GREENING THE SUPPLY CHAIN:

WHEN IS CUSTOMER PRESSURE EFFECTIVE?

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Forthcoming *Journal of Economics & Management Strategy*

*Corresponding Author. The authors thank Pratima Bansal, Charles Corbett, Catherine Ramus, Ann Terlaak, and Phil Threadgould for detailed comments on previous versions of this article, as well as two anonymous reviewers for their suggestions. We particularly thank Tom Lyon for his editorial guidance.

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ABSTRACT

Suppliers face increasing pressure from their customers to improve their environmental performance. When firms downstream in the supply chain seek to achieve such improvements themselves, they frequently request that their suppliers adopt greener practices. This paper investigates the rationale for suppliers to comply with or resist the mandate of their customers to adopt the international environmental management standard 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 cost and information theories to suggest that suppliers, whether in a dependent or distant relationship with their customers, have incentives to comply with the requests of their customers but through different mechanisms. Our study analyzed the characteristics of 3,152 automotive suppliers located in the US, Canada, and Mexico over the 2000-2003 period. Findings indicate that suppliers with highly specialized assets, as well as younger suppliers, suppliers headquartered in Japan, and those reporting to the Toxic Release Inventory, are more likely to respond to their customers' pressures to adopt the certified management standard ISO 14001.

1 INTRODUCTION

Firms seeking to improve their environmental performance are increasingly concerned about the performance of other firms upstream in their supply chain. Such concern is justified considering that unsatisfactory environmental performance records of suppliers could degrade the reputation of downstream customers who buy their products. Negative performance could also result in regulators halting suppliers' operations and therefore halting the supply of their products to downstream customers. Conversely, firms could also leverage the positive environmental performance of their suppliers to enhance their own environmental reputations. These are some of the reasons why increasing numbers of customers require their suppliers to adopt better environmental management practices (Darnall 2006; Walton, Handfield, and Melnyk 1998). A famous example of this is the Wal-Mart sustainable supply chain initiative (Plambeck and Denend 2008).

Little is known about the effectiveness of such requirements, and particularly about the conditions under which suppliers will resist or comply with their customers' requests to improve their environmental practices beyond regulatory compliance. This paper attempts to increase understanding of the issue by investigating the rationale for automotive suppliers to respond to a mandate from their downstream customers to adopt the international environmental management system standard 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 the supplier and its customer. Such characteristics wield influence because they can mitigate the pressure exerted by industrial customers on their suppliers. Furthermore these characteristics can affect incentives to signal commitment to improving environmental performance.

We develop and test hypotheses based on both transaction cost economics and information theory that suggest apparently conflicting explanations for the adoption of ISO 14001. Transaction cost economics identifies characteristics of the supplier-customer exchange that lead to a dependent relationship and therefore increase incentives for the supplier to comply with the requests of the industrial customer. Conversely, information theory emphasizes the benefits to arms-length relationships of using ISO 14001 to signal good environmental behavior in order to reduce information asymmetries. We argue that these two approaches should be viewed as complementary. While transaction cost economics emphasizes ex post contractual difficulties resulting from asset specificity, information economics focuses on the consequences of ex ante assessment and search difficulties for firm strategies. Our paper explores both rationales as drivers of the adoption of ISO 14001.

A process standard issued in 1996 by the International Organization for Standardization (ISO), ISO 14001 helps an organization implement an environmental management system (EMS). The costs of standard certification are substantial. Estimates range from around $50,000 for small firms to greater than $1,000,000 for larger firms (Watkins and Gutzwiller 1999; Potoski and Prakash 2005). ISO 14001 anticipates that organizations using the standard to manage environmental matters systematically will learn how to reduce or eliminate pollution. By doing so, firms are expected to improve their environmental performance to a greater degree than firms that do not adopt ISO 14001 (Coglianese and Nash 2001). More than 100,000 facilities have adopted the standard worldwide since its inception, with a recent yearly increase of over 20,000 certificates (ISO 2005).

Empirical studies analyzing the factors behind adoption of ISO 14001 show that the level of pressure exerted by external stakeholders, including downstream customers, does affect the likelihood of adoption, and that adoption also varies according to 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 and Taylor 2001; Darnall 2003, 2006; Delmas 2002; Kollman and

Prakash 2002; Toffel 2006). In general terms, customer pressure and the supplier organization's characteristics stand out in these studies as important driving forces behind the adoption of certified management standards. Few studies, however, analyze how the characteristics of the relationship between industrial customers and suppliers influence adoption. There remains also a lack of a comprehensive theoretical perspective on this issue (King, Lenox, and Terlaak 2005).

We chose to use the North American automotive sector to test our hypotheses because it features strong customer pressures requiring suppliers to adopt ISO 14001, and because it allows observation of important variations in suppliers' adoption rates. The Big Three US automakers (General Motors, Ford, and Daimler-Chrysler) formally requested their suppliers to adopt ISO 14001 by 2003. The Big Three requirement received considerable publicity among business scholars and the media (Bansal and Bogner 2002; Christmann and Taylor 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).[1] Surprisingly, despite the insistence of the biggest automakers, by July 2003 only 24% of the automotive suppliers located in North America had adopted ISO 14001.[2] The failure of a very large percentage of suppliers to meet expectations deserves further inquiry and attention.

Our results show that both transaction cost and information theories can explain the adoption of voluntary practices through complementary mechanisms. We find that firms engaged in transactions marked by high asset specificity, younger firms entering the market, and firms with headquarters located in Japan are more likely to adopt ISO 14001. Identifying the incentives for firms to adopt the standard

[1] 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, 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 an EMS by March 2003, and worked with their suppliers to help them obtain ISO14001 certification by 2005 (Nissan 2005).

