 1995; Hart & Milstein, 2003; Christmann, 2000; Klassen & McLaughlin, 1996; Prahalad & Hamel, 1990; Russo & Fouts, 1997; Sharma & Vredenberg, 1998). However, these studies and others (e.g., Hart & Ahuja, 1996) have suggested that there may be a potential lag in
firms’ financial benefits due to their ESP adoption efforts. Future research therefore would benefit from undertaking a more longitudinal analysis to examine how costs are related with ESP adoption over time. My expectation is that the financial benefits derived from ESPs might accrue at a slower rate over time for those facilities with high production costs. If so, a more compelling case can be made for companies to reduce their production costs as much as possible as soon as possible. Similarly, prospective scholarship would benefit by examining the threshold in which production and transaction costs reduce facilities’ ESP benefits. Such an assessment may be of particular interest to business managers in helping them to understand the extent to which they should adopt ESPs. Along the way we may find there is a point of diminishing return on ESP benefits which differs across facilities and industries.

Finally, future work would benefit by improving upon this analysis in a way that accounts for other effects that might explain the relationship between facilities’ adoption of ESPs and their costs. Such an analysis would require access to a much larger dataset of facilities to simultaneously control for facilities’ self-selection of their ESPs, and data related to control and instrumental variables. For example, linking my data with other demographic datasets, such as COMPSTAT or KLD Social Ratings, would provide a better understanding of the numerous factors which influence facilities’ adoption of ESPs and their costs. Additionally, such information could be combined with my findings to create a typical ‘profile’ of demographic factors which directly influence facilities’ adoption of ESPs. While collecting these sorts of data can be costly, the results of my analysis offer some initial justification for undertaking a broader study.
Conclusion

In sum, this research extends prior studies that examine the broader connections between ESP adoption and costs. It offers some of the first empirical evidence that the suggested variation in ESP adoption specified by Walley & Whitehead (1994) is related to facilities’ costs. More specifically, I assess the extent to which production costs (such as employee time and effort and acquisition of natural resources) and transaction costs (such as the negotiation of goods and services) are associated with ESP adoption. I reveal that production and transaction costs are associated with facilities’ ESP adoption in that they follow a similar direction and trend. However, the influence of production costs related with ESP adoption is greater than the influence of transaction costs related with ESP adoption. My results suggest that companies which incur high production costs are likely to adopt fewer ESPs. These findings offer another important piece of information to managers and researchers about the need to reduce costs in order to adopt ESPs and reap greater financial benefits, while improving the natural environment.
Environmental Sustainability Practices (ESPs) are projects, programs, or initiatives that are designed to protect the environment and society and are integrated into day-to-day operations and management decisions. When facilities choose to adopt these practices, the generation of economic cost savings is believed to have a role (Cordano & Frieze, 2000; Hart, 1995; Henriques & Sadorsky, 1999; Sharma & Vredenburg, 1998; Shrivastava, 1995). For instance, the economic cost savings associated with the substitution of raw materials with renewable materials during the manufacturing process (Hart, 1995; Hart & Milstein, 1999) are expected to influence a facility’s adoption of ESPs. However, some scholars have argued that ESP adoption is costly (Nordhaus, 1992; Rienhardt, 1999; Walley & Whitehead, 1994) thereby generating fewer economic cost savings for facilities than perceived.

In practice, numerous facilities still choose to adopt ESPs even if doing so is costly and generates fewer economic cost savings than perceived. This paradox has led some scholars to suggest that facilities’ capabilities may also influence ESP adoption (Hart, 1995; Sharma & Vredenburg, 1998; Shrivastava, 1995). Such capabilities result from complex coordination between employees and other resources to effect a desired end (Amit & Shoemaker, 1993; Grant, 1991; Hart, 1995). In the context of the natural
environment, capabilities (e.g. employee knowledge, prior experience, collaborative
teams, etc.,) are essential for the adoption of ESPs (Sharma & Vredenburg, 1998) and can
facilitate adoption by reducing the cost or amount of resources (Darnall & Edwards,
2006) or knowledge required (Russo & Fouts, 1997).

To date, prior ESP adoption research has examined complementary capabilities,
and economic cost savings separately. For instance, both complementary capabilities and
economic cost savings have been associated with the adoption of more ESPs (Hart, 1995;
Hart & Milstein, 1999; Porter & van der Linde, 1995; Sharma & Vredenburg, 1998;
Shrivastava, 1995), while economic costs have been argued to lead to the generation of
fewer savings than perceived (Walley & Whitehead, 1994). When considering these
relationships together, a dynamic cooperative paring appears to exist since each holds the
possibility of encouraging ESP adoption. For instance, facilities that have previously
adopted quality management systems are more likely to adopt some types of ESPs, since
both practices require similar knowledge, cross-functional communication and other tacit
capabilities (Hersey, 1998; Scrimshire, 1996; Zutshi & Sohal, 2004). By doing so, the
amount of time and resources needed to adopt ESPs may be reduced (Corbett & Kirsch,
2000; Zutshi & Sohal, 2004) generating economic cost savings. But as of yet, the
cooperative relationship between complementary capabilities, economic cost savings and
ESP adoption has not been addressed conceptually or empirically.

This paper examines this partnership by assessing the moderating effect of
complementary capabilities on the relationship between facilities’ perceived economic
cost savings and their adoption of ESPs. To examine these relationships I used a bivariate
probit regression analysis and survey data for 4,013 manufacturing facilities operating in
Canada, France, Germany, Hungary, Japan, Norway and the U.S. The results of my
analysis indicate that complementary capabilities positively moderate the relationship
between perceived economic cost savings and facilities’ ESP adoption even after
controlling for self-selection effects related to ESP adoption decisions. Knowledge of this
relationship offers three important contributions to existing management literature. First,
this research offers evidence of the positive moderating effect of complementary
capabilities on perceived economic cost savings, such that facilities may still choose to
adopt ESPs even if doing so is costly. Second, this research suggests policy makers may
have greater success encouraging ESP adoption by enacting new programs that enhance
facilities’ complementary capabilities. Finally, this research examines these relationships
using data that were collected in six countries and across numerous manufacturing
sectors. The results therefore are applicable to multiple international and organizational
settings.

**Economic Cost Savings and Facilities’ Adoption of Environmental Sustainability Practices**

An organization’s primary economic motive is to generate revenue while
increasing cost savings to enhance profitability (Porter, 1980). Economic cost savings are
those activities undertaken by organizations to reduce direct and indirect labor, materials,
and allocatable utilities that are incurred by a facility during manufacturing (Walker &
Weber, 1984). Economic cost savings are an inverse indicator of facilities’ economic
costs since organizations that reduce their costs derive a savings from doing so (Coase,
1937; Porter, 1980; Williamson, 1979). Related to strategy and profitability, economic
cost savings can help explain facilities’ changes over time (Safizadeh, Field & Ritzman, 2008; Teece, 1982). For example, in the manufacturing industry, economic cost savings are very influential when facilities’ contemplate vertical integration decisions (McIvor, 2009; Leiblein & Miller, 2003; Parmigiani, 2007). These savings can also influence decisions associated with internal production processes such as the adoption of new technologies or the substitution of raw materials (Alchain & Demsetz, 1972; Milgrom & Roberts, 1990). Finally, these savings influence outsourcing decisions (Safizadeh, Field & Ritzman, 2008) for facilities operating within the financial services industry.

Related to organizations and the natural environment, economic cost savings have been associated with the development or selection of environmental policy (McCann, et al., 2005; Baldrusson & von der Fehr, 2004; Zhao & Kling, 2003; Venkatachalam, 2008; Vatn, 2005; Schneider & Volkert, 1999) and whether to use marketable permits for pollution control (Montero, 1998; Netusil & Braden, 2001; Woerdman, 2001).

