Title

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Publication Date

2007-09-11

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THE ADOPTION OF ISO 14001 WITHIN THE SUPPLY CHAIN:

WHEN ARE CUSTOMER PRESSURES EFFECTIVE?

ABSTRACT

Voluntary programs are now widely used by governments and other actors to improve the environmental performance of firms beyond regulatory compliance. However, it is important to understand the effectiveness and limitations of these voluntary approaches. This paper investigates the rationale for firms to 'comply' with or 'resist' the mandate of their customers to adopt the international certified management standard (CMS) ISO 14001 in the North American automotive industry. We argue that the effectiveness of such a mandate will vary according to the characteristics of the relationship between suppliers and customers. We contrast and test hypotheses based on both transaction costs economics and signaling theories to suggest that both suppliers marked by a dependent relationship with their customers as well as those marked by a distant relationship with their customers have incentives to comply with the requests of their customers but through different mechanisms. Our results, based on the analysis of the characteristics of 3,152 automotive suppliers located in the US, Canada and Mexico over the 2000-2003 period, indicate that suppliers with highly specialized assets as well as younger suppliers and those reporting to the Toxic Release Inventory are more likely to adopt the certified management standard ISO 14001.

Keywords: ISO 14001, Voluntary standards, international diffusion, Automotive industry, environmental management, supply chain, environmental voluntary programs.

1. INTRODUCTION

Voluntary programs are now widely used by governments and other actors to improve the environmental performance of firms beyond regulatory compliance. However, it is important to understand the effectiveness and limitations of these voluntary approaches. This paper investigates the rationale for firms to 'comply' with or 'resist' the mandate of their customers to adopt the international certified management standard (CMS) ISO 14001 in the North American automotive industry. We argue that the effectiveness of such a mandate will vary according to the characteristics of the relationship between suppliers and customers.

Firms seeking to improve their environmental performance are increasingly concerned about the performance of firms in the upstream section of their supply chain. Their concern is justified because firms could be affected by the negative environmental performance of their suppliers. For example, suppliers with unsatisfactory environmental performance records could degrade the reputation of customers who buy their products. Unsatisfactory performance could also result in regulators halting their operations and therefore the supply of their products to customers. Conversely, firms could also leverage the positive environmental performance of their suppliers to enhance their own environmental reputation. These are some of the reasons that have led to increasing numbers of customers that require their suppliers to adopt better environmental management practices (Darnall, 2006; Walton, Handfield, and Melnyk, 1998)

Little is known about the effectiveness of such requirements, and it is difficult to understand the conditions under which suppliers will 'resist' or 'comply' with their customers' request to improve their environmental practices beyond compliance. This

paper attempts to fill this void by empirically analyzing the case of the CMS for environmental management ISO 14001 in the automotive sector in North America.

The ISO 14001 standard, issued in 1996 by the International Organization for Standardization (ISO), is a process standard that helps organizations to implement Environmental Management Systems (EMS). The ISO 14001 standard anticipates that organizations that manage environmental matters systematically through ISO 14001, will learn how to reduce or eliminate pollution production processes, and therefore will perform better than firms that do not adopt ISO 14001 (Coglianese and Nash, 2001). Since the inception of ISO 14001 in 1996, more than 100,000 facilities have adopted the ISO 14001 standard worldwide with a recent yearly increase of more than 20,000 certificates (ISO 2005).

Our empirical analysis involves the North American Automotive industry where the Big Three US automakers (General Motors, Ford, and Daimler-Chrysler) formally requested their suppliers to adopt ISO 14001 by 2003. Surprisingly, despite the insistence of the biggest customers that suppliers adopt ISO 14001, by July of 2003 only 25% of the automotive suppliers located in North America adopted the standard. The failure of such a large percentage of plants to meet expectations deserves further inquiry and attention. Our research objective is to understand the characteristics of those suppliers that complied with this request and the characteristics of those that resisted it.

Empirical studies analyzing the motivations of firms adopting ISO 14001 show that compliance varies according to the level of pressure exerted by external stakeholders, and the characteristics of firms such as ownership structure, level of financial and managerial resources and environmental performance (Potoski and Prakash, 2005; Bansal

and Hunter, 2003; Christmann et al., 2001; Darnall, 2003, 2006; Delmas, 2002; Kollman and Prakash, 2002). While these studies show, in general terms, the importance of customer pressures and the organization's characteristics as driving forces behind the adoption of certified management standards, little literature exists that analyzes or discusses the characteristics of the relationship between customers and suppliers (King, Lenox and Terlaak, 2005). In this paper, we argue that the characteristics of the relationship between a buyer and a supplier are important factors that explain a firm's decision to adopt or to resist the adoption of 14001. The relationship plays a significant role in the adoption of standards because its characteristics mitigate the pressure exerted by customers on their suppliers and diminish the incentives to signal commitment to improving environmental performance.

We develop and test hypotheses based on both transaction costs economics and signaling theories that suggest apparently conflicting explanations for the rationale to adopt ISO 14001. Transaction cost economics identifies characteristics of the transaction that lead to a dependent relationship between a customer and a supplier and therefore increase the incentives to comply with the requests of the customer. Conversely, signaling theory emphasizes the benefits of using ISO 14001 to signal good environmental behavior for more distant relationships to reduce information asymmetries.

Our results show that it is important to include both the transaction cost economics rationale and signaling theory to explain the adoption of voluntary practices as both theories can explain adoption behavior. We find that firms engaged in transactions marked by high specificity, as well as younger firms entering the market have incentives to adopt ISO 14001.

Identifying the incentives for firms to adopt ISO 14001, enables our research to also recognize the characteristics of firms that resisted the adoption of ISO 14001 within the 2003 deadline set by the Big Three US automakers. Firms resisting adoption of ISO 14001 by the deadline tend to be older, smaller and engaged in market-length relationships. Additionally, the resistant firms are not required to report their emissions to the US EPA Toxic Release Inventory, and therefore, they are less visible to regulators or environmental NGOs. Our research also reveals the limitations of voluntary approaches in reaching less visible firms that are not required to report to the EPA.

2. ISO 14001 IN THE NORTH AMERICAN AUTOMOTIVE INDUSTRY

ISO 14001 shares many common traits with its predecessor ISO 9000, which is the international standard for quality management. Like ISO 9000, ISO 14001 does not focus on outcomes, such as pollution, but focuses on processes. ISO 14001 also involves a possible third-party audit similar to ISO 9000. The ISO 14001 standard describes the basic elements of an effective Environmental Management System (EMS). These elements include creating an environmental policy, setting objectives and targets, implementing a program to achieve those objectives, monitoring and measuring its effectiveness, correcting problems, and reviewing the system to improve it and overall environmental performance (Tibor and Feldman, 1996). As ISO 14001 is a process standard, organizations that set out to manage environmental matters systematically through ISO 14001 can be expected to learn about production processes that result in pollution, take action against these and perform better than firms that do not implement the standard (Coglianese and Nash, 2001). However, even if improvement in

environmental performance is expected of ISO 14001 certified facilities; the actual impact of ISO 14001 on environmental performance is not guaranteed. The standard does not establish absolute requirements for environmental performance other than a commitment to compliance with applicable regulations and to continuous improvement. Furthermore, it does not identify environmental performance as a factor in the actual certification process (Christmann and Taylor, 2001). Therefore, ISO 14001 certification represents the adoption of an Environmental Management System and a formal commitment to future environmental performance improvement rather than a proof of improved environmental performance.