[2] Out of 4133 facilities registered in the ELM Guide Automotive Supplier Database, 998 facilities (24%), obtained ISO 14001 certification by 2003.

enables us also to uncover 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 by the deadline tend to be older, smaller, and to produce less specialized products. Resistant firms additionally include those that are not required to report their emissions to the US Environmental Protection Agency (EPA) Toxic Release Inventory (TRI). This exemption makes them less visible to regulators and environmental NGOs. Our research thus reveals the limitations of voluntary approaches such as ISO 14001 in reaching these less visible firms.

In this study, we first develop a set of hypotheses based on the information economics literature to suggest that more distant suppliers may find greater benefits from the adoption of ISO 14001 in order to signal their commitment to improved environmental performance. We then develop a competing hypothesis based on transaction cost economics to predict that firms in much closer relationships– specifically those engaged in transactions marked by high specific investments which are therefore more dependent on their current customers than firms with lower asset specificity—are more likely to adopt ISO 14001. Finally, we describe the empirical analysis and discuss the findings of our study and its limitations, showing the complementary roles of our hypotheses in explaining the response by upstream suppliers to pressure from downstream customers for improved environmental performance.

2 ISO 14001 AND INFORMATION ASYMMETRIES

When buyers face difficulty in acquiring information about suppliers' attributes, it can be advantageous for suppliers to indicate that their operation features certain desirable aspects. Challenges arise particularly for buyers seeking information about their suppliers' environmental management, because the practices involved in such management are embedded in the internal organization of firms. Environmental improvement also often proves very hard for external parties to assess. Frequently, no quantifiable criteria or parameters exist to measure the environmental impact of an operation (Jiang and

Bansal 2003). A firm's inability to communicate its environmental responsiveness to outside audiences can also make it challenging to gauge its environmental impact. Due to these challenges, a supplier tends to hold more information about its environmental performance and impact than its customers. This result is known as an information asymmetry.

Signaling theory suggests mechanisms for the transfer of information to another party that helps to resolve information asymmetries (Spence 1973). Spence (1973) used college education as an example to show how signaling can solve problems of pre-contractual information asymmetries. College diplomas, in his example, act to help differentiate job seekers' intelligence and ability to a prospective employer. The signal works on the assumption that people who are skilled in learning, and therefore of relatively higher intelligence, are more likely to finish college than people who are unskilled in learning. The attainment of a college diploma, then, indicates greater ability to prospective employers. This signaling mechanism works even if a potential employee actually learned nothing at college, and schooling served merely as a means to obtain the signal of greater ability—the diploma. In a business context where environmental issues are increasingly important, we argue that suppliers may consider the adoption of ISO 14001 as a signal of commitment to good environmental behavior and as a mechanism that potentially or actually resolves an asymmetry of information about a supplier's environmental practice.

Using the case of ISO 9000 as the international standard for quality management, scholars have demonstrated that obtaining a management system standard allows firms to communicate desirable organizational attributes, like quality, to parties that cannot observe them directly (Anderson, Daly, and Johnson 1999; Terlaak and King 2006). ISO 14001 holds many traits in common with ISO 9000, its predecessor, including its function as a signaling mechanism that firms use to convey information about otherwise unobserved environmental attributes. Like ISO 9000, ISO 14001 focuses not on outcomes,

such as pollution, but on processes. Therefore, although ISO 14001 includes third-party certification of a firm's EMS, certification of the standard signals the adoption of intangible environmental management practices rather than actual improved environmental performance.[3] The standard does not establish absolute requirements for environmental performance other than a commitment to compliance with applicable regulations and to continuous improvement (Coglianese and Nash 2001). Furthermore, it does not identify environmental performance as a factor in the actual certification process (Christmann and Taylor 2001). However, because environmental management practices represent a sunk investment that lowers the marginal cost of good performance, suppliers adopting ISO 14001 are expected to improve their environmental performance. Since the customer cannot readily observe this sunk investment, the supplier must adopt ISO 14001 in order to signal that the investment was made. Suppliers can therefore consider the standard a useful signal of potential for improved environmental behavior.

In the college diploma example, the best performers—by virtue of greater ability—incur lower costs in acquiring a diploma. In the same way, ISO 14001 certification as a signal is easier to attain for organizations with superior levels of environmental management practices. Although the costs of acquiring ISO 14001 are substantial for suppliers, they are lower for those suppliers who have already adopted environmental management practices. The fees associated with third-party certification are relatively small compared to the costs connected with organizational changes that firms may have to make, such as collecting and centralizing environmental information and training employees (Darnall and Edwards 2006). The most resource-intensive stages of EMS design come early, since an organization must at the outset assess its facilities' environmental impacts, undertake comprehensive

[3] These management practices, part of the EMS, include creating an environmental policy; setting objectives and targets; implementing a program to achieve those objectives, and monitoring and measuring its effectiveness; correcting

evaluations of the organization structure, train employees, and plan development (Stapleton, Glover, and Davis 2001). Firms that have already adopted an EMS incur only the very minor cost of the ISO 14001 audit certification (Jiang and Bansal 2003). Empirical research shows that organizations that decide to adopt the standard are more likely already to have a functioning EMS (King, Lenox, and Terlaak 2005). Likewise, the costs of adopting ISO 14001 may be lower for firms already certified for ISO 9000 due to the similarity in the requirements for each standard. Evidence shows here, too, that ISO 14001 adopters are more likely to have implemented the international quality management standard (Corbett and Kirsch 2001; Darnall 2003, Delmas 2002, 2005; Delmas and Montiel 2008; Moon and deLeon 2005, Potoski and Prakash 2004).