Economic cost savings also influence the extent to which facilities adopt ESPs. For instance, the cost savings associated with the substitution of raw materials with renewable materials during the manufacturing process (Hart, 1995; Hart & Milstein, 1999) are expected to influence a facility’s adoption of more ESPs. Also, the cost savings generated by reducing unnecessary packaging when incorporating ‘cradle-to-grave’ design into current manufacturing processes (Porter & van der Linde, 1995; Sharma & Vredenburg, 1998) are expected to encourage ESP adoption. In addition, the costs savings generated by the better utilization of inputs which creates less waste to dispose (Hart, 1995; Hart & Milstein, 2003) are likely to encourage more ESP adoption. The
economic cost savings created by eliminating the use of end-of-pipe control devices (Hart, 1995; Porter & van der Linde, 1995; Shrivastava, 1995) is also expected to influence the adoption of more ESPs. Finally, the economic cost savings related to the reduction of liability costs and legal fees (Hart, 1995; Shrivastava, 1995) may also encourage more facilities to adopt ESPs.

More comprehensive ESPs, such as environmental management systems (EMS), may also generate economic cost savings for facilities. An EMS is a collection of processes that enable facilities to continually reduce all aspects of their impact on the natural environment. By adopting EMSs, facilities can generate economic cost savings by decreasing energy costs, reducing water consumption, lowering expenses for waste disposal and treatment, and reducing remediation costs (Hersey, 1998). Other potential economic cost savings include a decrease in greenhouse gases, a lower potential for spills and releases, improved employee safety and less toxic and hazardous wastes (Corbett & Kirsch, 2000). For these reasons, there is a general belief that ESPs which are perceived to generate economic cost savings are more likely to be adopted by facilities.

However, otherwise similar facilities may perceive the generation of economic cost savings differently. This variation in perception can result from differences in parent companies’ organizational structure, strategic position, financial issues and managerial preferences (Delmas & Toffel, 2004; Hart, 1995; Henriques & Sadorsky, 1999). Managers are often responsible for identifying and implementing strategic initiatives for the organization (Floyd & Wooldridge, 1997) which includes ESP adoption. In that role, they evaluate the potential generation of economic cost savings for based on prior
experience (Grinblatt & Titman, 2002; Stickney & Weil, 2000) and their perceptions are expected to influence ESP adoption (Cordano & Frieze, 2000; Henriques & Sadorsky, 1999). Because of their central role, manager’s perceptions of economic cost savings are the focus of this research.

Finally, some scholars have argued that ESP adoption is costly (Walley & Whitehead, 1994) thereby generating fewer economic cost savings for facilities than perceived. This has led researchers to suggest that facilities’ capabilities can enhance the generation of economic cost savings (Hart, 1995; Hart & Ahuja, 1996; Sharma & Vredenberg, 1998). The moderating relationship between a facility’s complementary capabilities, its perceived economic cost savings and ESP adoption is described further below.

**Complementary Capabilities and Perceived Economic Cost Savings**

Capabilities encompass the way things are done in a facility or its processes which result from complex patterns of coordination among people and between people and other resources (Grant, 1991; Teece, Pisano & Shuen, 1997). Unlike physical assets, which deteriorate over time, capabilities are enhanced as they are applied (Prahalad & Hamel, 1990). The intangible and knowledge-based processes necessary for ESP adoption may be acquired with fewer resources if complementary capabilities already exist (Darnall & Edwards, 2006). A capability is considered complementary to ESP adoption if it facilitates the generation of economic cost savings.

I suggest that there are three aspects of facilities’ complementary capabilities – synergism, availability, and transferability – that positively moderate the relationship
between facilities’ economic cost savings and their decision to adopt ESPs as shown in Figure 5.

**Figure 5. Complementary Capabilities, Economic Cost Savings, and Facilities’ Decision to Adopt Environmental Sustainability Practices**

**Synergism**

A synergistic bundle is the aggregation of several independent, complementary capabilities into a well-organized process or procedure. By virtue of their synergy, these bundles have extraordinary idiosyncratic attributes which can help to reduce costs associated with the ESP adoption. For instance, quality management systems (QMSs) are known to generate synergistic bundles of complementary capabilities for facilities. QMSs consist of an integrated set of practices that emphasize continuous improvement, meeting customers’ requirements, increased employee involvement and teamwork, process redesign, and constant measurement of results (Powell, 1995). As part of their continual improvement process, QMSs incorporate the monitoring of manufacturing processes and procedures, the communication across different operational functions, leadership endorsement, and the implementation of corrective action plans. Each of these synergistic bundles can facilitate ESP adoption since QMSs share a common framework of policies.
and procedures with many other ESPs (Scrimshire, 1996; Zutshi & Sohal, 2004). For instance, when implementing quality management procedures, businesses develop formal processes for documenting and collecting the data collected during the manufacturing process. Similarly, as part of many ESPs, businesses need to retain important documents and data related to environmental protection (Scrimshire, 1996). Although the documents and data used for quality and environmental management may be different, the process for achieving document and data control can be integrated and systematized (Chichowicz, 1996). Because of their commonalities, the amount of time and resources needed to adopt ESPs may be reduced (Corbett & Kirsch, 2000; Zutshi & Sohal, 2004). The synergistic bundles of complementary capabilities that are developed as a part of a facility’s QMS therefore appear to positively moderate facilities’ perceived economic cost savings associated with ESP adoption.

**Availability**

Availability refers to the degree to which capabilities are accessible at some unknown point in time. In practice, not all complementary capabilities may be available for ESP adoption due to limitations such as low quantity, geographic location or inability to be reassigned. For example, facilities with QMSs typically have developed internal evaluation experience since annual reviews and audits are required to ensure continual performance. In turn, prior evaluation experience can be leveraged to facilitate the adoption of ESPs since they also require annual reviews and audits to ensure continual performance. By putting their prior evaluation experience into action, facilities may be able to moderate their time and labor costs (Corbett & Kirsch, 2000) necessary for ESP adoption.
adoption. Similarly, facilities readily available capabilities may enhance economic cost savings associated with ESP adoption.

**Transferability**
Transferability relates to the facilities’ capacity to move its complementary capabilities from one unit within an organization to another. The transferability of capabilities across organizational units is expected to heighten the exchange of tacit knowledge between employees increasing overall efficiency during adoption (Darnall, Gallagher, Andrews & Amaral, 2000). For example, quality management practices necessitate that facility employees work in multi-collaborative teams so that product quality practices are enacted across departments (Grant, Shani & Krishnan, 1994). Similarly, ESPs require cross-functional coordination among departments and working in multi-collaborative teams (Hart, 1995). As such, businesses that have existing multi-collaborative teams related to quality management can more readily transfer these existing attributes towards the development of ESPs (Cordano & Frieze, 2000; Hart, 1995). In so doing, these facilities are anticipated to moderate their time and labor costs associated with ESP adoption (Scrimshire, 1996; Zutshi & Sohal, 2004).

For these reasons, I anticipate that facilities’ complementary capabilities positively moderate the relationship between perceived economic cost savings and ESP adoption.

_Hypothesis: Complementary capabilities positively moderate the relationship between facilities’ perceived economic cost savings and their adoption of_
environmental sustainability practices such that the relationship is stronger for businesses with more complementary capabilities.

Methodology

Data: To evaluate my hypotheses, I relied on data collected from a twelve-page survey that was developed by the OECD Environment Directorate and university researchers from Canada, France, Germany, Hungary, Japan, Norway and the U.S. The survey was pretested with over 100 facilities in France, Canada and Japan before it was finalized (Labonne & Johnstone, 2005). Prior to its dissemination, the survey was translated into each country’s official language and back-translated to validate the accuracy of the original translation (Johnstone, et.al., 2007). The survey consisted of questions which solicited information on facilities’ characteristics (sector, size, stock market listing, etc.), commercial conditions (markets, competition, sales, profitability), public environmental policy framework (regulatory stringency, policy instruments) and management practices (environmental and otherwise) (Labonne & Johnstone, 2005).

In 2003, the postal survey was distributed to a sample of 17,000 manufacturing facilities having at least 50 employees. It targeted managers who were responsible for the facility’s environmental activities. The manufacturing sector was selected because it is commonly accepted as having significant environmental impacts to the air, soil, and water (Arora & Cason, 1996). The OECD survey included a stamped return envelop and contact details if respondents had questions. Additionally, the OCED sent two sets of reminders to increase response rates. The response rate was 24.7 percent (4,187) which is similar to previous studies of organizations’ environmental and social practices (e.g.
Christmann, 2004; Greening & Gray, 1994; Sharma & Henriques, 2005), where response rates were 20, 27 and 25 percent, respectively.