External stakeholders find it difficult to examine environmental management practices adopted by a firm or a facility. The difficulty arises because these practices are embedded in the internal organization of firms. Environmental improvement is also hard to assess for external parties. Jiang and Bansal (2003) define environmental impact opacity as the extent of difficulty in measuring and understanding the environmental impact of a firm by external stakeholders. A certified environmental management standard (CMS), such as the international standard ISO 14001 to certify Environmental Management Systems (EMS), represents a governance mechanism aimed to reduce the different transaction costs related to acquiring and monitoring the environmental behavior of suppliers. The reduction in costs includes information costs (costs associated with gathering environmental information about suppliers) and monitoring costs (costs associated with conducting environmental audits and inspections among suppliers). In addition, because ISO 14001 requires a third-party audit, potential costs associated with opportunistic behavior from the supplier may also be reduced.

Although ISO 14001 seems an efficient governance mechanism that enables customers to check the environmental management practices of their suppliers, the costs of acquiring ISO 14001 are substantial for suppliers. To acquire ISO 14001 certification, an organization must undertake an initial audit and complete five surveillance visits during the three-year validity of the certificate (Adams, 1999). The costs of certification vary widely, depending on the size of the company, the nature of its operation, and the environmental system already in place. Estimates range from less than $50,000 for small firms to greater than $200,000 for larger firms (Watkins and Gutzwiller, 1999). These estimations involve the certification process only and do not take into account the cost of organizational changes that firms may have to carry out to attain the ISO 14001 standard. We therefore need to understand the circumstances under which a supplier would be willing to incur the cost of adopting ISO 14001.

Previous literature explaining the rationale of firms to adopt ISO 14001 show the importance of market and regulatory pressures as drivers of adoption (Bansal and Hunter, 2003; Christmann et al., 2001; Darnall, 2003, 2006; Delmas, 2002; Kollman and Prakash, 2002). By demonstrating their commitment to improved environmental performance through ISO 14001, firms could enhance their external image and external legitimacy and improve their relationships with regulators, customers or NGOs. Researchers also analyzed the relationship between environmental performance and the adoption of ISO 14001 (Delmas, 2001; King, Lenox and Terlaak, 2005; Melnyk et al, 2002; Potoski and Prakash, 2005). The research shows that lower performers have more to gain by adopting ISO 14001 than higher performers. However, the cost of adopting ISO 14001 is lower for higher performers that may already have adopted an Environmental Management System.

Others authors identify firm ownership structure and previous experience with management standards as reasons for adoption (Corbett and Kirsch, 2001; Darnall, 2006; Darnall & Edwards Jr., 2006; Delmas, 2005). Previous research also reveals that firms headquartered in Europe and Asia were more likely to seek certification than firms located in the United States and that firms certified to ISO 9000 are more likely to obtain ISO 14001 certification.

While these studies shed light on the reasons behind the adoption of ISO 14001, they seldom identify the characteristics of the relationship between customers and suppliers to understand the adoption of ISO 14001. We argue that it is very important to focus our attention on the characteristics of the customer-supplier relationship as it can mitigate some of the factors identified in the previous literature. More specifically, we argue that while customer pressures can have a positive influence on a supplier's decision to adopt ISO 14001, the presence of conditions that create greater dependence between the supplier and the customer can increase this influence. On the other hand, ISO 14001 could also facilitate communication about environmental management practices where relationships between suppliers and customers are more distant. The distance in the relationship could exist because of geographical location or because the supplier is a newcomer in the industry and has not established close ties with customers when compared to older firms in the industry.

We chose to study the North American automotive sector because it is marked by high customer pressures requiring suppliers to adopt ISO 14001. In 1999, the Big Three Northern American auto-assemblers – Ford, General Motors (GM), and Daimler-Chrysler – required their suppliers to attain ISO 14001 certification by 2003. That same year, the

Automotive Industry Action Group[1] (AIAG) sent a formal joint letter on behalf of the Big Three to remind all their suppliers of the required date for ISO 14001 certification. The AIAG program manager declared that the Big Three had stated that failure to meet their deadlines for ISO 14001 requirements could affect future sourcing decisions (Whitmore and De Mink, 2002) with resultant sanctions for failing to meet the requirements by the deadline. In fact, the Big Three had previously imposed sanctions on suppliers that did not meet ISO 9000 certification requirements (Detwiler and Sedlak, 2005). In the case of Ford, suppliers that did not provide ISO 14001 certifications by the prescribed deadline stood to lose their Q1 status (preferred supplier status). The loss of Q1 status did not mean that they no longer supplied to Ford but that they were not a preferred supplier, therefore, endangering their ability to win future business or maintain current business.[2]

The so-called Big Three requirement received considerable publicity among business scholars and the media (Bansal and Bogner, 2002; Christmann et al., 2001; Handfield, Sroufe and Walton, 2005; Jiang and Bansal, 2003; King, Lenox and Terlaak, 2005; Melnyk, Sroufe and Calantone, 2003; Sabatini, 2000; Sissell, 1997; Thornton, 2000; Wilson, 1998). In addition to the Big Three, other auto-assembler companies also supported initiatives to facilitate the adoption of ISO 14001 in the automotive supplier industry. For instance, Toyota gives preference to ISO 14001-certified suppliers (King et al., 2005; Orsato, 2006). Moreover, their North American branch, Toyota North America,

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[1] The Automotive Industry Action Group (AIAG) is a globally recognized organization founded in 1982 by a group of visionary managers from DaimlerChrysler, Ford Motor Company, and General Motors. Its purpose is to provide an open forum where members cooperate in developing and promoting solutions that enhance the prosperity of the automotive industry. AIAG's focus is to continuously improve business processes and practices involving trading partners throughout the supply chain.

[2] Information provided by Ms. Monique Oxender, Global Manager of the Supply Chain Sustainability at Ford Motor Company's Global Purchasing Strategy Office (July 24th, 2007).

provides an ISO 14001 Guidance Manual to suppliers who pursue ISO 14001 certification of their EMSs by choice or by requirement (Toyota, 2005). Another Japanese auto-assembler, Nissan, also requested its suppliers to establish EMS by March 2003, and worked with their suppliers to help them obtain ISO14001 certification by 2005 (Nissan, 2005). Despite these customer pressures, by July 2003 only 25% of the automotive suppliers located in North America adopted the standard. Figure 1 shows the continuous increment of ISO 14001 certifications for the two different groups represented: suppliers selling to the Big Three, and suppliers not selling to the Big Three. Figure 1 indicates that Big Three suppliers maintained higher adoption rates by June of 2003 than suppliers not selling to the Big Three. These differences, however, are not statistically significant. Therefore, we analyze the factors that persuaded some suppliers to adopt the standard within the Big Three deadlines while others did not. In this paper, we argue that differences in the characteristics of the relationship between the customer and the supplier will explain the differences in the adoption of ISO 14001 by suppliers. In the next section, we argue that trading partner dependency and liability of newness (the difficulty for newer firms to obtain legitimacy and enter new markets), are key factors that explain the rationale of firms adopting ISO 14001.

Insert Figure 1 around here

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3. HYPOTHESES

We first develop arguments based on transaction costs economics (Williamson, 1985). Building on transaction cost economics, we predict that firms engaged in

transactions marked by high specific investments, that are more dependent on their current customers than firms with lower asset specificity, are more likely to adopt ISO 14001. We subsequently develop arguments based on signaling theory (Spence 1973) and suggest that younger as well as more distant suppliers may find higher benefits from the adoption of ISO 14001 to signal their commitment to improved environmental performance than older firms and firms that are closer geographically. We test our hypotheses with a database of 3,152 automotive suppliers located in the US, Canada, and Mexico.