From an information theory perspective, we explore how transaction characteristics might affect the ability of customers to gain knowledge regarding their suppliers and in this way decrease information asymmetries. We argue that ISO 14001 will be advantageous for arms-length relationships, or relationships involving non specialized products, where the downstream customer has little information about the supplier. An arms-length relationship is a "distant" relationship, where the buyers and sellers of a product are otherwise unrelated and act independently. Physical and cultural distances, as shown by scholars, increase asymmetries of information (King, Lenox, and Terlaak 2005). In arms-length relationships, or non specialized relationships, buyers are faced with many alternative suppliers, which raise the search and information costs of identifying the best environmental performer. Arms-length relationships therefore feature greater asymmetry of information regarding the suppliers' environmental performance.

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problems; and reviewing the system, both to improve it and to improve overall environmental performance (Tibor and Feldman 1996).

Suppliers engaged in more dependent and longer-term relationships may be better known and trusted by downstream customers than suppliers engaged in arms-length relationships. Customers might, therefore, be able to gain relevant information easily about the supplier's environmental practices. Thus, the adoption of ISO 14001 would not add as much benefit as it would to a supplier with a more distant relationship with the customer. In this case, it follows that:

Hypothesis 1: Suppliers engaged in arms-length relationships with their customers will be more likely to adopt ISO 14001, in order to gain the advantages of decreased information asymmetries, than suppliers involved in more dependent transactions.

Suppliers in the US automotive industry might adopt ISO 14001 because it could increase their chances not only of remaining in business, but also of establishing new business transactions with large auto-assembler companies. New suppliers, for example, as they come to introduce their products and/or services to the market may voluntarily follow auto-assembler requirements to adopt certification standards. New suppliers possess very little objective financial and operational data, or history of quality, for disclosure to prospective investors (Sanders and Boivie 2004) and potential customers. Also, 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). To accumulate legitimacy, new firms may take up activities that can help them signal their quality to customers. ISO 14001 is one of the few third-party certified standards available to a new supplier to signal its quality and commitment to environmental excellence. We therefore predict that:

Hypothesis 2: Younger automotive suppliers are more likely to adopt ISO 14001, in order to gain the advantages of decreased information asymmetries, than older suppliers.

3 ISO 14001 AND TRADING PARTNER DEPENDENCY

While we just argued that increased 'distance' between a customer and a supplier can favor the adoption of ISO 14001, we will argue below that the presence of conditions that create greater dependence between a supplier and a customer can lead to the adoption of ISO 14001. Transaction cost economics identifies the characteristics of transactions that lead to bilateral dependency and contractual difficulties. Building on transaction economics (Williamson 1985), we predict that firms engaged in transactions involving high specific investments, and therefore greater dependency on their current customers than firms with lower asset specificity, are more likely to adopt ISO 14001.

Williamson (1985) defined asset specificity as non-redeployable physical and human investments that are specialized and unique to a task. Parties to a transaction with specific assets face only imperfect exchange alternatives. The more specialized the 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 four dimensions of asset specificity: site specificity, physical asset specificity, dedicated capacity, and human asset specificity (Williamson 1985). Specificity in the case of the automotive industry occurs, for example, in the production of a certain automotive part that requires: (i) the supplier facility to be located close to the automaker (site specificity), (ii) investments in specialized machinery (physical asset specificity), and (iii) 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 that carry out firm-specialized investments in order to supply a particular product to auto-assemblers will engage in a bilateral relationship with their customers. Their assets are difficult to redeploy in alternative uses or by alternative users without sacrificing their productive value (Williamson 1991). This situation worsens for suppliers when customers can turn to alternative suppliers. Suppliers in such cases possess weak bargaining powers vis-à-vis their customers. Non-compliance with a customer's mandate could lead to termination by the customer of the current contract. The Big Three stated that failure to meet their deadlines for ISO 14001 adoption could affect future sourcing decisions (Whitmore and De Mink 2002). The Big Three had, in fact, previously imposed sanctions on suppliers that did not meet ISO 9000 certification requirements (Detwiler and Sedlak 2005). Ford in particular threatened suppliers that did not provide ISO 14001 certification by the prescribed deadline with loss of their Q1 status (preferred supplier status). A supplier might then continue to supply Ford, but its loss of Q1 status would endanger its ability to win future business or maintain current business.[4]

From a transaction cost perspective**,** a supplier that expects substantial switching costs in its 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 could translate to higher ISO 14001 adoption rates by suppliers in order to satisfy customer requirements. We therefore expect the following:

Hypothesis 3: If relationship-specific investment weakens the bargaining power of suppliers, then suppliers with higher specialized assets will be more likely to adopt ISO 14001 than suppliers involved in less asset-specialized transactions.

In summary, we have developed competing hypotheses regarding the likelihood of a supplier to obtain ISO 14001 certification. We predict that both distant relationships, such as arms-length

[4] Information provided by Ms. Monique Oxender, Global Manager of the Supply Chain Sustainability at Ford Motor

relationships, and much closer, dependent trade relationships could explain adoption. In the first case, firms use ISO 14001 as a mechanism to help them build new relationships and resolve information asymmetries. In the second case, firms in a dependent relationship seek to please their customers in order to keep their relationship alive. We test which of these motivations is a more important determinant of ISO 14001 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 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 publication of the Big Three requirement 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 were 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 for approximately 80% of the automotive suppliers operating in North America, on their supply chain characteristics (e.g., the customers they supply, 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 used supplier facility data to conduct our analysis. We complemented our facility information with information from the Supplier Company database (e.g., export characteristics) to

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Company's Global Purchasing Strategy Office (July 24th, 2007).

control for company characteristics. After completing the matching process, our final sample consisted of 3,152 supplier facilities: 74.6% of them located in the United States, 15.2% in Mexico, and the remaining 10.2% in Canada.[5] 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). Out of the 3,152 facilities, 861 (27%) were ISO 14001 certified by June of 2003.