To check for common method variance, I relied on the post-hoc single-factor test developed by Harmon (1967). This test examines the variance between the independent and dependent variables by factor analysis such that if the data result in a single factor accounting for the majority of the covariance substantial bias exists (Doty & Glick, 1998). Social desirability bias was addressed by ensuring anonymity for all respondents. For Canada, France, Germany, Hungary, Japan and Norway there was no evidence that respondents always over- or under-reported data in a consistent manner since there are variations in facility responses (Labonne & Johnstone, 2005). However, for U.S. facilities, some industries were over- or under-represented (Darnall, Potoski & Prakash, 2010). Following the standard practice for addressing response bias I weighted the U.S. portion of the sample to reflect the actual industry representation within the U.S. Nonresponse bias was addressed by assessing the industry representation and facility size of the sample relative to the distribution of facilities in the broader population (Johnstone, et al., 2007).

**Dependent Variable**

To measure whether or not a facility had adopted an ESP, I determined whether each facility implemented an environmental management system (EMS). An EMS is a collection of processes that enable facilities to continually reduce their impact on the natural environment. Unlike government regulation, which imposes requirements on organizations from the outside, an EMS is a proactive regulatory structure that arises
from within the organization (Coglianese & Nash, 2001). EMSs consist of an environmental policy, as well as a set of evaluation process that require facilities to assess their environmental impacts, establish goals, implement environmental goals, monitor goal attainment, and undergo management review (Lamprecht, 1997; Netherwood, 1998).

At the most basic level an EMS can help organizations assure that their management practices conform to environmental regulations. However, the EMS structure assists enterprises to scrutinize their internal operations, engage employees in environmental issues, continually monitor their progress, achieve greater efficiencies, and create opportunities for improving their strategic value, because at a basic level they depend upon intensive employee involvement (Lawler, 1986; Hart 1995; Cole, 1991). EMSs are considered an ESP because they help move businesses beyond compliance with regulatory requirements (Darnall, Henriques & Sadorsky, 2008).

To assess whether facilities had actually adopted an EMS, I drew on the OCED survey question which asked: “Has your facility actually implemented an environmental management system?” Facility managers replied either “Yes,” “In progress” or “No”. Since facilities that were “In progress” had committed to adopting EMS, I combined these responses with “Yes”.

**Independent Variables**

Perceived Economic Costs: Perceived economic costs were measured using two perceived cost savings variables. Perceived economic costs were assessed by relying on OECD survey data that asked facility managers “How important do you consider cost savings to have been with respect to environmental practices of your facility?”
Respondents indicated the importance of two types of cost savings: cost savings in terms of inputs/waste management and cost savings in general. Using a three-point Likert scale, respondents indicated whether each type of cost savings was “not important” = 1, “moderately important” = 2, or “very important” = 3.

Complementary Capabilities: To measure facilities’ complementary capabilities for ESP adoption, I accounted for whether or not they had quality management capabilities. More specifically, I relied on data derived from an OECD survey question that asked facility managers, “Has your facility implemented a QMS (e.g. ISO 9000).” Facility responses were coded 1 = “Yes” and 0 = “No.”

Finally, a high correlation may exist between facilities which implemented a QMS and perceived cost. To deal with issues of multicollinearity, I centered the perceived cost variables. By subtracting the means from each of the perceived cost variables, I was able to clarify the relationship between the two variables and avoid problems with possible multicollinearity.

Instrumental Variable: Before exploring the relationship between an organization’s transaction costs and EMS adoption, it was necessary to consider whether businesses that adopt an EMS do so because of some exogenous factors that are also correlated with their quality management capabilities. The origin of the concern relates to the fact that adoption of QMS is subject to selection bias. That is, businesses may “self-

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4 Given their similar scope, the data from the survey questions related to cost savings in terms of inputs and waste management were combined using common factor analysis. The factor demonstrated a large positive eigenvalue (1.72) and together accounted for 91 per cent of the total variance (with subsequent varimax rotation). Reliability was assessed for the factor using Cronbach’s alpha—0.94 was reported for the factor analysis—where values over 0.7 are suitable for basic research (Peterson, 1994). The results are presented in Appendix I.
select” to adopt a QMS because of observed or unobserved characteristics that are correlated with their EMS, and these characteristics must be controlled for by way of empirical instrumentation.

In selecting an instrument, I needed a robust predictor of QMS adoption that was likely to be unrelated to EMS adoption. I selected the importance of facilities’ product quality factors in their ability to compete in the market. QMSs are developed as a consequence of a facility’s motivation to develop its product quality differentiation strategy (Schonberger, 1992). However, product quality differentiation strategies are not likely to be related to ESP adoption, even though environmental differentiation may be an important goal of ESP adoption. It therefore is plausible to assume that whether or not a facility used a product quality differentiation strategy to compete in the market is unrelated to whether or not it considers or implements an EMS. I measured facilities’ product quality differentiation strategy by relying on an OECD survey question that asked facilities to assess how important “product quality factors were in your facility’s ability to compete on the market for its most important products within the past three years.” Using a three-point Likert scale, respondents indicated whether product quality factors were ‘not important’ = 1, ‘moderately important’ = 2, or ‘very important’ = 3. I used a dummy variable that took the value of one if facilities reported that product quality impacts the business’ ability to compete in the market.

Endogeneity would lower the estimated effect of QMS on EMS adoption, and my estimate would therefore represent a lower bound of the impact of QMS on EMS.
adoption. A finding that quality management capabilities are related with EMS adoption therefore would be robust against these instrumentation issues.

Control Variables: To account for the possibility that facilities using a great deal of natural resources in the manufacturing processes may be more sensitive to the potential impact these resources may have on the environment (Sharma & Henriques, 2005), I relied on survey data that asked respondents to rank their negative environmental impacts. Specifically, facilities were asked to “consider the potential for negative environmental impacts from your facility’s products and production processes” as it relates to the use of natural resources (1 = no negative impacts; 2 = moderate negative impacts; 3 = large negative impacts).

To control for pressures from regulatory stakeholders and their influence on ESP adoption (Henriques & Sadorsky, 1999) I relied on OECD survey data that asked managers how many times they have been inspected by public environmental authorities (central, state/province, and municipal governments) in the last three years. Facility responses were coded 1 = “Yes”, 0 = “No.”

I accounted for whether or not facilities were publicly traded since publicly traded facilities differ significantly from privately owned operations (Mascarenhas, 1989). While there is some overlap between ownership structures in funding streams and disposition of revenues, there are clear differences in who is served by the facility’s productive capacity and its general aim (James, 1983). Additionally, publicly traded and privately owned facilities have varied levels of resources and capabilities available for developing a proactive environmental strategy which relate to their organizational

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structure (Darnall & Edwards, 2006). Whether or not the facility was publicly traded were measured by using OECD survey data indicating whether the facility was listed on a stock exchange. Facilities’ responses were coded 1 = “Yes” and 0 = “No”.

I also accounted for whether or not facilities were foreign owned. Foreign owned facilities are likely to contend with a broader array of pressures from stakeholders both at home and abroad. For instance, Nakamura et al. (2001) suggest that foreign owners may increase their environmental initiatives to secure goodwill from the regulatory authorities of their host country so as to increase their legitimacy in the eyes of these authorities. Facilities which were foreign-owned were coded 1 = “Yes” or 0 = “No”.