3.1 Trading partner dependency

Williamson (1985) defined asset specificity as non-redeployable physical and human investments that are specialized and unique to a task. Asset specificity, when associated with behavioral uncertainty, potentially leads to situations where it becomes costly to rely on market transactions. Specific assets, because of their specialized and durable nature, imply that parties to a transaction face only imperfect exchange alternatives for an extended period. The more specialized those assets, the larger the incentive for agents to attempt to influence the terms of trade through bargaining or other rent-seeking activities once the investments are in place (Masten, 1984). Williamson identified three dimensions of asset specificity: site specificity, physical asset specificity, and human asset specificity (Williamson, 1985). An example of specificity in the case of the automotive industry is the production of a certain automotive part that may require: (i) the supplier facility to be located close to the automaker (site specificity), (ii) investments in specialized machinery (physical asset specificity), (iii) and professional know-how human skills (human asset specificity). Monteverde and Teece showed that in the automotive sector, transactions

marked with high specificity lead to vertical integration decisions (Monteverde and Teece, 1982). In the case of ISO 14001 and the automotive supplier industry, we expect that suppliers, who carry out firm-specialized investments to supply a particular product to auto-assemblers, face higher transaction costs in potential customer switching scenarios. Indeed, their assets are less redeployable to alternative uses and by alternative users without sacrificing their productive value (Williamson, 1991). From a transaction cost perspective**,** a supplier that expects substantial switching and termination costs in their relationship with a customer is said to be dependent on that customer (Joshi and Arnold, 1998; Morgan and Hunt, 1994). This higher degree of dependence might translate to higher ISO 14001 adoption rates by suppliers to satisfy customer requirements; therefore, we expect the following:

Hypothesis 1A: Automotive suppliers with higher specialized assets will be more likely to adopt ISO 14001 than suppliers involved in less asset specialized transactions.

Signaling theory states that some activities or attributes qualify as credible indicators of potential quality that alter the belief of, or convey information to, other individuals in the market (Spence, 1973). Spence (1973) used college education as an example to show how signaling can solve problems of pre-contractual information asymmetries. Additionally, previous research applied the signaling argument to product warranties (Akerlof, 1970), insurance markets (Rothschild and Stiglitz, 1976), advertising campaigns (Milgrom and Roberts, 1986), the choice of independent auditors (Titman and Trueman, 1986), the valuation of new firms in emerging markets (Sanders and Boivie, 2004), and even the adoption of the certified quality standard ISO 9000 (Anderson, Daly,

and Johnson, 1999; Terlaak and King, 2006). Similarly, the adoption of CMS for environmental management, such as ISO 14001, is a mechanism that signals a firm's commitment to improve environmental management practices and environmental performance in the future, but does not signal actual improved performance. In a business context where environmental issues are increasingly important, suppliers are able to consider the adoption of a CMS such as ISO 14001 to signal their commitment to good environmental behavior and to reduce information asymmetries with customers; however, not all suppliers will perceive the same benefits of adopting ISO 14001.

Suppliers with specialized assets (e.g., sub-assembler suppliers) might be better known and trusted by automakers than suppliers with lower levels of asset specificity. Therefore, suppliers with high-specialized assets might feel less need to certify their EMSs with ISO 14001 immediately to avoid a deterioration of their working relationship with customers. The fact that suppliers with specialized assets retain a close and ongoing relationship with the automakers means that the customer is more likely to know the supplier well. Thus, the adoption of ISO 14001 will not add as much benefit as it would to a supplier that has a more distant relationship with the customer. From an information perspective, ISO 14001 should be more important for arms-length relationships where the customer has little information about the supplier; therefore, we hypothesize that:

> *Hypothesis 1B: Automotive suppliers with higher specialized assets will be less likely to adopt ISO 14001 than suppliers involved in less asset specialized transactions.*

3.2. Liability of newness

Suppliers might adopt a required CMS not only to remain in business, but also to establish new business transactions with large auto-assembler companies. New suppliers might follow auto-assembler requirements and adopt required certification standards to gain competitive advantage, and introduce their products and/or services into the market. Competitive advantage for new supplier facilities is important because firms tend to suffer from significant risks of business failure during early and adolescent periods (Henderson, 1999). Several scholars describe the relationship between age and failure as a liability of newness (Freeman, Carroll and Hannan, 1983; Hannan and Freeman, 1984) or liability of adolescence (Bruderl and Schussler, 1990; Levinthal and Fichman, 1988). New organizations must accumulate capital, commitment of potential members, entrepreneurial skills, and legitimacy (Hannan et al., 1984). To avoid these liabilities (e.g. liabilities of adolescence failure), and to accumulate legitimacy, new firms seek to embark on new activities that could help them signal to their customers that they are in a good position.

Within the automotive industry, adopting ISO 14001 helps suppliers to avoid liabilities of newness and generate legitimacy. New suppliers possess very little objective financial and operational data as well as quality history that can be disclosed to prospective investors (Sanders et al. 2004) and potential customers. ISO 14001 provides one of the few third party certified standards that a new supplier can show to potential customers to signal its quality and commitment to environmental excellence. Further, the standard helps build the firm's reputation within the industry to compete with already established firms.

In addition, organizational ecologists find that organizational age reduces a firm's learning capacity, and its chances of radically changing its strategy or behavior (Hannan et al., 1984; Sorensen and Stuart, 2000). Older and well-established firms are more reluctant to change their environmental management practices than younger ones; therefore, older firms remain less likely to adopt a new governance structure and change their environmental management system to include the new ISO 14001 guidelines. In summary, due to the need for increased legitimacy for younger firms and the highest reluctance to change behavior in older firms, we predict that:

Hypothesis 2A: Younger automotive suppliers are more likely to adopt ISO 14001 than older suppliers.

From a cost perspective, the opposite behavior is possible because it is less costly for older, well-established and financially stable firms, to adopt the ISO 14001 standard. Scholars propose that scale economies encourage the adoption of new practices (King and Lenox, 2001; Mansfield, 1968; Oster, 1982); therefore, we could expect the opposite behavior than the one presented in the previous hypothesis. Namely that:

Hypothesis 2B: Younger automotive suppliers are less likely to adopt ISO 14001 than older suppliers.

In summary, we have developed competitive hypotheses regarding the likelihood of a supplier obtaining ISO 14001 certification. We expect that both dependent trade relationships and the liability of newness could explain adoption as well as resistance to the adoption.

4. DATA & METHOD

4.1. Sample

To test our hypotheses we assembled a panel data set for the 2000-2003 period containing information for about 3,152 automotive supplier facilities drawn from the population of automotive suppliers located in Mexico, Canada, and the United States. By constructing a four year panel, we covered the entire period starting with the Big Three requirement publicized in 1999 until the June 2003 certification deadline. We expected facilities to need a few months to achieve the required certification after the Big Three requirement, so we chose 2000 as the first year for our dependent variable: ISO 14001 adoption. We lagged the independent variables one year, thus, covering the 1999-2002 period.

Data was derived primarily from the ELM Guide Automotive Supplier Database, and the ISO 14001 North American World Preferred Registry database. The ELM Guide Automotive Supplier Database includes information of approximately 80% of the automotive suppliers operating in North America on their supply chain characteristics (e.g. the customers they supply to, the parts and processes produced) at the parent and facility level. Considering that the ISO 14001 certification is awarded at the facility/plant level, we utilized the Supplier Plant level to conduct our analysis. We complemented our facility information by adding information from the Supplier Company database (e.g. exports characteristics) to control the company characteristics.

Data on the number of ISO 14001 certifications by country were collected from the ISO survey of ISO 9000 and ISO 14000 certificates (ISO, 2003). To control for the political dimensions of the environment in which US suppliers operate, we collected information from several databases and state reports. The first step of the analysis

matched the supplier facility database with the World Preferred ISO 14001 database. Our initial supplier facility database included information about 4,133 supplier facilities, of which 25% of supplier facilities adopted the standard by June of 2003.