We conducted two analyses. The first one focuses on the U.S. and allows us to control for the political dimensions of the environment in which U.S. suppliers operate. In addition to our U.S. adoption analysis, we conducted a second adoption analysis for the supplier facilities located in 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.

4.2 Statistical Analysis

Our empirical analysis is based on the estimates of discrete choice models. We use a random effects logit regression model to assess the effects of the independent variables on the likelihood of a supplier facility to adopt ISO 14001 certification (Aldrich and Nelson 1984). We selected this model instead of fixed effects for two reasons: First, facilities in the majority (70%) of our sample do not show variation in certification status during the period of analysis (2000-2003) because they did not pursue certification during this period. Fixed effects estimates would be based only on facilities that changed their certification status during this period, whereas random effects estimates are based on the full

[5] These include Tier 1 facilities only.

sample. Second, we conducted the Hausman test (Hausman 1978) that suggested the use of random-effects models.[6]

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 reverse 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 certification 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

Asset Specificity. Previous empirical studies of transaction cost economics have operationalized asset specificity in many ways (David and Han 2004). Physical asset specificity, for example, 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

[6] 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.

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 that 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 brake and suspension components. These so-called sub-assembly suppliers produce and assemble industry-specific customized auto parts. Due to customers' product specification requirements, in addition to having assets that may be difficult to redeploy, sub-assembly suppliers also usually operate more complex production processes than those of non-sub-assembly suppliers.

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

Production Generalization $_i$ = Σ (Number of suppliers producing the same part for each part that facility *i* produces/ Number of parts produced by facility i).

A high value on this variable represents product generalization or arms-length relationships. A low value represents "specialization."

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

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 number of years since the supplier company that owns the facility was founded (log transformed). The second variable *Young Supplier* represents younger facilities (six years old or younger by 2003). 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).

4.3.3 Control variables

The control variables are divided into two main categories related to the characteristics of the different supplier facilities and to the nature of the institutional environment.

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,* which 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* of each facility. Last, we control for the number of non-automaker customers of each facility by calculating the *Percentage of Non-Automaker Customers*.

QS 9000. We also control for the experience with related management standards, such as the international quality management standard QS 9000. Developed by Daimler-Chrysler, Ford, and General Motors, QS 9000 was first published in 1994 and later re-issued in 1998. 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 adoption of QS 9000 by a facility. 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. Studies in international business have defined the term "liability of foreignness" to denote the difficulty and cost of selecting and monitoring foreign suppliers (King, Lenox and Terlaak 2005; Kogut and Singh 1998). In order to reduce information asymmetry, companies could request that their foreign suppliers adopt certified management standards and use standards as a tool to screen and select foreign partners. 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 those countries or to trade with local firms (Corbett 2006). Japan and Europe were the two regions with the highest penetration level of ISO 14001 as of 2003.[7] 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. 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. A certification with an internationally recognized standard may therefore play a strong role in signaling difficult-to-observe attributes about environmental behavior and in 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 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 (Delmas 2002). We created two binary variables,

[7] 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).

Headquarters in Japan and *Headquarters in Europe,* to account for facilities owned by Japanese and European companies.

The next few control variables refer only to the U.S. analysis.

TRI reporter. We introduce this variable to account for whether the facility reports to the US EPA 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 the TRI.[8] We include this variable because firms that report to the TRI receive more scrutiny from NGOs and the public, and thus are more likely to signal their good behavior, than firms that do not report to the TRI.

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 each of the U.S. firms operates. Several researchers have used the scores of the League of Conservation Voters (LCV) as a measure of the preferences of a state's elected representatives to Congress (Delmas, Russo, and Montes 2007; Hamilton 1997; Hedge and Scicchitano 1994; Kahn 2002; Kassinis and Vafeas 2002, 2006; Lubell et al. 2002; Ringquist and Emmert 1999; Viscusi and Hamilton 1999). The variable is the average of the environmental scores of the members of Congress from the states where each utility operates.

Sierra Club members. As in previous studies (Delmas and Montes-Sancho 2007; Helland 1998; Kassinis and Vafeas 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 U.S. have developed their own voluntary EMS programs. In some states, these voluntary programs include explicit EMS requirements for firms seeking to join a program (Potoski and Prakash 2005). To control for 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.

State Pollution. The level of pollution in the state where a facility is located might have been a determinant factor in a firm's decision to adopt the ISO 14001 standard. More polluted states might be subject to greater scrutiny by and pressure from national environmental NGOs 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 on 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 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).

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[8] Since only 30% of our sample facilities report to the TRI, we do not include a variable representing the toxic releases from the facility. Including such a variable would drastically reduce our sample and incorporate a bias into the analysis.

State Audit Protection and Self-Disclosure Policies. Finally, 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 final binary variable, *State Self-Disclosure Policies,* to control for whether the state had adopted self-disclosure policies. This information was gathered at the U.S. Environmental Protection Agency website. The decision 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.

5 RESULTS

Tables 1 and 2 include the descriptive analysis for the variables included in the U.S. and North American analyses respectively. 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.

In Table 3 and 4 we present five different models. In Model 1 and Model 2, we introduce the variables *Young Supplier* and *Age* independently since they represent similar concepts and are correlated. In Models 3 and 4, we introduce the variables *Sub-Assembly Supplier* and *Production Generalization* independently since they both represent inverse measures of dependence between a buyer and a supplier. In model 5 we add an interaction term *Sub-Assembly Supplier*(-Number of customers)* to capture better the degree of a supplier's dependence on its customers. All models correctly classify 84% of the observations.