Other controls related to organizations operating in a competitive or global market since they are more likely to adopt EMSs in order to be recognized as being green or environment-friendly (Darnall, Gallagher, Andrews & Amaral, 2000). I accounted for this by relying on an OECD survey question that asked “What best characterizes the scope of your facility’s market?” Respondents were able to choose from (1= local, 2 = national, 3 = regional (neighboring countries), 4 = global). Facilities which indicated they participated in regional or global markets were coded as 1 = “Yes” or 0 = “No”.
Likewise, I constructed three dummy variables to account for the facility’s market concentration, which equal one if the number of competitors for the facility’s most commercially important product is fewer than five (zero, otherwise), if the facility’s number of competitors is between 5 and 10 (zero, otherwise), or if the number of competitors is greater than 10 (zero, otherwise). The omitted reference category is “less than five competitors.”
Similarly, older operations often utilize mature environmental technologies and capital equipment (Portney & Stavins, 2000), which may affect a facility’s decision to adopt ESPs. As such, I controlled for facility’s age. To control for the size of facilities’ operations, I determined how many full-time workers (logged) were employed at the facility. Finally, I controlled for industry and country by using dummy variables to account for manufacturing sector and country of operation. The USA was the omitted country dummy variable and the chemical sector was the omitted dummy variable.

Table 8 provides the correlation coefficients and descriptive statistics for each of the variables used in the multivariate probit regression analysis. The majority of the variables had statistically significant (p=0.01) correlations, with the strongest correlation (>0.80) occurring between the interaction variable. The correlation occurring between the two interaction variables (QMS and economic costs) was expected since they represent the direct integration of quality management variables and economic cost variables for the study. I assessed variance inflation factors (VIFs) test to determine if multicollinearity might be problematic among the variables. The resulting VIFs scores were each close to one and much less than the recommended maximum threshold of 10, indicating that multicollinearity between variables is not a concern (Kennedy, 2008). As a result, all of the variables, including the two interaction variables, were used in my analysis.
## Table 8. Correlation Coefficients and Descriptive Statistics

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<th>1</th>
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<td>-0.05***</td>
<td>0.02</td>
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<tr>
<td>Impact of natural res</td>
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<td>0.11***</td>
<td>0.04***</td>
<td>0.07***</td>
<td>0.07***</td>
<td>1.00</td>
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<tr>
<td>Regulatory influence</td>
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<td>0.12***</td>
<td>0.07***</td>
<td>0.04**</td>
<td>0.03</td>
<td>0.09***</td>
<td>1.00</td>
<td></td>
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<tr>
<td>Product Quality</td>
<td>0.13***</td>
<td>0.05***</td>
<td>0.06***</td>
<td>0.16***</td>
<td>-0.01</td>
<td>0.05***</td>
<td>0.04***</td>
<td>1.00</td>
<td></td>
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<tr>
<td>Qual Mgmt Sysm (QMS)</td>
<td>0.23***</td>
<td>0.12***</td>
<td>0.11***</td>
<td>0.14***</td>
<td>-0.01</td>
<td>0.14***</td>
<td>0.07***</td>
<td>0.10***</td>
<td>1.00</td>
<td></td>
<td></td>
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<tr>
<td>Perceived cost savings - input</td>
<td>0.25***</td>
<td>0.21***</td>
<td>0.17***</td>
<td>0.24***</td>
<td>0.04**</td>
<td>0.19***</td>
<td>0.18***</td>
<td>0.12***</td>
<td>0.14***</td>
<td>1.00</td>
<td></td>
<td></td>
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<tr>
<td>Perceived cost savings - general</td>
<td>0.16***</td>
<td>0.10***</td>
<td>0.07***</td>
<td>0.06***</td>
<td>-0.01</td>
<td>0.14***</td>
<td>0.10***</td>
<td>0.09***</td>
<td>0.04***</td>
<td>0.23***</td>
<td>1.00</td>
<td></td>
<td></td>
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<tr>
<td>QMS x PC - savings</td>
<td>0.20***</td>
<td>0.19***</td>
<td>0.16***</td>
<td>0.21***</td>
<td>0.03*</td>
<td>0.14***</td>
<td>0.13***</td>
<td>0.10***</td>
<td>0.04***</td>
<td>0.88***</td>
<td>0.20***</td>
<td>1.00</td>
<td></td>
<td></td>
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<tr>
<td>QMS x PC - general</td>
<td>0.27***</td>
<td>0.14***</td>
<td>0.13***</td>
<td>0.14***</td>
<td>-0.01</td>
<td>0.18***</td>
<td>0.09***</td>
<td>0.12***</td>
<td>0.87***</td>
<td>0.22***</td>
<td>0.44***</td>
<td>0.15***</td>
<td>1.00</td>
<td></td>
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<tr>
<td>EMS Adopted</td>
<td>0.28***</td>
<td>0.18***</td>
<td>0.11***</td>
<td>0.05***</td>
<td>0.01</td>
<td>0.25***</td>
<td>0.17***</td>
<td>0.04***</td>
<td>0.27***</td>
<td>0.17***</td>
<td>0.08***</td>
<td>0.12***</td>
<td>0.27***</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Mean                  | 325 | 0.17 | 0.12 | 0.50 | 42.6 | 1.85 | 0.20 | 2.83 | 0.72 | 1.10 | 2.29 | 0.06 | 1.67 | 0.37 |
Std. Dev.             | 848 | 0.37 | 0.32 | 0.50 | 36.7 | 0.68 | 0.40 | 0.39 | 0.45 | 0.94 | 0.69 | 0.82 | 1.18 | 0.48 |
Variance Inflation Factors | 1.10 | 1.25 | 1.20 | 1.33 | 1.13 | 1.14 | 1.07 | 1.05 | 8.88 | 5.12 | 3.51 | 4.72 | 14.72 | 1.37 |

Notes: n = 4,013  
*Statistically significant at p<.10; **Statistically significant at p<.05; ***Statistically significant at p<.01
Empirics

I estimated my relationships of interest using a bivariate probit regression analysis. Bivariate probit regression does not use standard linear numerical approximation to estimate the outcomes but rather use a simulation method to estimate maximum likelihood (Woolridge, 2009). The maximum likelihood approach employs a two-stage model to control for selection bias where the second stage estimates a two-way choice response (Greene, 2003) that reflects the nature of my bivariate dependent variable: no EMS adoption or EMS adoption. In estimating the interrelationship, a bivariate probit regression produces “rho” from the first portion of model estimation. Since rho represents a non-linear function of the variables in the first portion of model estimation, the second portion is identified even without instrumental variables via the normality assumption for the probit model (Greene, 2003). When rho is statistically different from zero (α=.05), there is at least a 95 percent probability that a relationship exists between the factors associated with organizations’ perceived economic costs and the factors associated with EMS adoption such that simulation method to maximize likelihood estimation are essential to appropriate estimation. Model significance in bivariate probit estimation was determined by evaluating the Wald chi-square value.

The survey data were used in two stages in the bivariate probit analysis (Table 9). Additionally, the bivariate probit analysis was used to examine the data in three ways. Model 1 of the analysis examines facilities’ motivations for adopting QMS using the instrumental variable and the control variables. Model 2 of the analysis builds on Model 1 by examining facilities’ motivations for not adopting EMS or actually adopting an
EMS. Model 3 of the analysis builds on Model 2 by using the interaction variables, the perceived economic costs and control variables to estimate facilities’ motivations for not adopting EMS or actually adopting an EMS.

A likelihood ratio test was used to evaluate the improvement in statistical fit between the three models (Kennedy, 2008). If the difference between the models is statistically significant, then the less restrictive model (the one with more variables) is said to fit the data significantly better than the more restrictive model (Greene, 2003).

Additionally, I computed the marginal effects for each perceived economic cost savings variable to determine whether the moderating relationship is stronger for savings related to inputs/waste management or savings in general. Marginal effects were calculated as the first derivative to the bivariate probit function with respect to the cost savings variable of interest.

**Results**
Model 1 evaluates the relationship between the control variables and facilities’ decision not adopt EMS or adopt an EMS (Table 10), and is included for comparison purposes. In Model 1, the Wald chi-square statistic (1,211) and the Wald test of rho (11.31) were statistically significant ($p<0.01$). Related to the control variables for Model
1, facilities which reported that their impact of natural resources was significant were more likely \( (p<0.01) \) to adopt an EMS. A more stringent regulatory environment was also related \( (p<0.01) \) to the adoption of an EMS. Additionally, facilities with a publicly-traded parent company were more likely \( (p<0.01) \) to adopt an EMS. Facilities which had foreign parent companies and those that operated in a competitive or global market were more likely \( (p<0.01) \) to adopt an EMS. The number of competitors (0-5) in the marketplace was significant \( (p<0.01) \). However, the age of the facility did not factor into its decision to adopt an EMS, but the size of the facility (measured as the log of the number of employees) was significant \( (p<0.01) \). Facilities operating within food and beverages or nonmetallic metals or machinery equipment industries were less likely \( (p<0.01) \) to adopt an EMS but those in the transportation were more likely \( (p<0.01) \) to adopt EMS. U.S. facilities were more likely to adopt an EMS than Germany \( (p<0.10) \) and Hungary \( (p>0.10) \), but were less likely to adopt an EMS \( (p<0.01 \text{ -0.10}) \) than Canada and Japan.