The second step was to collect information from the ELM Guide Automotive Supplier Database at the company level (e.g. company age and exports characteristics) to include it in our facility database and control for company characteristics. We also decided to remove suppliers that were not directly selling products to automakers, i.e. Tier II suppliers, because the requirement for ISO 14001 only applied to Tier I suppliers. After completing the matching process, our final sample was of 3,152 Tier I supplier facilities: 74.6% of them located in the United States, 15.2% in Mexico, and the remaining 10.2% in Canada. Out of the 3,152 facilities, 861 were ISO 14001 certified by June of 2003. In the case of the United States, 116 automotive supplier facilities attained ISO 14001 certification by 2000 (4.8%), 207 suppliers by 2001 (8.5%), 499 suppliers by 2002 (20.5%) and 672 by June of 2003 (27.4%).

4.2. Statistical Analysis

Our empirical analysis is based on the estimates of discrete choice models. We use a random effects logit regression model, which is used to assess the effects of the independent variables on the likelihood of a supplier facility being ISO 14001 certified (Aldrich and Nelson, 1984). A majority of the facilities (70 percent) in our sample do not show variation in certification status during the four-year period of analysis, 2000-2003, i.e. they do not pursue certification during this period. We use a random effects logit model instead of fixed effects for two reasons. First, fixed effects estimates would be based only on facilities that changed their certification status during the period, whereas

random effects estimates are based on the full sample. Second, the Hausman test shows that we cannot reject the null hypothesis that the firm-specific effects are uncorrelated with the independent variables (χ^2=2.0, p-value=0.57).[3] The Hausman test (Hausman 1978) showed that random-effects models are more appropriate than fixed-effects models.[4].

The certification model in the binary logit model is specified as follows:

$$\text{Prob (ISO14001 }_{i,t}=1) = F(Z_{i,t-1}'\beta)$$

where ISO 14001 is the binary dependent variable indicating certification, $Z_{i,t-1}$ is the set of independent variables, and F is the cumulative logistic distribution ($F(x)=e^x/(1+e^x)=1/(1+e^{-x})$). The independent variables are used with one lagged year to avoid reserve causality.

4.3. Measures

4.3.1. Dependent variable

The dependent variable for the analysis is a dichotomous variable with value 1 if the automotive supplier facility had ISO 14001 that particular year. We gathered certification information from the WorldPreferred database on ISO 14001 certified facilities (WorldPreferred, 2004). Tables 1 and 2 summarize all the variables included in our US and North American analyses respectively.

4.3.2. Independent variables

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[3] Due to convergence issues, we were able to conduct the Hausman test using only two of the main independent variables (*Production Generalization, Age*).

[4] The Hausman specification test compares the fixed effects with the random effects model. It tests the null hypothesis that the coefficients estimated by the efficient random effects estimator are the same as the ones estimated by the consistent fixed effects estimator. If they are insignificant, then it is appropriate to use random effects. In our case, the calculated tests statistics is 2.0 for adoption (p=0.57) and it justifies the use of the random rather than the fixed effects model.

Asset Specificity. Previous empirical studies of transaction cost economics have operationalized asset specificity in many ways (David & Han 2004). For example, physical asset specificity has been previously measured by the degree of customization of a final product (Andersen and Buvik, 2001; Buvik and Gronhaug, 2000; Poppo and Zender, 1998; Zaheer and Venkatraman, 1995) or the degree of technological complexity involved in the production process (Delmas, 1999; Oxley, 1999). In our analysis, we account for the degree of customization (asset specificity) required by a particular supplier by generating a measure, *Sub-Assembly Supplier,* which takes the value of 1 for those suppliers developing sub-assembly tasks (i.e. sub-assemblers of auto parts) and 0 otherwise. Suppliers with a 0 value, produce basic products, which are used in a number of industries besides auto assembly such as raw steel, paints, or chemical coatings. Suppliers with a value of 1 produce parts specifically for the automotive industry, specialized for a particular make and model such as stampings, seat assemblies, and break and suspension components. These so-called, sub-assembly suppliers produce and assemble industry-specific customized auto parts. In addition to having assets that may be difficult to redeploy, production processes of sub-assembly suppliers are also usually more complex than the production processes of non-sub-assembly suppliers due to customers' product specification requirements. Facilities that specialize in highly complex products (that is, with high product specification requirements) may need to have tighter relationships with customers and more frequent contact with them(Hutson, 2006). This tighter relationship between sub-assembly suppliers and automakers might impact adoption decisions.

In addition, we have designed another measure, *Production Generalization*, as a proxy to account for the degree to which the production of each supplier facility is generalized. To generate this variable, we build on the work of Monteverde and Teece (1982) that identified parts specific to a single assembler. However, we identify the level of competition associated with the parts at stake instead. This variable represents the degree to which the parts produced by a supplier are also produced by other suppliers. We generate the variable as:

Production Generalization $_i$ = Σ (# of suppliers producing the same part for each part that facility *i* produces)

Our regression models control for the *Number of parts* produced by the supplier and for the *Number of customers* maintained by each supplier facility to ensure that the variable is a useful measure of the extent to which the production of a particular supplier facility is generalized.

Age. We use two variables to test for the impact of company age on ISO 14001 certification rates. The first variable, *Age,* is measured as the logarithm number of years since the supplier company that owns the facility was founded. The second variable specifically accounts for the effect of being a young facility, which is anticipated to impact the adoption of ISO 14001. We created a binary variable, *Young supplier*, which takes the value of 1 for those facilities owned by companies that were six years old or younger by 2003. Both the newness and adolescence liability perspectives agree that the early years of a firm's life are the most hazardous, and that failure rates decline with age (Henderson, 1999). No common threshold of years has been discovered under which a company can be considered safe from these liabilities. For instance, Bruderl and

Schussler (1990) found that firms with low initial resources faced the highest failure rates during their first year of business, while firms with higher initial resources only faced this highest risk after 60 to 72 months of existence. In general, the first six years appear to be a crucial period in which survival is determined for the majority of companies (US Small Business Administration, 1992; Shrader, Oviatt and McDougall, 2000). For the purpose of our analysis of the adoption of ISO 14001, we also consider companies established within the last six years, i.e., during the 1997-2002 period, as our group of young suppliers. This group corresponds to the 4.65% percentile of the youngest companies in our sample. We need to point out the fact that the ISO 14001 standard was published in 1996 and was officially mandated by the Big Three automakers in 1999. Companies starting business within this period might have adopted ISO 14001 to increase their legitimacy quickly and to signal their good environmental behavior.

4.3.3. Control variables

We generate several measures to control for alternative explanations of the adoption decision.

TRI Reporter We introduce a variable to account for whether the facility reports to the US EPA Toxic Releases Inventory (TRI). The US EPA TRI program includes facilities that manufacture, import, process, or use any of the listed substances in amounts greater than threshold quantities (25,000 pounds for manufacturing and processing activities and 10,000 pounds for usage) and have at least 10 full-time employees (EPA 1999). In our

US sample, we find that 30% of the US supplier facilities report to TRI.[5] We included this variable because firms that report to the TRI are under more public scrutiny than firms that do not report to the TRI. NGOs may target them more for scrutiny and therefore firms that report to the TRI are more likely to signal their good behavior than firms that are not under TRI.

Customer portfolio. We include three measures to control for the impact of customer portfolio characteristics on the adoption of the ISO 14001 standard. First, we include a binary variable *Big Three Customer* that takes a value of 1 for those supplier facilities that sell their parts to any of the Big Three automakers. Furthermore, we control for the *Number of customers* that each facility has. Last, we control for the number of non-automaker customers that each facility has by calculating the *Percentage of non-automaker customers*.