Hypothesis 1 predicts that "distance" between suppliers and customers should increase information asymmetries and therefore the value of adopting ISO 14001, while hypothesis 3 predicts that relations marked by high asset specificity would lead to higher levels of adoption. The variable

Production Generalization, as a measure of the degree to which the parts produced by a supplier are also produced by other suppliers, is negative and significant. This result seems to invalidate hypothesis 1 and suggests support for hypothesis 3. Yet, the appearance of competition between the hypotheses arises if the focus rests only on the factors of distance and information asymmetry. While hypothesis 3 assumes the absence of these factors, it introduces another, the presence of asset specificity, that creates dependency, which turns out to be equally powerful. This hypothesis is further confirmed by the variable *Sub-Assembly Suppliers,* which represents more specialized suppliers, and which is positive and significant in all models ($p<0.01$). The probability of adopting ISO 14001 among sub-assembly suppliers was 30%, while it reached only 23% among the rest of suppliers.[9]

We find some evidence that this effect is enhanced when using an interaction term in Model 5. In the U.S. context, we find that the interaction between *Sub-Assembly Suppliers* and *(–) Number of customers* is significant ($p<0.1$), indicating that the sub-assembly suppliers with a lower number of customers are more likely to adopt ISO 14001 in the U.S. The predicted probabilities of ISO 14001 adoption reaches 28% for sub-assembly suppliers with one customer while it is 23% for sub-assembly suppliers with four customers (the average number of customers in our study). With an increase in the number of customers beyond four customers, the probability of adopting ISO 14001 decreases to reach 16% for those sub-assembly suppliers with 10 customers (the maximum number of customers in our study). However, this interaction effect is not significant in the broader Northern American context. This might be because Mexican and Canadian sub-assembly suppliers do have a much more concentrated number of customers on average than their U.S. counterparts. So there is not enough variation to test interaction effects between the variable *Number of customers* and *Sub-Assembly Suppliers.*

[9] These predicted probabilities are calculated for the year 2002.

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 less dependent on their automaker customers because they have a pool of customers outside the industry which might serve as a backup if the supplier lost contracts with any of the main automakers. This result also provides credence to our claim that bilateral dependence will increase adoption.

Other factors associated with some measures of distance between a buyer and a supplier proved important in predicting adoption. All models strongly support hypothesis 2, which states that younger suppliers will be more likely to adopt ISO 14001. The variable *Age* is negative and significant in all models. In addition, the variable representing younger facilities introduced in Model 1 was significant and positive in predicting ISO 14001 adoption ($p<0.01$). Among younger suppliers the probability of adopting ISO 14001 reached 44%, while the percentage was only 25% among older suppliers.[10] It is possible that the signal provided by ISO14001 has more value for firms that are trying to establish themselves in the industry. The mechanism of information asymmetry is likely to be in operation as the customer cannot easily find out about a young supplier's quality due to the lack of a track record. Adoption of ISO 14001 would then stand in for information about more general quality, by expressing instead a commitment to firm quality through its investment in environmental quality. ISO 14001 may signal in this way not only environmental attributes but also other organizational attributes like quality.

In addition, facilities headquartered in Japan were more likely to adopt ISO 14001. The predicted probability of adoption for Japanese suppliers is 30% as compared to 24% for the rest of the suppliers. However, we did not find evidence that facilities headquartered in Europe would be more likely to adopt ISO 14001. Japan and the U.S. are more distant from one another culturally than the U.S. and Europe (Spolaore and Wacziarg 2008). This cultural distance may create a need to use ISO 14001 to

reduce ensuing information asymmetries. However, the effect of the variables *Exports to Japan* and *Exports to Europe*, included to control for the impact of exporting to regions where ISO 14001 had the highest penetration levels, is not significant. This could be explained by the fact that customers based in these countries did not formally require their suppliers in the U.S. to adopt ISO 14001.

Finally, in support of the signaling paradigm, our results show that facilities reporting to the TRI as well as suppliers that had previously adopted the international quality management standard QS 9000, are more likely to obtain ISO 14001 certification. The variable *TRI reporter* representing participation in TRI is positive and significant ($p<0.01$), indicating that facilities that have adopted a management system to report their emissions are more likely to certify their EMS with the ISO 14001 standard. In addition, we find that the variable *QS 9000*, representing adoption of the international quality management standard, is significant and positive in all models ($p<0.001$). These facilities already have an ISO management system in place and therefore incur lower costs of adoption of ISO 14001.

Last, the variable *Big Three customer* does not show any significant results, which indicates that pressure from a Big Three customer did not affect the likelihood of ISO 14001 adoption despite the existing requirement. This outcome shows again the need to investigate further the characteristics of the relationship between suppliers and their customers.

Interesting results also appeared for other control variables included in Table 3 for the U.S. analysis. These results 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 suppliers concerning the standard. This result differs from those of previous studies showing the effect of such a variable on voluntary environmental activities (Maxwell, Lyon, and Hacket 2000). This finding is possibly related to the fact that the Sierra Club and other U.S. environmental NGOs did not

[10] These predicted probabilities are calculated for the year 2002.

initially consider ISO 14001 as an effective system to improve environmental performance; firms located in regions with high community activism could have opted for other environmental programs.

Regarding the impact of facility location on adoption, Table 4 shows the finding 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 U.S. 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.

In conclusion, we find that sub-assembly suppliers are more likely to adopt the ISO 14001 standard than less specialized facilities that produce more basic parts. We find also that more specialized suppliers and suppliers with fewer competitors are more likely to adopt ISO 14001. Both findings support hypothesis 3. In addition, in support of hypothesis 2, we find that younger suppliers are more likely to adopt the standard. Our results reveal also that reporters to the TRI 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 and 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 U.S. TRI, and that are headquartered in Japan reached 66%, while the percentage was only 14% among the pool of facilities with the opposite characteristics. This finding shows that these variables are important to explain the adoption of ISO 14001. These results provide significant support for the hypotheses under investigation, sustaining the assertion that dependence

between suppliers and their customers as well as some measure of distance between them influence the likelihood of ISO 14001 adoption among North American supplier facilities.