Model 2 evaluates the relationship between facilities’ decision to adopt EMS and perceived economic cost savings (Table 10). For the model, the Wald chi-square statistic \( (1,457) \) and the Wald test of rho \( (12.04) \) were statistically significant \( (p<0.01) \). A likelihood ratio test was performed between Model 1 and Model 2 to evaluate the improvement in statistical fit. Results of the likelihood test were significant \( (p<0.01) \) indicating that Model 2 is an improvement in fit over Model 1. In examining a perceived reduction in cost savings in terms of inputs/waste management, the results suggest that they are associated with a greater likelihood of facilities which adopt EMS \( (p<0.01) \).
Additionally, perceived reductions in general cost savings were associated with a greater likelihood of facilities which consider EMS adoption ($p > 0.01$). Related to the control variables for Model 2, each are closely similar to the control variable coefficients of Model 1 in terms of significance, direction and trend.

Model 3 evaluates the relationship between the interaction variables (perceived economic costs and complementary capabilities) and facilities’ decision to adopt EMS (Table 10). For the model, the Wald chi-square statistic (1,678) and the Wald test of rho (21.32) was statistically significant ($p < 0.01$). A likelihood ratio test was performed between Model 2 and Model 3 to evaluate the improvement in statistical fit. Results of the likelihood test were significant ($p < 0.01$) indicating that Model 3 is an improvement in fit over Model 2. In examining the interaction between perceived reduction in cost savings in terms of inputs/waste management and complementary capabilities, the results suggest that they moderate perceived costs and are associated with a greater likelihood of EMS adoption ($p < 0.01$). Additionally, the interaction between facilities’ perceived reduction in general cost savings and complementary capabilities are associated with a greater likelihood of EMS adoption ($p < 0.10$). These findings offer support for my hypothesis, which suggests that complementary capabilities moderate the relationship between facilities’ perceived economic costs and their adoption of ESPs. Related to the control variables for Model 3, each are closely similar to the control variable coefficients of Model 1 and Model 2 in terms of significance, direction and trend as described above.
Table 10. Results from Second-Stage Bivariate Probit Regression Analysis (Predicting the Moderating Impact of Complementary Capabilities’ on Perceived Economic Cost Savings and ESP Adoption†)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1 (Control Variables)</th>
<th>Model 2 (Perceived Economic Cost Savings)</th>
<th>Model 3 (Perceived Economic Cost Savings and Complementary Capabilities)</th>
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<td></td>
<td>Coeff. Std. Error</td>
<td>Coeff. Std. Error</td>
<td>Coeff. Std. Error</td>
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<td>Impact of natural resources</td>
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<td>Regulatory influence</td>
<td>0.454*** 0.059</td>
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<td>Publicly traded</td>
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<td>0.344*** 0.064</td>
<td>0.353*** 0.067</td>
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<td>Foreign owned</td>
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<td>0.401*** 0.070</td>
<td>0.408*** 0.073</td>
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<td>0.281*** 0.053</td>
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<td>Number of competitors, 0-5</td>
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<td>0.140*** 0.052</td>
<td>0.141*** 0.058</td>
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<tr>
<td>Number of competitors, 5-10</td>
<td>0.092** 0.051</td>
<td>0.103** 0.048</td>
<td>0.093* 0.051</td>
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<td>Age</td>
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<td>-0.001** 0.001</td>
<td>-0.001** 0.001</td>
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<tr>
<td>Size</td>
<td>0.381*** 0.024</td>
<td>0.366*** 0.023</td>
<td>0.360*** 0.025</td>
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<td>Quality Mgmt System</td>
<td>0.699*** 0.244</td>
<td>0.947*** 0.126</td>
<td>0.944*** 0.268</td>
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<td>Food, beverages, textiles</td>
<td>-0.505*** 0.075</td>
<td>-0.516*** 0.074</td>
<td>-0.530*** 0.078</td>
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<td>Pulp, paper, print</td>
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<td>-0.101 0.159</td>
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<td>Nonmetallic minerals, metals</td>
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<td>-0.220*** 0.074</td>
<td>-0.244*** 0.078</td>
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<td>0.430*** 0.156</td>
<td>0.389*** 0.154</td>
<td>0.399*** 0.160</td>
</tr>
<tr>
<td>Canada</td>
<td>0.211* 0.110</td>
<td>0.256* 0.106</td>
<td>0.243* 0.112</td>
</tr>
<tr>
<td>France</td>
<td>0.205** 0.109</td>
<td>0.267** 0.106</td>
<td>0.229** 0.114</td>
</tr>
<tr>
<td>Germany</td>
<td>-0.036 0.085</td>
<td>-0.097 0.086</td>
<td>-0.039 0.097</td>
</tr>
<tr>
<td>Hungary</td>
<td>0.089*** 0.101</td>
<td>0.311*** 0.092</td>
<td>0.275*** 0.100</td>
</tr>
<tr>
<td>Norway</td>
<td>0.243*** 0.107</td>
<td>0.336*** 0.102</td>
<td>0.292*** 0.110</td>
</tr>
<tr>
<td>Japan</td>
<td>0.658*** 0.084</td>
<td>0.995*** 0.079</td>
<td>0.995*** 0.084</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.09*** 0.256</td>
<td>-2.57*** 0.230</td>
<td>-2.58*** 0.265</td>
</tr>
<tr>
<td>Perceived cost savings - inputs</td>
<td>0.375*** 0.031</td>
<td>0.593*** 0.077</td>
<td>0.593*** 0.077</td>
</tr>
<tr>
<td>Perceived cost savings - general</td>
<td>0.059** 0.028</td>
<td>0.130** 0.059</td>
<td>0.130** 0.059</td>
</tr>
<tr>
<td>TQM x PC– savings</td>
<td>0.233*** 0.064</td>
<td>0.233*** 0.064</td>
<td>0.233*** 0.064</td>
</tr>
<tr>
<td>TQM x PC - general</td>
<td>0.087* 0.067</td>
<td>0.087* 0.067</td>
<td>0.087* 0.067</td>
</tr>
</tbody>
</table>

| Observations                     | 4,013                        | 4,013                                    | 4,013                                    |
| Wald Chi2(40)                    | 1,211.36***                  | 1,457.32***                             | 1,678.01***                             |
| Rho                              | 0.000***                     | 0.000***                                | 0.000***                                |
| Wald test of rho=0 Chi2(1)       | 11.31                        | 12.04                                   | 21.32                                   |

†Excluded industry dummy is the petroleum, chemicals, and rubber products industry. Excluded country: United States
*Statistically significant at p<.10; **statistically significant at p<.05; ***statistically significant at p<.01

Table 11 presents the results of the first-stage bivariate probit analysis by estimating facilities’ motivations for adopting quality management capabilities. The instrumental variable, product quality represents facilities’ differentiation strategies that
are not likely to be related to ESP adoption. In Model 1, the Wald chi-square statistic (1,211) and the Wald test of rho (11.31) were statistically significant ($p<0.01$). For Model 2, the Wald chi-square statistic (1,457) and the Wald test of rho (12.04) were statistically significant ($p<0.01$). In Model 3, the Wald chi-square statistic (1,678) and the Wald test of rho (21.04) was statistically significant ($p<0.01$). A likelihood ratio test was performed between all three models to evaluate the improvement in statistical fit. Results of the likelihood test were significant ($p<0.01$) indicating that Model 3 is an improvement in fit over Model 1 and Model 2.