Number of parts. We include the *Number of parts* as a control variable so that we can control for the effect that the number of parts produced by a particular supplier facility has on the likelihood of adopting ISO 14001 and especially the effect on the *Production Generalization* variable.

QS 9000. We also control for the experience with related management standards, such as quality standards. Quality standards have been shown to influence a company's decision to become certified with ISO 14001 (Albuquerque, Bronnenberg and Corbett, 2006; Corbett, 2002; Corbett et al., 2001; Darnall, 2003; Delmas, 2005). To account for this, we create the variable *QS9000*. QS 9000 is the version of the quality management standard

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[5] Since only 30% of our sample facilities report to the TRI, we did not include a variable representing the toxic releases from the facility. Including such a variable would have drastically reduced our sample and incorporated a bias into the analysis.

ISO 9000 developed by Daimler-Chrysler, Ford, and General Motors. QS9000 was first published in 1994 and later re-issued in 1998. It is based on ISO 9000 but it incorporates additional quality requirements expected by the Big Three. We collected QS 9000 certification data from both the Global Automotive Industry Database and the QS 9000 Registered Company Directory (QSU, 2005). This variable is coded so that "1" indicates that the facility has adopted the QS 9000 quality management standard. The QS 9000 standard has been extensively adopted by the automotive industry. For instance, 62% of the facilities in our sample had already adopted the standard. In fact, the QS 9000 standard has been revised and integrated into the new international quality standard for the automotive industry, the ISO 16949:2002 certification. Automotive supplier companies all over the world have already started to adopt this new standard with more stringent quality requirements. Last, we account for the possible effects of facility size by including a control for the facility's square footage (log transformed).

Exports. We control for the exports characteristics of the company to whom the supplier facility belongs. Guler et al. (2002) noted that trade networks (cohesion) can generate isomorphism for coercive and mimetic, as well as for normative reasons. In a customer-supplier relationship, whether coercive, mimetic, or normative, the effect of isomorphism is that cohesive actors or organizations tend to adopt similar patterns of behavior (Guler et al. 2002). Furthermore, studies in international business have defined the term "liability of foreignness" to denote the difficulty and cost of selecting and monitoring foreign suppliers (King et al., 2005; Kogut and Singh, 1998). Companies will almost certainly request that their foreign suppliers adopt certified management standards and use standards as a tool to screen and select foreign partners. Henceforth, in the context of

ISO 14001, companies that export to countries where a high number of local firms have adopted a management standard may need to adopt the same standard to export to these countries or to trade with local firms there. Japan and Europe were the two regions with the highest penetration level of ISO 14001 as of 2003. For instance, by December of 2003, the total number of ISO 14001 certifications in Japan and Europe was 13,416 and 31,997 respectively; in the United States, the number of certifications was 3,553 (ISO 2003). We then created two binary variables *Exports to Japan* and *Exports to Europe*, which take the value of 1 when the facility is owned by companies exporting to these two regions.

Headquarters' location. Similarly, we also control for the location of headquarters. This measure can be a proxy of geographical distance between customers and suppliers. Customers may trust foreign firms less because of the difficulty in assessing the environmental performance of firms located in a foreign country and subjected to different environmental regulations. So, a certification with an internationally recognized standard may play a strong role in signaling difficult-to-observe attributes about environmental behavior and generating trust (King, Lenox and Terlaak, 2005). In addition, the business culture characteristics in the country where the headquarters of a particular supplier company are located will also influence the decision to adopt a particular management practice. For instance, a company located in a country where ISO 14001 has been strongly diffused will behave differently from a company located in a country where the standard is not yet well known. Mimetic behaviors will also arise in this context, and companies located in high-adopting regions will certify their facilities with ISO 14001 worldwide (Delmas, 2002). Accordingly, we first determined the location of the

company's headquarters by using several online databases such as Hoovers, E-Zource, and Goliath, and by accessing the companies' websites. Once the location was determined, we created two binary variables, *Headquarters in Japan* and *Headquarters in Europe,* to account for facilities owned by Japanese and European companies. Last, we control for the year effects by including three binary variables for the 2000-2002 period.

League of Conservation Voters. We control for the pressure emanating from political/legislative actors by the voting record of each state's congressional delegation (members of the US Senate and US House of Representatives) in which the firm operates. Several researchers have used the scores of the League of Conservation Voters (LCV) as a measure of the preferences of a state elected representatives (Hamilton, 1997; Hedge and Scicchitano, 1994; Kassinis and Vafeas, 2002, 2006; Lubell, Schneider, Scholz and Mete, 2002; Ringquist and Emmert, 1999; Viscusi and Hamilton, 1999). Each year, the LCV selects environmental issues to constitute an "environmental agenda" with a panel comprising the main U.S. environmental groups. The organization then creates an index by counting the number of times each representative or senator in Congress votes favorably on the environmental agenda (e.g. on the global warning gag rule, tropical forest conservation, and global climate change). The index ranges from 0--100, with 100 representing a record of voting for the environmental agenda in all cases. The variable is the average of the environmental scores of the U.S. House of Representatives and U.S. senators of the states where each utility operates, weighted (Kahn, 2002), by the percentage of generation of each firm in each state for multi-state utilities.

Sierra Club members. Similar to previous studies (Delmas and Montes-Sancho, 2007; Helland, 1998; Kassinis et al., 2002, 2006; Maxwell, Lyon and Hackett, 2000; Riddel,

2003), we control for the environmental preferences of the population of the state in which the supplier facility operates based on membership figures for one of the major environmental non-governmental organizations, the Sierra Club. The measure itself is the number of dues-paying Sierra Club members per 1,000 residents.

State EMS Program. Many states in the US have developed their own voluntary programs, including some that have explicit EMS requirements (Potoski and Prakash, 2005). To control this effect, we include a variable called State EMS Program that represents the number of years that the state has had the EMS program in place. According to the State's Official Guide to Environmental Management Systems, 18 states had active Environmental Leadership Programs with an EMS requirement by 2002 (CSG 2003). We expect that facilities located in states with EMS requirements, will be more likely to adopt ISO 14001.

State Pollution. The level of pollution in the state where the facility is located might have been a determinant factor in the decision of a firm to adopt the ISO 14001 standard. More polluted states might be subjected to greater scrutiny by and pressure from environmental NGOs at the national level to undertake some action to reduce CO_2 emissions. Following King and Lenox (2000) and Kassinis and Vafeas (2002), we base the measure of pollution using the state's toxic emissions (the total amount of on- and off-site toxic release) for all sectors (log transformed); we collected this information from the EPA's Toxics Release Inventory (TRI) database.

State Environmental Regulations. Following Potoski (2001) and Potoski and Prakash (2005), we control for the stringency of the state hazardous air pollutants regulations**.** We include the *State Hazardous Air Regulation* variable, which takes the value of 1 if the

state's regulations were more stringent than the corresponding EPA minimum criteria (Potoski, 2001). In addition, we include a measure to control for *State Waste Regulations,* which takes the value of 1 if state regulations on waste management were more stringent than federal regulations that particular year. This information was gathered at the Association of Lighting and Mercury Recyclers website (alcm.org). We might expect that facilities located in states with more stringent regulations will be more likely to adopt the ISO 14001 as a means to signal their proactive environmental behavior to state agencies.