6 DISCUSSION AND CONCLUSION

Our results show the utility of theories of transaction cost and of information economics. Using both, we identified the importance of 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 have identified the importance of customer pressures to influence the adoption of voluntary environmental management practices, they have rarely sought to understand the conditions under which these pressures could be effective.

We demonstrate that suppliers both with tighter relationships with their customers and with more distant relationships are likely to adopt the ISO 14001 standard, though for different reasons. In the first case, investments in specialized assets combined with fewer customer alternatives may weaken bargaining power for suppliers. The greater dependency of suppliers on their customers in this case could make them more likely to listen to their customers' requests. Bilateral dependent relationships, however, may involve other reasons for suppliers to listen to their customers' requests. Close relationships of this kind are marked by frequent meetings between customers and suppliers that facilitate the understanding of the advantages of such requests. Customers in bilateral dependent relationships also have more incentives to persuade their suppliers to adopt ISO 14001. The closeness of ties between the two parties makes it more likely that unsatisfactory environmental performance on the part of the supplier could have a devastating impact on the reputation of the customer. Evidence shows that the U.S. automakers spent time and effort to convince their "preferred" suppliers to adopt ISO 14001 by engaging them in ISO 14001 training modules (Sabatini 2000). In the second case, both the lack of close ties between supplier and customer and the supplier's independence of action stem from

the location of a supplier in a different country than their customer; or such independence occurs because a supplier is too young to have formed ties with customers of the type and strength typically established by incumbents. In order to enter or be retained in a "preferred supplier" list, such suppliers need to increase information flow by communicating more formally, or showing more formal commitment to, environmental improvement than firms that have already established connections.

Our results suggest that arguments based on transaction cost and information theories are better viewed as complementary than as contradictory. Application of information theory in terms of signaling emphasizes the value of ISO 14001 to communicate underlying attributes in order to obtain new contracts, with the necessity of signaling increasing with distance. Transaction cost theory in relation to the supplier-customer relationship focuses on bilateral dependence between the two parties and explains how adoption of ISO 14001 becomes a condition for the relationship to continue. We show that dependence and distance are two factors that increase the benefits of adoption of governance mechanisms such as certified environmental management standards. In more general terms, our research indicates that both post contractual relationship management as well as pre contractual asymmetry matter to explain the adoption of an environmental management standard. Further research could identify how these findings can be generalized to the adoption of other governance mechanisms.

Our findings indicate that customer strategies to influence suppliers–such as requiring suppliers to adopt a certified management standard within a governance structure to expand environmentally neutral or beneficial practices within the automotive supply chain—have limited appeal, restricted to suppliers with the characteristics described above. To affect a larger pool of suppliers, present strategies are not enough. Without additional strategic efforts, very few firms—outside of new suppliers and suppliers engaged in more dependent relationships with assemblers—will adopt new governance mechanisms, such as ISO environmental management standards.

Previous research found that voluntary programs are not very effective in the absence of explicit sanctions (King and Lenox 2000; Delmas and Montes-Sancho 2007). In the automotive sector, sanctions may not have been sufficiently credible to persuade more suppliers to participate in new governance practices. It follows that companies aiming to green their supply chain need to evaluate ways to impose explicit sanctions on non-adopters. The inverse could also apply, where customers explicitly increase the value to suppliers of adoption of voluntary practices.

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 and Taylor 2001; Delmas 2002; Kollman and 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 rate of adoption of the standard. Our findings show the interaction between a specific environmental policy–the U.S. EPA TRI–and the adoption of ISO 14001. More specifically, we show that facilities required to report their toxic emissions to the TRI are more likely to adopt ISO 14001. As discussed, this result can be explained by the fact that facilities subjected to TRI are under intense scrutiny from various stakeholders and have already undertaken steps to centralize environmental information and reduce their emissions. For these facilities, ISO 14001 provides a relatively inexpensive mechanism to signal their commitment to improve their environmental performance. Studies related to the effectiveness of the TRI have had mixed results (Bui 2005; Khanna, Quimio, and Bojilova 1998; Konar and Cohen 1996). [11] Our results show, however, that TRI may encourage commitment by facilities to improve environmental performance. This finding is important as more governments around the world begin to embrace the mandatory disclosure of information policies.

[11] 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. Bui (2005) found, however, that the decline in emissions after TRI reporting events was more likely attributable to regulation than to investor pressure.

Additional research could further identify how regulatory pressures interact with customer pressures and particularly 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, additional firms may have sought certification after the 2003 deadline. Future research needs to follow up on the ISO 14001 adoption process among automotive suppliers in the subsequent years. Moreover, research on the adoption of the standard among suppliers operating in other regions of the world would be of interest. The Big Three requirement, for instance, might not be seen as a real threat among North American suppliers, but may be regarded as such by suppliers in other institutional environments, as indicated by the higher percentage of adoption by suppliers headquartered in Japan. Finally, further research could apply our framework in order to assess the conditions that facilitate the adoption of management standards within the supply chain in other industrial contexts. The retailing sector, where highly visible customers such as Wal-Mart have begun to seek to green their supply chain, would be a likely candidate.