Across all three models (Model 1, Model 2, and Model 3) the instrumental variable, product quality was significant ($p=0.01$) suggesting it is related to facilities’ QMS adoption (Table 11). As such, facilities that are concerned with product quality are more likely to have QMS. Additionally, the majority of the other control variables are significant ($p=0.01$) across all three models (Model 1, Model 2, and Model 3) with the exception of those facilities operating within the machinery, media equipment or transportation manufacturing industry.

To determine whether the moderating relationship of QMS adoption is stronger for perceived cost savings related to inputs/waste management or cost savings in general, I computed the marginal effects for each perceived cost savings variable (Table 12). Marginal effects were calculated as the first derivative to the bivariate probit function with respect to the perceived cost savings variable of interest. For each perceived cost savings variable, there is a direct effect, an indirect (QMS moderation) effect, and a total...
Table 11. Results from First-Stage Bivariate Probit Regression (Assessing the Relationship between Instrumental and Control Variables†)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1 (Control Variables)</th>
<th>Model 2 (Perceived Economic Cost Savings)</th>
<th>Model 3 (Perceived Economic Cost Savings and Complementary Capabilities)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff.</td>
<td>Std. Error</td>
<td>Coeff.</td>
</tr>
<tr>
<td>Product Quality</td>
<td>0.239***</td>
<td>0.056</td>
<td>0.235***</td>
</tr>
<tr>
<td>Publicly traded</td>
<td>0.2238***</td>
<td>0.074</td>
<td>0.236***</td>
</tr>
<tr>
<td>Foreign owned</td>
<td>0.325***</td>
<td>0.083</td>
<td>0.3335***</td>
</tr>
<tr>
<td>Market scope</td>
<td>0.318***</td>
<td>0.053</td>
<td>0.319***</td>
</tr>
<tr>
<td>Number of competitors, 0-5</td>
<td>0.133**</td>
<td>0.057</td>
<td>0.129**</td>
</tr>
<tr>
<td>Number of competitors, 5-10</td>
<td>0.133***</td>
<td>0.052</td>
<td>0.131**</td>
</tr>
<tr>
<td>Age</td>
<td>-0.002***</td>
<td>0.001</td>
<td>-0.002**</td>
</tr>
<tr>
<td>Size</td>
<td>0.319***</td>
<td>0.026</td>
<td>0.325***</td>
</tr>
<tr>
<td>Food, beverages, textiles</td>
<td>-0.338***</td>
<td>0.075</td>
<td>-0.333***</td>
</tr>
<tr>
<td>Pulp, paper, print</td>
<td>-0.475***</td>
<td>0.148</td>
<td>-0.480***</td>
</tr>
<tr>
<td>Nonmetallic minerals, metals</td>
<td>-0.266**</td>
<td>0.119</td>
<td>-0.265**</td>
</tr>
<tr>
<td>Machinery, media equipment</td>
<td>0.040</td>
<td>0.080</td>
<td>0.040</td>
</tr>
<tr>
<td>Transport equipment</td>
<td>0.132</td>
<td>0.172</td>
<td>0.128</td>
</tr>
<tr>
<td>Canada</td>
<td>0.191*</td>
<td>0.111</td>
<td>0.182*</td>
</tr>
<tr>
<td>France</td>
<td>0.397***</td>
<td>0.111</td>
<td>0.385***</td>
</tr>
<tr>
<td>Germany</td>
<td>0.431***</td>
<td>0.085</td>
<td>0.419***</td>
</tr>
<tr>
<td>Hungary</td>
<td>0.511***</td>
<td>0.100</td>
<td>0.535***</td>
</tr>
<tr>
<td>Norway</td>
<td>0.492***</td>
<td>0.107</td>
<td>0.515***</td>
</tr>
<tr>
<td>Japan</td>
<td>0.747***</td>
<td>0.081</td>
<td>0.760***</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.33***</td>
<td>0.218</td>
<td>-2.35***</td>
</tr>
</tbody>
</table>

Observations: 4,013
Wald Chi2(63): 1,211.36***
Rho: 0.000***
Wald test of rho=0 Chi2(3): 11.31

†Excluded industry dummy is the petroleum, chemicals, and rubber products industry. Excluded country: United States
*Statistically significant at p<.10; **statistically significant at p<.05; ***statistically significant at p<.01

The direct effect of perceived cost savings related to inputs/waste management increases the likelihood of ESP adoption by 0.342 on average. Also, the indirect (QMS moderation) effect (0.023) is positive which increases the likelihood of ESP adoption. For perceived general cost savings the direct effect (0.360) and the indirect (QMS moderation) effect (0.004) are both positive, thereby increasing the likelihood of ESP adoption. Notice that, for a business, when complementary capabilities are present the
indirect effects are both positive. These findings offer additional support for my hypothesis which states complementary capabilities positively moderate the relationship between ESP adoption and perceived economic cost savings.

Table 12. Marginal Effects of Firm Capabilities by Perceived Economic Cost Savings

<table>
<thead>
<tr>
<th></th>
<th>Quality Mgmt System</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct</td>
<td>Indirect</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Perceived cost savings related to inputs/waste management</td>
<td>0.342</td>
<td>0.023</td>
<td>0.365</td>
<td></td>
</tr>
<tr>
<td>Perceived cost savings in general</td>
<td>0.360</td>
<td>0.004</td>
<td>0.364</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>4,013</td>
<td>4,013</td>
<td>4,013</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

To date, prior ESP adoption research has argued that complementary capabilities lead to the adoption of more ESPs (Hart, 1995; Russo & Fouts, 1997; Sharma & Vredenburg, 1998; Shrivastava, 1995), while economic costs lead to the adoption of fewer ESPs (Walley & Whitehead, 1994). To my knowledge, no scholarship has investigated the moderating relationship between facilities’ complementary capabilities’, perceived economic cost savings and adoption of ESPs. This study offers initial evidence for the notion that complementary capabilities positively moderate the relationship between facilities’ perceived economic cost savings, and their adoption of ESPs. I suggest that facilities adopt ESPs even in the presence of higher economic costs because of their synergistic, available and transferable complementary capabilities.

My findings are important to management scholarship for three reasons. First, this research offers evidence of the positive moderating effect of complementary capabilities on perceived economic cost savings. While economic cost savings may not be as great as
perceived (Nordhaus, 1992; Rienhardt, 1999; Walley & Whitehead, 1994), this research suggests complementary capabilities may positively moderate cost savings (such as time and labor costs) thereby enhancing ESP benefits for facilities (Scrimshire, 1996; Zutshi & Sohal, 2004). By putting their prior experience into action, facilities may moderate time and labor costs associated with adoption and maximizing savings and other ESP benefits. As such, facilities with complementary capabilities may still undertake ESP adoption even if the ESPs are perceived to have low economic cost savings.

However, these results also suggest that complementary capabilities have a nuanced relationship with economic cost savings and their association with ESPs. When I assessed the moderating effect of complementary capabilities on perceived economic cost savings, the significance of their association differed. That is, when evaluating complementary capabilities and perceived general cost savings simultaneously, there was only a slight association (p<0.10) with ESP adoption. This research expands on prior research examining complementary capabilities influence on ESP adoption (Hart, 1995; Sharma & Vredenburg, 1998; Shrivastava, 1995) by suggesting their role does vary between facilities. My research suggests in some cases facilities are less likely to value their complementary capabilities’ synergistic, available and transferable properties.

Second, these findings raise important issues related to public policy. Many policy efforts, fashioned in the form of a voluntary environmental program (VEP), are designed to encourage companies to pursue a proactive environmental strategy. In the U.S. alone, there are more than 200 VEPs that operate at the federal level (Carmin, Darnall & Mil-Homens, 2003). Most scholars and government officials encourage of
adoption these VEPs by reporting the benefits associated ESPs. For example, many scholars have argued ESPs can enhance a facility’s financial performance in that they can increase operational efficiency (Hart & Ahuja, 1996). This research suggests that the benefits experienced by one facility will likely be shared by all other facilities who adopt ESPs. However, in practice, facilities rarely experience the same level of benefits from the same ESP (Walley & Whitehead, 1994).