State Audit Protection and Self-Disclosure Policies. Finally, and also following Potoski and Prakash (2005), we measure the legal environment in states with the *State Audit Protection* variable*,* scored 1 if the state provided privilege or immunity protection that particular year for information uncovered in facilities' self-audits. We also include a last binary variable, *State Self-Disclosure Policies,* to control for whether the state has adopted self-disclosure policies. This information was gathered at the US Environmental Protection Agency website. The decisions of facilities to adopt ISO 14001 may be influenced by the state policy regarding self-audit findings since certification involves both internal and third party environmental audits.

In addition to our US adoption analysis, we conducted a second adoption analysis for the supplier facilities located in entire North America (United States, Mexico, and Canada). By including this analysis, we were able to increase our pool of supplier facilities and identify whether different adoption patterns existed in these three countries. Table 2 includes the descriptive analysis for the variables included in the North American analysis. We removed the US-specific control variables and instead included two new

control variables, *Facility located in Mexico* and *Facility located in Canada*, to control for the different regulatory environments. We therefore consider facilities located in the United States as our comparison group.

5. RESULTS

Tables 3 and 4 present the analysis of the likelihood of automotive supplier facilities located in the United States and North America respectively, to obtain the ISO 14001 certification standard .

Table 3, shows two different models of adoption of ISO 14001 among US automotive supplier facilities. In Model 1, we test the different hypotheses using *Age* as a measure of the age of the supplier. In Model 2, we use a different measure, *Young supplier,* to account for facility's age to better understand how younger supplier facilities behave. Similarly, we include two additional models 3 and 4 in Table 4, which test the same hypotheses as models 1 and 2 respectively, but for all North American supplier facilities. All models correctly classify 84% of the observations.

Hypotheses 1A and 1B predict opposite results regarding the relationship between asset specificity and the likelihood of obtaining ISO 14001certification. We find support for hypothesis 1A in all our models for both the United States and the North American analyses (Models 1-4). For instance, in Model 1 we find that suppliers with sub-assembly activities are more likely to adopt the standards ($p<0.01$) than suppliers without sub-assembly tasks. Second, we find that suppliers with a more generalized production process (i.e. producing parts that are also produced by a large number of suppliers) are less likely to adopt ISO 14001 ($p<0.05$) as indicated by the *Production Generalization* variable. Identical results are found in Models 3 to 4 for the North American adoption analyses.

The second pair of hypotheses, Hypotheses 2A and 2B, predict opposite results with respect to the relationship between facility age and the likelihood of certification. Our results in all 4 models strongly support Hypotheses 2A that younger suppliers are more likely to certify with ISO 14001 than others older suppliers. In Models 1 and 3, we test the hypothesis using *Age* ($p<0.01$) while in Models 2 and 4 we use the variable *Young supplier* ($p<0.01$). Both variables show that younger suppliers are more likely to adopt the standard than older suppliers.

We calculated the predicted probabilities for the year 2002 to provide some insights into the magnitude of the different effects. For instance, among younger suppliers the probability of adopting ISO 14001 reached 44 percent while the percentage was only 25 percent among older suppliers. The probability of adopting ISO 14001 among sub-assembly suppliers was 30 percent while it reached only 23 percent among the rest of suppliers.

Finally, we find that all control variables behave as expected. Our results in Models 1 and 2 show that facilities reporting to the Toxic Releases Inventory (TRI) are more likely to certify with ISO 14001. The variable *TRI reporter* representing participation in TRI is positive and significant indicating that most polluting facilities (i.e. those facilities that are required to report their emissions and toxic releases to the Environmental Protection Agency) are more likely to certify their EMS with the ISO 14001 standard. We also find that facilities with a higher percentage of non-automaker customers are less likely to certify with ISO 14001. These facilities are probably under less pressure to adopt ISO 14001 because they have a pool of customers outside the industry that might serve as a backup if they lose contracts with any of the main automakers.

In addition, we find that suppliers that had previously adopted the CMS for quality management, QS 9000, are more likely to certify with ISO 14001. The influence of headquarters' location, measured with a binary variable indicating whether the headquarters are located in Europe or Japan, is significant for facilities whose headquarters are located in Japan, indicating that these are more likely to certify than facilities whose headquarters are in North America. Japan has been an extremely proactive and leading country in terms of adopting ISO 14001 and this effect might have been transmitted to their facilities abroad. In addition, the variables about exports to Japan in Europe, included to control for the impact of exporting to regions where ISO 14001 had the highest penetration levels, are positive and significant, which indicate that suppliers' firms exporting to these two regions are more likely to certify. However, these

effects disappear after controlling for additional regulatory and political factors in the case of US facilities (see Models 3 to 4).

Regarding the different control variables included in Table 3 for the US analysis, we also find some interesting results. The variable *Big Three customer*, does not show any significant results which indicates that being a Big Three customers did not modify the likelihood of ISO 14001 adoption despite the existing requirement. Our findings do not support the claim that the environmental preferences of the population measured by the number of Sierra Club's membership per 1,000 residents affected the behavior of utilities concerning the Program. This result differs from previous studies showing the effect of such a variable on environmental voluntary activities (Maxwell, Lyon, Hacket, 2000). This finding is possibly related to the fact that Sierra Club and other US environmental NGOs did not initially consider ISO 14001 as an effective system to improve environmental performance. Firms located in regions with high community activism might have opted for other more trusted environmental programs.

Regarding the impact of facility location on adoption, we find in Table 4, that supplier facilities located in Canada are more likely to certify than facilities located in the United States while supplier facilities located in Mexico are less likely to certify than facilities in the US. Mexico has a different regulatory environment than the other two countries. Like most developing countries, Mexico has weaker environmental regulations (or enforcement agencies) and a shorter history of environmental activism (Raines, 2002). These differences of institutional and regulatory environments might explain why facilities located in Mexico are lagging behind their northern counterparts in terms of adoption rates of ISO 14001.

6. DISCUSSION AND CONCLUSION

In conclusion, these results provide significant support for the hypotheses under investigation, sustaining the assertion that dependence between customer and supplier as well as the liability of newness impact the likelihood of ISO 14001 adoption among North American supplier facilities. We find that supplier facilities with a more dependent relationship with the auto-assembler supply chain are more likely to adopt the ISO 14001 standard than those facilities with a less dependent association with the auto-assemblers. We also find that younger suppliers are also more likely to adopt the standard, suggesting than they adopt it to gain a better reputation within the automotive industry. In addition, our results reveal that reporters to the Toxic Release Inventory are more likely to adopt ISO 14001 than firms that do not report to TRI. In agreement with previous studies, we also find that larger suppliers, already certified with the management quality standard ISO 9000 with headquarters in Japan are more likely to seek certification.

The probability of adopting ISO 14001 for younger sub-assembly suppliers that are ISO 9000 certified, that report to the US TRI and that are headquartered in Japan reached 66 percent, while the percentage was only 14 percent among the pool of facilities with the opposite characteristics. As we mentioned, when we calculated the probability of the variable younger supplier or the variable sub-assembly suppliers independently we reached probabilities of 44 percent and 30 percent respectively. This shows that these variables are important to explain the adoption of ISO 14001.

Our results show the significance of identifying the characteristics of the relationship between customers and suppliers to assess the effectiveness of customer

pressure on the adoption of environmental management practices within the supply chain. While previous studies had identified the importance of stakeholder pressures to influence the adoption, they rarely seek to understand the conditions under which these pressures could be effective. We demonstrate that both suppliers with tighter relationships with their customers and those with more distant relationships are likely to adopt the ISO 14001 standard but for different reasons. In the first case, firms are more dependent on their customers and therefore do not have any alternatives but to listen to their customers' requests. In addition, close relationships are marked by frequent meetings between customers and suppliers that facilitate the understanding of the advantages of such requests. In the second case, suppliers are more distant from customers either because they are located in a different country or because they are newcomers without the existing ties among incumbents. In order to enter or be retained in the 'preferred supplier' list, these companies need to communicate more formally, or show more formal commitment to environmental improvement than firms that already have established connections. Note that these two conditions are not necessarily independent. Although we initially contrasted the hypotheses based on transaction costs and signaling theories, our results suggest that arguments based on transaction cost and signaling theories need not be formulated in opposition but could be better viewed as complementary. Transaction costs arguments often underestimate the role of pre-existing relationships or networks which could influence the efficiency of governance mechanisms. We show that dependence and distance are two conditions that increase the benefits of governance mechanisms such as certified environmental management

standards. Further research could identify how these findings can be generalized to other governance mechanisms.