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

	Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1	ISO 14001	0.15	0.36	1										
2	Sub-Assembly supplier	0.49	0.49	0.04	1									
3	- # customers	-4.46	2.73	0.01	-0.00	1								
4	Sub-Assembly*-# customers	-2.17	2.94	-0.02	-0.75	0.45	1							
5	Production generalization	5.25	0.99	-0.04	-0.09	0.09		1						
6	Young supplier	0.05	0.21	0.06	0.00	0.04	0.02	0.01	1					
7	Age	3.60	0.85	-0.03	-0.02	-0.01	0.01	0.03	-0.59	1				
8	TRI reporter	0.26	0.44	0.16	-0.04	-0.07	-0.00	-0.07	-0.00	0.05	1			
9	Non-automaker customers	0.23	0.25	-0.03	-0.01	-0.45	-0.20	-0.00	-0.00	-0.02	0.03	1		
10	Big Three Customer	0.91	0.28	0.00	-0.01	-0.16	-0.07	0.02	-0.05	0.19	0.00	-0.09	1	
11	Facility Size	11.68	0.95	0.14	0.07	-0.09	-0.10	-0.14	0.03	0.04	0.32	0.00	0.05	1
12	QS 9000	0.65	0.47	0.03	-0.00	-0.04	-0.02	0.04	0.03	0.03	0.02	-0.00	0.15	0.05
13	Headquarters in Japan	0.08	0.27	0.06	0.07	-0.05	-0.11	-0.12	0.03	-0.24	0.03	0.02	-0.27	0.06
14	Headquarters in Europe	0.08	0.26	0.00	0.01	-0.02	-0.03	-0.05	0.00	-0.01	0.06	-0.04	0.01	0.08
15	Exports to Japan	0.26	0.44	0.04	0.01	-0.14	-0.07	-0.09	-0.06	0.05	0.09	0.03	-0.06	0.09
16	Exports to Europe	0.48	0.49	0.01	-0.01	-0.08	-0.03	-0.01	-0.08	0.14	-0.03	-0.00	0.15	-0.03
17	League of Conservation Voters	0.44	0.19	-0.01	0.01	-0.02	-0.02	0.01	-0.01	0.03	-0.08	0.01	0.11	-0.07
18	Sierra Club	1.63	0.95	-0.00	0.01	-0.01	-0.02	0.01	-0.02	0.03	-0.02	0.03	0.03	-0.04
19	State EMS promotion	1.93	2.39	0.04	0.04	-0.01	-0.03	0.06	-0.00	0.01	-0.07	0.02	0.10	-0.10
20	State Pollution	17.72	0.81	0.02	0.01	0.01	-0.01	0.01	0.02	-0.06	-0.00	-0.01	-0.03	-0.00
21	State hazardous air regulations	0.05	0.22	-0.02	0.03	-0.00	-0.03	-0.03	-0.01	0.02	0.02	0.03	-0.01	0.01
22	State waste regulations	0.88	0.32	0.01	0.03	-0.03	-0.03	-0.02	0.01	-0.02	-0.06	0.02	0.05	-0.04
23	State Audit Protection	0.72	0.45	0.01	0.02	0.01	-0.01	0.02	0.01	-0.02	0.00	-0.00	-0.00	-0.02
24	State Self-Disclosure Policies	0.19	0.39	-0.02	0.00	-0.01	-0.01	-0.03	-0.02	0.02	-0.02	0.00	0.00	0.03

		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 promotion	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 regulations	-0.05	0.00	-0.02	0.03	0.00	0.01	0.38	-0.13	-0.26	1			
22	State 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	-0.03	0.00	0.04	0.00	0.01	0.11	0.20	-0.32	-0.25	0.32	0.16	-0.68	

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

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

	Variable	Mean	SD	1	2	3	4	5	6	7	8	9
1	ISO 14001	0.15	0.36	1								
2	Sub-Assembly supplier	0.49	0.50	0.05	1							
3	- # customers	-4.31	2.67	0.01	-0.00	1						
4	Sub-Assembly*(-# customers)	-2.11	2.86	-0.02	-0.75	0.45	1					
5	Production generalization	5.24	0.98	-0.04	-0.07	0.10	0.11	1				
6	Young supplier	0.05	0.22	0.05	0.01	0.04	0.03	0.00	1			
7	Age	3.57	0.84	-0.01	-0.01	-0.00	0.00	0.05	-0.58	1		
8	Non-automaker customers	0.21	0.25	-0.03	-0.03	-0.45	-0.20	-0.00	0.00	-0.02	1	
9	Big Three Customer	0.91	0.28	0.01	-0.03	-0.16	-0.07	0.00	-0.05	0.18	-0.08	1
10	Facility Size	11.65	0.97	0.13	0.07	-0.09	-0.10	-0.13	0.02	0.04	0.00	0.05
11	QS 9000	0.61	0.48	0.02	-0.02	-0.04	-0.02	0.03	0.02	0.03	0.02	0.15
12	Headquarters in Japan	0.08	0.27	0.06	0.09	-0.05	-0.11	-0.09	0.02	-0.22	0.02	-0.29
13	Headquarters in Europe	0.08	0.27	-0.00	0.02	-0.02	-0.03	-0.05	0.01	-0.01	-0.03	0.01
14	Exports to Japan	0.24	0.43	0.06	0.03	-0.14	-0.07	-0.09	-0.05	0.05	0.03	-0.05
15	Exports to Europe	0.47	0.50	0.03	-0.00	-0.08	-0.03	0.01	-0.08	0.12	0.00	0.13
16	Canada	0.10	0.30	0.03	-0.02	0.04	0.03	0.00	-0.02	-0.02	-0.02	0.03
17	Mexico	0.15	0.36	-0.03	0.06	0.08	0.01	-0.02	0.00	-0.05	-0.13	-0.04

		10	11	12	13	14	15	16
10	Facility Size	1						
11	QS 9000	0.06	1					
12	Headquarters in Japan	0.05	-0.08	1				
13	Headquarters in Europe	0.07	0.03	-0.08	1			
14	Exports to Japan	0.08	0.00	0.11	-0.02	1		
15	Exports to Europe	-0.01	0.07	-0.06	-0.00	0.27	1	
16	Canada	-0.05	0.03	-0.05	0.01	-0.05	0.03	1
17	Mexico	-0.03	-0.17	0.05	0.00	-0.03	-0.08	-0.13