My research suggests facilities with few or no complementary capabilities may be inclined to forgo VEP participation and ESP adoption due to low cost savings. As such, policy makers may have greater success by taking a pragmatic approach for encouraging ESP adoption by enacting new programs that enhance facilities’ complementary capabilities. Currently, many VEPs encourage ESP adoption by way of information sharing, government-funded grants or technical assistance (Darnall, 2003). However, assessments are needed to determine the effectiveness of these actions since many facilities forgo ESP adoption. This research offers important evidence that facilities may lack the complementary capabilities to adopt ESPs and underscores the potential for VEPs to provide these essential services. As such VEPs should focus on creating consortiums or similar outlets to encourage greater development and sharing of complementary capabilities.

Third, this research advances our understanding of ESP adoption in the global environment. I examined the moderating effect of complementary capabilities on perceived economic cost savings for facilities in seven OECD countries to offer a broader perspective of these relationships. ESPs are being adopted worldwide and the results of
my analysis indicate that complementary capabilities positively moderate the relationship between perceived economic cost savings and facilities’ ESP adoption even after controlling for self-selection effects. However, future research would benefit by examining these relationships in lesser developed countries. My expectation is that the results would be consistent, especially since these facilities are competing in emerging markets and striving to develop new products more cheaply in an environmentally-friendly manner. As such, they should be more inclined to adopt ESPs by way of utilization their existing complementary capabilities and generating greater cost savings.

Related to future research, researchers have suggested that companies typically choose to adopt ESPs since they might be able to generate cost savings or revenue (Hart, 1995; Hart & Milstein, 2003; Christmann, 2000; Klassen & McLaughlin, 1996; Prahalad & Hamel, 1990; Russo & Fouts, 1997; Sharma & Vredenberg, 1998). However, these studies and others (e.g., Hart & Ahuja, 1996) have suggested that there may be a potential lag in firms’ financial benefits due to their ESP adoption efforts (Nehrt, 1996). Future research therefore would benefit from undertaking a more longitudinal analysis to examine how complementary capabilities moderate cost savings and ESP adoption over time. My expectation is that complementary capabilities moderate economic cost savings at a slower rate over time. If so, a more compelling case might be made for companies to develop robust capabilities quickly. Similarly, prospective scholarship would benefit by examining the threshold in which complementary capabilities reduce facilities’ economic costs. Such an assessment may be of particular interest to business managers in helping them to understand the extent to which they should adopt ESPs. Along the way we may
find there is a point of diminishing return on complementary capabilities’ benefits which differs across facilities and industries.

In order to investigate the relationship between complementary capabilities, perceived economic cost savings and ESPs, this research relied on a cross-section of multi-country data that included numerous manufacturing sectors. The estimated coefficients for these were statistically significant in most cases, indicating the importance of controlling for country and industry effects. One limitation to this study, however, is that by using cross-section data, I was unable capture any dynamic effects that influence the relationship between complementary capabilities, perceived economic cost savings and ESP adoption. Future research could focus on not only recognizing the importance of complementary capability moderate perceived economic cost savings effects but also studying whether complementary capability moderated economic cost savings effects change across time.

Finally, future work would benefit by improving upon this analysis in a way that accounts for other effects that might explain the relationship between facilities’ adoption of ESPs and their cost savings. Such an analysis would require access to a much larger dataset of facilities to simultaneously control for facilities’ self-selection of their ESPs, and data related to control and instrumental variables. For example, linking my data with other demographic datasets, such as COMPUSTAT or KLD Social Ratings, would provide a better understanding of the numerous factors which influence facilities’ adoption of ESPs and their cost savings. Additionally, such information could be combined with my findings to create a typical ‘profile’ of demographic factors which
directly influence facilities’ adoption of ESPs. While collecting these sorts of data can be costly, the results of my analysis offer some initial justification for undertaking a broader study.

**Conclusion**

In sum, this research extends prior studies that examine the broad connections between economic cost savings, complementary capabilities and the adoption of ESPs. It offers initial empirical evidence suggesting that complementary capabilities positively moderate perceived economic cost savings. Using bivariate probit regression analysis, I reveal that perceived economic cost savings are related to facilities’ adoption of ESPs with each following a similar direction and trend. However, when interacted with complementary capabilities, perceived economic cost savings association with facilities that adopt ESPs is greatly reduced. These findings indicate that facilities may leverage their existing complementary capabilities to moderate their perceived economic cost savings, thereby increasing the likelihood of ESP adoption. These findings offer another important piece of information to managers and researchers about the possible conditions in which facilities actually adopt ESPs.
CHAPTER FIVE - CONCLUSIONS

In spite of the benefits associated with adopting environmental sustainability practices (ESPs) (e.g., Hart, 1995; Hart & Ahuja, 1996; Hart & Milstein, 2003; Christmann, 2000; Klassen & McLaughlin, 1996; Prahalad & Hamel, 1990; Russo & Fouts, 1997; Sharma & Vredenberg, 1998), many facilities struggle to determine which types of ESPs to adopt (Margolis & Walsh, 2003) or simply forgo adoption altogether (Nordhaus, 1992; Walley & Whitehead, 1994). This research attempts to understand why by examining the complex relationship between financial performance, economic costs, complementary capabilities and ESP adoption. I have done this by way of three independent essays each of which explore the different aspects of this complex relationship in greater detail.

In essay one, I examined the economic returns associated with the two types of ESPs (lower-order vs. higher-order) derived from Hart & Milstein’s (2003) framework. My results suggest that both types of ESPs are associated with firms’ financial performance. However, the financial benefits associated with firms’ higher-order ESPs exceed the financial benefits related to firms’ lower-order ESPs. Such knowledge is important to scholarly literature, but also to businesses since managers are more likely to adopt specific sustainability activities if they are to be associated with greater financial advantages (Margolis & Walsh, 2003).
In essay two, I examined the relationship between facility production and transaction costs and the adoption of ESPs. The results of my analysis reveal that production and transaction costs are associated with facilities’ ESP adoption in that they follow a similar direction and trend. However, the association of production costs with ESP adoption is greater than the association of transaction costs with ESP adoption. This research suggests, despite ESPs association with financial performance (e.g., Hart, 1995; Hart & Ahuja, 1996; Hart & Milstein, 2003; Russo & Fouts, 1997; Sharma & Vredenberg, 1998), many facilities may still forgo adoption due to costs (Nordhaus, 1992; Walley & Whitehead, 1994).

In essay three, I examined the moderating effect of complementary capabilities on the relationship between facilities’ perceived economic cost savings and their adoption of ESPs. The results of my analysis indicate that complementary capabilities positively moderate the relationship between perceived economic cost savings and facilities’ ESP adoption even after controlling for self-selection effects related to ESP adoption decisions. In practice, numerous facilities still choose to adopt ESPs even if doing so is costly. My research suggests complementary capabilities positively moderate perceived economic cost savings such that facilities with high costs may still adopt ESPs.

These findings offer four important contributions to management science and public policy literature. First, this research relates to the role of costs during facilities’ decision to adopt ESPs. Knowledge of the relationship between anticipated production and transaction costs and ESP adoption is important for researchers and business managers alike. Recent studies have suggested that companies typically choose to
implement lower-order ESPs since they might be able to generate cost savings or revenue faster than other types of ESPs (Christmann, 2000), whereas higher-order ESPs may benefit firms over a longer time horizon (Hart, 2007). However, these studies do not take into account anticipated production and transaction costs during ESP adoption. My research suggests both production and transaction costs are associated with ESP adoption such that facilities with high anticipated costs are anticipated to adopt fewer ESPs. Based on this information, the financial benefits associated with lower- and higher-order ESP adoption may be lower than originally suggested due to costs.

Future research would benefit from undertaking a comprehensive analysis to examine how different types of ESPs and costs are related with financial performance over time. My expectation is that the financial benefits derived from higher-order ESPs might accrue at a slower rate over time because of production costs. If so, a more compelling case can be made for companies to reduce their costs as much as possible when developing far-reaching sustainability programs. For example, researchers could work to identify which types of costs (e.g. acquisition or negotiation costs) within each category (e.g. production costs or transaction costs) are most likely to influence ESP adoption (e.g. lower- or higher-order) and strategic positioning. My research has taken the first step by examining the relationship between anticipated production and transaction costs and ESP adoption. However, facility managers and policy makers alike would benefit from the knowledge of which specific type of production cost and transaction cost influence ESP adoption and ultimately strategic positioning. Doing so would allow development of public or private programs designed to specifically reduce
such costs thus increasing the overall adoption of ESPs and competition within the marketplace.