Our findings indicate that strategies – such as requiring suppliers to adopt a certified management standard as a governance structure to expand environmentally friendly practices within the supply chain –still has a limited appeal which is restricted to the suppliers with the characteristics described above. To affect a larger pool of suppliers, such an instrument would need to be complemented with additional practices. Otherwise, only new suppliers engaged in a more dependent relationship with the assembler will adopt the new governance structure.

Previous research found that voluntary programs are not very effective in the absence of explicit sanctions (King & Lenox 2000; Delmas and Montes-Sancho, 2007). It is possible, that in the automotive sector, the sanctions were not sufficiently credible to persuade more suppliers to participate in the program. Companies aiming to green their supply chain will therefore need to evaluate the methods to provide more explicit sanctions to non-adopters.

As we noted, recent research on ISO 14001 has highlighted the importance of the regulatory environment as a predictor of the adoption of the standard within a specific country or a specific industry (Bansal and Bogner, 2002; Christmann & Taylor, 2001; Delmas, 2002; Kollman & Prakash, 2002). Despite the "voluntary" nature of adopting ISO 14001, our results show that in addition to customer pressures, the government may have a role to play in affecting the adoption of ISO 14001. Our findings show the interaction between a specific environmental policy and the adoption of ISO 14001. More specifically, we show that facilities required to report their toxic emissions to the Toxic

Release Inventory are more likely to adopt ISO 14001. This result can be explained by the fact that facilities subjected to TRI are under intense scrutiny from various stakeholders and need to signal their commitment to improve their environmental performance. Studies related to the effectiveness of the Toxic Release Inventory have had mixed results. Konar and Cohen (1996) and Khanna, Quimio and Bojilova (1998) found that stock movements associated with the U.S. (TRI) announcements led to increased abatement and reduced emissions. However, Bui (2005) found that the decline in emissions after TRI reporting events were more likely attributable to regulation than investor pressure. Our results show that TRI may have an effect on the commitment of facilities to improve environmental performance. This result is important as more governments around the world begin to embrace the mandatory disclosure of information policies. Further research could identify how regulatory pressures interact with customer pressures and, more specifically, how mandatory disclosure policies facilitate the diffusion of certified environmental management standards.

Although we included several control variables in the analysis, our findings need to be interpreted with caution. First, it is possible that more firms sought certification after the 2003 deadline. Future research needs to follow up on the ISO 14001 adoption process among automotive suppliers in the next years. Moreover, research on the adoption of the standard among suppliers located in other regions of the world would be of interest. For instance, the Big Three requirement might not be seen as a real threat among North American suppliers, but such a requirement might be regarded as such among suppliers in other institutional environments.

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TABLE 1. Descriptive statistics and correlations (US Analysis)[a]

	Variable	Mean	Std. Dev	1	2	3	4	5	6	7	8	9	10	11
1	ISO 14001	0.15	0.36	1										
2	Sub-Assembly plant	0.48	0.50	0.03	1									
3	Production Generalization	6.24	1.14	-0.05	-0.05	1								
4	Age	3.60	0.85	-0.03	-0.02	0.02	1							
5	Young supplier (6 years or less)	0.05	0.22	0.05	0.00	-0.01	-0.59	1						
6	TRI reporter	0.26	0.44	0.16	-0.04	-0.07	0.05	-0.00	1					
7	Number of parts	3.32	2.37	-0.04	0.03	0.45	-0.01	-0.02	-0.01	1				
8	Number of customers	4.46	2.73	-0.00	0.00	0.04	0.01	-0.04	0.07	0.19	1			
9	Percentage of non-automaker customers	0.23	0.25	-0.03	-0.01	0.08	-0.02	-0.00	0.02	0.13	0.49	1		
10	Big Three customer	0.91	0.28	0.00	-0.01	0.07	0.19	-0.05	0.00	0.09	0.17	-0.09	1	
11	Log of square footage	11.68	0.96	0.14	0.07	-0.10	0.04	0.02	0.32	0.02	0.09	0.00	0.05	1
12	QS 9000	0.65	0.47	0.03	-0.00	0.05	0.03	0.02	0.02	0.03	0.04	-0.00	0.15	0.05
13	Headquarters in Japan	0.08	0.27	0.06	0.07	-0.15	-0.23	0.02	0.03	-0.06	0.05	0.02	-0.27	0.07
14	Headquarters in Europe	0.08	0.26	0.00	0.01	-0.07	-0.01	0.00	0.06	-0.03	0.02	-0.04	0.01	0.08
15	Exports to Japan	0.26	0.44	0.04	0.01	-0.01	0.05	-0.06	0.09	-0.01	0.14	0.02	-0.06	0.09
16	Exports to Europe	0.48	0.50	0.01	-0.01	-0.00	0.13	-0.08	-0.03	0.01	0.08	-0.00	0.14	-0.03
17	League of Conservation Voters	0.44	0.19	-0.01	0.01	0.05	0.03	-0.01	-0.08	0.06	0.02	0.01	0.11	-0.07
18	Sierra Club	1.63	0.95	-0.00	0.00	0.01	0.03	-0.02	-0.02	0.01	0.01	0.03	0.02	-0.04
19	State EMS program	1.93	2.40	0.04	0.04	0.07	0.01	-0.00	-0.07	0.02	0.01	0.02	0.10	-0.10
20	State Pollution	17.71	0.81	0.01	0.01	0.02	-0.06	0.02	-0.00	0.02	-0.01	-0.01	-0.03	-0.00
21	State hazardous air regulation	0.06	0.25	-0.02	0.03	-0.04	0.02	-0.01	0.02	-0.01	0.00	0.03	-0.01	0.01
22	State exceeds waste regulations	0.88	0.32	0.01	0.03	-0.01	-0.02	0.01	-0.06	-0.00	0.03	0.02	0.05	-0.04
23	State Audit Protection	0.72	0.44	0.01	0.01	0.04	-0.02	0.01	0.00	0.03	-0.01	-0.00	-0.00	-0.02
24	State Self-Disclosure Policies	0.18	0.38	-0.02	0.00	-0.04	0.02	-0.02	-0.01	-0.02	0.01	0.00	0.00	0.03

[a] N=9,686. Correlations with an absolute value greater than 0.02 are significant at 5% level

	Variable	12	13	14	15	16	17	18	19	20	21	22	23
12	QS 9000	1											
13	Headquarters in Japan	-0.07	1										
14	Headquarters in Europe	0.03	-0.08	1									
15	Exports to Japan	-0.00	0.11	-0.03	1								
16	Exports to Europe	0.07	-0.06	-0.02	0.27	1							
17	League of Conservation Voters	0.02	-0.08	-0.02	-0.03	0.03	1						
18	Sierra Club	-0.04	-0.02	-0.01	-0.01	0.00	0.34	1					
19	State EMS program	0.07	-0.08	-0.01	-0.02	0.03	0.42	0.16	1				
20	State Pollution	0.03	-0.00	0.00	0.02	-0.00	-0.24	-0.35	0.02	1			
21	State hazardous air regulation	-0.04	0.00	-0.02	0.03	0.00	0.01	0.38	-0.13	-0.26	1		
22	State exceeds waste regulations	0.00	-0.00	-0.02	0.01	0.04	0.34	0.13	0.15	-0.11	0.04	1	
23	State Audit Protection	0.02	-0.03	-0.02	0.01	-0.00	-0.09	-0.18	0.30	0.36	-0.28	-0.21	1
24	State Self-Disclosure Policies	-0.04	0.00	0.04	0.00	0.01	0.10	0.20	-0.32	-0.25	0.31	0.16	-0.68