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

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

	1	2	3	4	5
Sub-Assembly supplier	0.30**	0.30**	0.32**		0.60**
	(0.11)	(0.11)	(0.11)		(0.20)
- # customers	0.00	0.01	0.00	0.01	-0.03
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Sub-assembly supplier * (- # customers)					0.07+
					(0.04)
Production generalization	-0.10*	-0.10+		-0.10*	-0.10+
	(0.05)	(0.05)		(0.05)	(0.05)
Young supplier	0.89**				
	(0.18)				
Age		-0.22**	-0.20**	-0.22**	-0.22**
		(0.05)	(0.05)	(0.05)	(0.05)
TRI reporter	0.98**	0.99**	1.02**	0.96**	1.00**
	(0.12)	(0.12)	(0.11)	(0.11)	(0.12)
Non-automaker customers	-0.46+	-0.45+	-0.44+	-0.45+	-0.45+
	(0.24)	(0.24)	(0.24)	(0.24)	(0.24)
Big Three customer	-0.12	-0.05	-0.03	-0.05	-0.04
	(0.21)	(0.21)	(0.21)	(0.21)	(0.21)
Facility size	0.41**	0.42**	0.44**	0.44**	0.42**
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
QS 9000 certification	0.19+	0.20+	0.21*	0.20+	0.20+
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
Headquarters in Japan	0.61**	0.47*	0.51**	0.51*	0.50*
	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
Headquarters in Europe	-0.10	-0.13	-0.11	-0.12	-0.12
	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
Exports to Japan	0.14	0.14	0.17	0.15	0.13
	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
Exports to Europe	0.18	0.19+	0.18	0.18	0.19+
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
League of Conservation Voters	0.09	0.08	0.10	0.08	0.08
	(0.26)	(0.27)	(0.26)	(0.26)	(0.27)
Sierra Club	-0.08	-0.08	-0.08	-0.08	-0.08
	(0.06)	(0.06)	(0.05)	(0.06)	(0.06)
State EMS promotion	0.02	0.02	0.01	0.02	0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
State Pollution	0.12+	0.12+	0.12+	0.12+	0.12+
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
State hazardous air regulations	-0.08	-0.08	-0.11	-0.05	-0.07
	(0.22)	(0.22)	(0.22)	(0.22)	(0.22)
State waste regulations	0.06	0.05	0.05	0.06	0.05
	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)
State audit protection	-0.05	-0.06	-0.06	-0.06	-0.06
	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)
State self-disclosure policies	-0.18	-0.19	-0.19	-0.18	-0.19
	(0.18)	(0.18)	(0.17)	(0.18)	(0.18)
Year effects	Included	Included	Included	Included	Included
Constant	-11.22**	-10.59**	-11.33**	-10.61**	-10.82**
	(1.46)	(1.47)	(1.42)	(1.47)	(1.48)
Observations	8839	8839	9061	8839	8839
Wald χ^2	730.20**	728.01**	734.45**	724.13**	728.98**
Log likelihood full model	-3141.94	-3144.93	-3212.02	-3148.84	-3143.50
% correctly classified (pooled)	83.91	83.91	84.06	83.81	83.89

[a]Number of US facilities: 2,674. Standard errors in parentheses. +significant 10%, *5%, **1%.

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

	1	2	3	4	5
Sub-Assembly supplier	0.33**	0.34**	0.35**		0.45*
	(0.11)	(0.11)	(0.10)		(0.20)
- # customers	0.00	0.01	0.00	0.01	-0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Sub-assembly supplier * (- # customers)					0.03
					(0.04)
Production Generalization	-0.11*	-0.11*		-0.11*	-0.11*
	(0.05)	(0.05)		(0.05)	(0.05)
Young supplier	0.86**				
	(0.17)				
Age		-0.17**	-0.16**	-0.17**	-0.17**
		(0.05)	(0.05)	(0.05)	(0.05)
Non-automaker customers	-0.47+	-0.46+	-0.46*	-0.47*	-0.46+
	(0.24)	(0.24)	(0.24)	(0.24)	(0.24)
Big Three customer	-0.02	0.03	0.05	0.03	0.04
	(0.20)	(0.21)	(0.20)	(0.21)	(0.21)
Facility size	0.53**	0.54**	0.56**	0.55**	0.54**
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
QS 9000 certification	0.21*	0.22*	0.23*	0.22*	0.22*
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
Headquarters in Japan	0.74**	0.64**	0.68**	0.69**	0.65**
	(0.19)	(0.20)	(0.20)	(0.20)	(0.20)
Headquarters in Europe	-0.06	-0.09	-0.05	-0.08	-0.09
	(0.19)	(0.19)	(0.19)	(0.20)	(0.20)
Exports to Japan	0.39**	0.39**	0.41**	0.40**	0.38**
	(0.13)	(0.13)	(0.12)	(0.13)	(0.13)
Exports to Europe	0.28*	0.28*	0.27*	0.28*	0.28*
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
Canada	0.41*	0.38*	0.39*	0.37*	0.38*
	(0.16)	(0.16)	(0.16)	(0.16)	(0.16)
Mexico	-0.33*	-0.34*	-0.33*	-0.32*	-0.35**
	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
Year effects	Included	Included	Included	included	Included
Constant	-10.64**	-10.22**	-11.09**	-10.12**	-10.28**
	(0.74)	(0.75)	(0.67)	(0.75)	(0.75)
Observations	11856	11856	12104	11856	11856
Wald χ^2	890.37**	884.67**	887.78**	878.63**	884.62**
Log likelihood full model	-4065.66	-4071.50	-4147.59	-4076.43	-4071.27
% correctly classified (pooled)	84.24	84.22	84.39	84.19	84.21

[a] Number of North American facilities: 3,152. Standard errors in parentheses. +significant 10%, *5%, **1%.