The second contribution of this research relates to the moderating effect of complementary capabilities on the relationship between facilities’ perceived economic costs and their adoption of ESPs. Based on my earlier essays, higher-order ESPs are more closely associated with greater financial performance but few facilities adopt higher-order ESPs due to their costs and longer payback period. However, complementary capabilities are anticipated to moderate the cost of adopting ESPs—including higher-order ESPs. This may shorten the payback period associated with higher-order ESPs while simultaneously quickly enhancing financial performance for firms. As such, complementary capabilities may enable firms to adopt more higher-order ESPs in spite of their longer payback period.

Future work would benefit by improving upon my analysis in a way that accounts for which specific types of complementary capabilities may offset ESP adoption costs. My research has shown that complementary capabilities moderate the relationship between costs and ESP adoption. However, very little is known about which types of complementary capabilities offset ESP adoption costs. Future research should strive to identify the specific types of complementary capabilities (e.g. pollution prevention, clean technology, community engagement, etc.) that moderate ESP adoption costs. Armed with such information, facility managers and policy makers alike could design programs to maximize the development of complementary capabilities which provide the greatest financial offset to ESP adoption costs.
The third contribution relates to the moderating effect of complementary capabilities on production costs and transaction costs. My research suggests both types of costs influence the adoption of fewer ESPs but production costs are more closely associated with the adoption of fewer ESPs when compared to transaction costs. However, complementary capabilities are anticipated to moderate the costs of adopting ESPs—including both production and transaction costs. As such, complementary capabilities are expected to lessen the negative influence of production and transaction costs on ESP adoption.

Future work would benefit by improving upon my analysis in a way that accounts for how complementary capabilities may offset production and transaction costs (individually). My research has shown that complementary capabilities moderate the relationship between costs and ESP adoption in general. However, very little is known about how complementary capabilities moderate the two different types of adoption costs. Future research should strive to identify how complementary capabilities moderate both production and transaction costs, individually. Armed with such information, facility managers and policy makers alike could design programs to maximize the development of complementary capabilities which provide the greatest financial offset to both production and transaction costs.

The fourth contribution of this research relates to public policy. Facilities operating in developing countries often compete in emerging markets. Such markets are characterized by their rapid pace of development (Hoskisson et. al., 2000), and are not well defined in terms of industry norms for production or customer preferences.
Consequently, facilities often implement lower-order ESPs given their short payback period and their ability to quickly add value. This may lead to an economy characterized by volatile markets with high business/industry turnover, to the detriment of the government and inhabitants of the country. Based on this research, policy makers in developing countries should strongly encourage the adoption of higher-order ESPs as part of the effort to stabilize their economy. Higher-order ESPs could simultaneously help businesses, the government and its inhabitants. By engaging disenfranchised stakeholders at the base of the pyramid in the development of new products for emerging markets, higher-order ESPs can create economic stability through long-term growth for businesses and governments alike.

Additionally, the international community should strongly encourage the adoption of higher-order ESPs by companies that operate or serve markets in developing countries with weak internal governance structures. For example, ESPs are being adopted worldwide, and are recognized even as viable policy tools even in countries with comparatively weak environmental regulatory systems (Blackman, et al., 2007). My findings offer evidence that higher-order ESPs could simultaneously help businesses, the government and its inhabitants. Subsequently, international organizations such as the Organisation for Economic Co-operation and Development (OECD) should develop policies and standards for business operating in developing countries which emphasize practices to improve the economic and social well-being of people around the world. Such policies and standards should also be integrated with existing international
initiatives particularly the International Organization for Standardization’s 26000 series on social responsibility.

Finally, to be successful international organizations should offer technical assistance and grants to businesses interested in adopting higher-order ESPs. My research has shown that capabilities may moderate the costs associated with adoption of ESPs. By contrast, organizations with few complementary capabilities may be less likely to adopt ESPs without external assistance. This suggests that regulators could provide additional support to organizations that have few complementary capabilities through government-sponsored programs. By doing so, these organizations may be able to develop stronger internal capabilities and adopt higher-order ESPs.

Going forward, firms, facilities and public policy would benefit from additional knowledge gained by looking across corporate-wide issues such as strategic positioning and outsourcing decisions as it relates to ESP adoption. For example, knowledge of whether production costs or transaction costs are more closely associated with the adoption of ESPs is important to facilities competing using a low-cost leadership strategy. This research has shown that production costs are more closely associated with facilities’ adoption decision and if not managed properly may reduce overall profitability. As such, facility managers must take an active role during the ESP evaluation process by fully accounting for their anticipated production costs. By doing so, the facility can ensure that they maintain their low-cost leadership strategy while protecting the environment.
Additional future research opportunities relate to facilities’ organizational structure and their decision to outsource capabilities. Many facilities choose to outsource their capabilities which may help reduce their overall operating costs (Jacobides & Winter, 2005; Kogut & Zander, 1997; Leiblein & Miller, 2003). However, this decision may also impact their ability to adopt ESPs. For example, facilities’ that outsource capabilities may increase ESP adoption costs since additional time and effort must be extended to identify appropriate outside sources to manage implementation (Prahalad & Hamel, 1990; Kogut & Zander, 1997). As such, facilities must take a broader view of the decision to outsource their capabilities since they may reduce their operating costs but at the expense ESP adoption. Furthermore, by understanding that capabilities can facilitate ESP adoption, managers may be able to assess their organization’s internal structures and determine how they might need to invest when adopting ESPs. Still other managers, who seek to elevate environmental concerns within their organization, may benefit from the knowledge that their organization’s complementary capabilities may create internal efficiencies that can be leveraged to reduce ESP adoption costs.

In sum, my research extends prior studies that examine the broader connections between ESPs, financial performance, costs and complementary capabilities. It offers some of the first empirical evidence suggesting that ESPs are related to firms’ financial performance in different ways. I reveal that lower- and higher-order ESPs are similarly associated with firms’ financial performance in that they follow a similar direction and trend. In addition, this research also highlights the complex connection between production costs and transaction costs and ESP adoption. By examining both types of
costs and ESP adoption simultaneously, I was able to show that production costs are more closely associated to the adoption of fewer ESPs. Moreover, my research takes an important step forward by considering how economic cost savings and complementary capabilities simultaneously influence ESP adoption. Consistent with earlier literature, my results suggest that complementary capabilities positively moderate economic cost savings which may lead to the adoption of more ESPs. As such, those facilities with complementary capabilities are anticipated to adopt ESPs even in the presence of higher economic costs. These findings have implications for both facility managers and policy makers alike and offer information about the possible conditions in which ESPs may generate greater financial performance and when facilities may forgo ESP adoption even though it may benefit them financially.
## APPENDIX

### Table 13. Economic Cost Factor Analysis

<table>
<thead>
<tr>
<th>Variables</th>
<th>Factor Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs savings due to reduction of use of inputs</td>
<td>0.9137</td>
</tr>
<tr>
<td>Cost savings due in terms of waste management</td>
<td>0.9102</td>
</tr>
<tr>
<td>Alpha coefficient</td>
<td>0.7163</td>
</tr>
</tbody>
</table>

Notes: * *Loadings stronger than ±0.50 are in bold.*  
Extraction method: principal factors analysis.  
Rotation method: unrotated.
REFERENCES


CURRICULUM VITAE

Brent C. Kurapatskie is a Sustainability Program Manager within the Office of the Secretary at the Department of Transportation. In this role, he is responsible for the development and oversight of organization-wide policies and programs for addressing the energy, environmental and sustainability requirements of Executive Order 13514 and other environmental regulations. He has 14 years of environmental management experience while serving at the Department of Transportation and the U.S. Postal Service and working in the private sector. He holds a Master’s degree in Environmental Science and Policy and a M.B.A. both from Johns Hopkins University.