TABLE 2. Descriptive statistics and correlations (North American Analysis)[a]

	Variable	Mean	Std. Dev	1	2	3	4	5	6	7	8	9	10
1	ISO 14001	0.15	0.36	1									
2	Sub-Assembly plant	0.49	0.50	0.05	1								
3	Production Generalization	6.20	1.13	-0.05	-0.05	1							
4	Age	3.57	0.84	-0.01	-0.01	0.03	1						
5	Young supplier (6 years or less)	0.05	0.21	0.05	0.01	-0.00	-0.58	1					
6	Number of parts	3.22	2.31	-0.03	0.02	0.45	-0.01	-0.01	1				
7	Number of customers	4.31	2.67	-0.00	-0.01	0.03	0.01	-0.04	0.20	1			
8	Percentage of non-automaker customers	0.21	0.25	-0.03	-0.03	0.09	-0.02	0.00	0.14	0.50	1		
9	Big Three customer	0.90	0.28	0.01	-0.04	0.05	0.19	-0.05	0.08	0.18	-0.08	1	
10	Log of square footage	11.65	0.97	0.13	0.07	-0.09	0.04	0.02	0.03	0.10	0.00	0.05	1
11	QS 9000	0.62	0.49	0.02	-0.02	0.05	0.03	0.02	0.05	0.06	0.01	0.15	0.06
12	Facility in Mexico	0.15	0.35	-0.03	0.06	-0.07	-0.05	0.00	-0.08	-0.07	-0.13	-0.04	-0.03
13	Facility in Canada	0.10	0.29	0.03	-0.02	0.01	-0.02	-0.02	0.00	-0.04	-0.02	0.03	-0.05
14	Headquarters in Japan	0.08	0.27	0.06	0.09	-0.13	-0.22	0.02	-0.07	0.04	0.02	-0.29	0.05
15	Headquarters in Europe	0.08	0.27	-0.00	0.02	-0.06	-0.01	0.00	-0.01	0.03	-0.03	0.01	0.07
16	Exports to Japan	0.24	0.43	0.06	0.03	-0.10	0.05	-0.05	-0.01	0.14	0.03	-0.05	0.08
17	Exports to Europe	0.47	0.50	0.03	-0.00	-0.00	0.12	-0.08	0.01	0.08	0.00	0.12	-0.01

	Variable	11	12	13	14	15	16
11	QS 9000	1					
12	Facility in Mexico	-0.16	1				
13	Facility in Canada	0.03	-0.13	1			
14	Headquarters in Japan	-0.08	0.05	-0.05	1		
15	Headquarters in Europe	0.03	0.00	0.01	-0.08	1	
16	Exports to Japan	0.00	-0.03	-0.05	0.11	-0.02	1
17	Exports to Europe	0.07	-0.08	0.03	-0.06	-0.00	0.27

[a] N=12,932. Correlations with an absolute value greater than 0.02 are significant at 5% level.

TABLE 3. Logit Regression Analysis for ISO 14001 adoption (US Analysis)[a]

	Model 1	Model 2
Sub-Assembly Plant	0.31**	0.30**
	(0.11)	(0.11)
Production Generalization	-0.11*	-0.12*
	(0.05)	(0.05)
Age	-0.22**	
	(0.05)	
Young supplier		0.88**
		(0.18)
TRI reporter	0.99**	0.98**
	(0.12)	(0.12)
Number of parts	-0.00	0.00
	(0.03)	(0.02)
Number of customers	-0.00	0.00
	(0.02)	(0.02)
Percentage of non-automaker customers	-0.42+	-0.44+
	(0.24)	(0.24)
Big Three customer	-0.04	-0.11
	(0.21)	(0.21)
Size (square footage)	0.43**	0.41**
	(0.06)	(0.06)
QS 9000 certification	0.20+	0.19+
	(0.11)	(0.11)
Headquarters in Japan	0.45*	0.59**
	(0.20)	(0.20)
Headquarters in Europe	-0.15	-0.12
	(0.20)	(0.20)
Exports to Japan	0.13	0.13
	(0.13)	(0.13)
Exports to Europe	0.19+	0.18
	(0.11)	(0.11)
League of Conservation Voters	0.09	0.10
	(0.27)	(0.26)
Sierra Club	-0.08	-0.08
	(0.06)	(0.06)
State promotes EMS adoption	0.02	0.02
	(0.02)	(0.02)
Log of Total State TRI Emissions	0.12+	0.13+
	(0.07)	(0.07)
State exceeds hazardous air regulations	-0.08	-0.08
	(0.22)	(0.22)
State exceeds waste regulations	0.05	0.05
	(0.16)	(0.16)
State Audit Protection	-0.06	-0.05
	(0.15)	(0.15)
State Self-Disclosure Policies	-0.19	-0.17
	(0.18)	(0.18)
Constant	-10.50**	-11.16**
	(1.47)	(1.46)
Year effects	Yes	Yes
Observations	8856	8856
Wald χ^2	729.17**	731.21**
Log likelihood full model	-3143.89	-3141.21
% correctly classified (pooled)	83.88%	83.92%

[a] Number of US American automotive facilities: 2,764. Standard errors are in parentheses.
+significant at 10%, * significant at 5%, **significant at 1%.

TABLE 4. Logit Regression Analysis for ISO 14001 adoption (North American Analysis)[a]

	Model 3	Model 4
Sub-Assembly Plant	0.34**	0.33**
	(0.11)	(0.11)
Production Generalization	-0.11*	-0.12*
	(0.05)	(0.05)
Age	-0.17**	
	(0.05)	
Young supplier		0.85**
		(0.17)
Number of parts	0.00	0.01
	(0.02)	(0.02)
Number of customers	-0.00	0.00
	(0.02)	(0.02)
Percentage of non-automaker customers	-0.44+	-0.45+
	(0.24)	(0.24)
Big Three customer	0.03	-0.02
	(0.21)	(0.20)
Size (square footage)	0.54**	0.53**
	(0.05)	(0.05)
QS 9000 certification	0.22*	0.21*
	(0.10)	(0.10)
Facility in Mexico	-0.35**	-0.34*
	(0.13)	(0.13)
Facility in Canada	0.38*	0.41**
	(0.16)	(0.16)
Headquarters in Japan	0.62**	0.72**
	(0.20)	(0.20)
Headquarters in Europe	-0.10	-0.07
	(0.20)	(0.20)
Exports to Japan	0.38**	0.38**
	(0.13)	(0.13)
Exports to Europe	0.28*	0.28*
	(0.11)	(0.11)
Constant	-10.26**	-10.72**
	(0.75)	(0.73)
Year effects	Yes	Yes
Observations	11884	11884
Wald χ^2	885.29**	890.47**
Log likelihood full model	-4071.14	-4065.47
% correctly classified (pooled)	84.24%	84.27%

Number of North American automotive facilities: 3,152.

Standard errors are in parentheses.

+significant at 10%, * significant at 5%, **significant at 1%.

FIGURE 1

Cumulative Percentage of ISO 14001 certificates

in the Northern Automotive Supplier Industry