DO BANDWAGONS MATTER?
EXPLORING THE EFFECT OF EARLY ADOPTERS ON THE DIFFUSION OF THE ISO 9000 MANAGEMENT STANDARD

Ann Terlaak[*]
Bren School of Env. Science & Mgmt.
University of California Santa Barbara
Physical Sciences North
Santa Barbara, CA 93106
Tel: (805) 893-2883
Fax: (805) 893-7612
aterlaak@bren.ucsb.edu

Andrew A. King
Stern School of Business
New York University
40 West 4th St. Suite 707
New York, NY 10012
Tel: (212) 998-0288
Fax: (212) 995-4227
aking@stern.nyu.edu

Accepted to the Nelson and Winter Conference - Aalborg, Denmark, June, 2001

Working paper 6/02/01– do not cite without the permissions of the authors

Abstract: Voluntary industry management standards are emerging as an important new form of industrial coordination. They now regulate management practices in industries as diverse as electronics and entertainment. One goal of these standards is the differentiation of well-management firms. Unfortunately, theories of diffusion suggest that such differentiation may be short lived. Adoption of a management standard by high quality firms should encourage other firms to adopt — particularly those firms with lower quality. Thus, 'negative' bandwagons may destroy the value of management standards. In this paper, we explore this dismal hypothesis by investigating how the number and nature of previous adopters influences the propensity of firms to participate in the ISO 9000 quality management standard. We do not find the predicted linear relationship between quality of initial adopters and subsequent adoption rates. Rather we find that adoption is suppressed both by high and low quality previous adopters. We propose some explanations for this relationship and discuss the implications for theory.

---

[*] Corresponding author. We would like to thank Magali Delmas and Michael Lenox for their help in the creation of this paper. We are also grateful for financial support from the Institute of Global Conflict and Cooperation at UC San Diego and the U.S. EPA (Grant # 99-063334).

Over the last fifteen years, the number of industry management standards has increased dramatically (Nash & Ehrenfeld, 1996). Voluntary standards now regulate management practices in industries as diverse as electronics and entertainment. Proponents of these standards argue that they fill two important needs. First, they synthesize information on best management practices and thus facilitate industry improvement (Rees, 1997). Second, they help to differentiate well-managed firms. This latter feature has particular relevance to modern business conditions. As supply chains become increasingly global and extended, firms need some means for differentiating their reliability and quality. Participation in international standards like ISO 9000 provides firms with one means of signaling their quality.

The value of participation in a standard is determined both by the nature of the standard itself and by the reaction of other firms. The meaning of participation is a function of the collective membership. The higher the quality of the firms that have joined the program, the more that participation should signal high quality. Unfortunately, this recognition can also destroy the signal value of the standard. If lower quality firms have the capacity to meet the standard, they may rush to join the program. Recognizing this, high quality firms may shy away or exit. A classic adverse selection problem may result and the standard may ultimately come to signal lower, rather than higher quality.

Scholars have long recognized that the nature of previous adopters can be an important factor governing future adoption (Mansfield, 1961; Burt, 1973; DiMaggio & Powell, 1983). Several previous studies suggest that initial adopters with high reputations can intensify pressures on other organizations to imitate adoption (Burt, 1973; Rosenkopf & Abrahamson, 1999). Adoption by high reputation firms supports imitation behavior as initial non-adopters may wish to associate with these first adopters. The opposite case – a potential slowing of adoption rates caused by the initial adoption by poorly managed firms – has received relatively little attention (Rogers, 1995). Furthermore, previous studies have not yet explored a case where a single practice was initially adopted by high quality firms in some industries and by low quality firms in other industries.

In this paper, we extend the literature on industry management standards and adoption pressure by exploring how the quality of initial adopters of the ISO 9000 management standard influenced future adoption rates and patterns. Drawing from ideas of bandwagon and signaling theories, we hypothesize that the higher the quality of initial adopters the more likely organizations will adopt the standard. Using a 13-year panel of data, we empirically test and support our contention that the quality of previous adopters indeed influences the propensity of other firms to adopt, but we do not find the hypothesized linear relationship. Instead, we find evidence of an inverted U-shaped relationship: previous adoption by both high *or* low quality facilities reduces the propensity for other organizations to adopt. This finding is important to both theory and practice.

For theory, it suggests that there might be a 'quality level' of initial adopters after which the propensity of other organizations to adopt decreases. One explanation is that adoption by high quality organizations sends a signal to other industry members that adoption is arduous or requires capabilities that are unique to the industry leaders. Consequently, the average firm might shy away from adoption. Alternatively, in some industries high quality firms may be able to maintain the signal value of adoption by preventing adoption by low quality firms.

For practice, our findings are particularly relevant for policymakers. Our findings suggest that policymakers that wish to support speedy adoption of management standards may seek to encourage initial adoption by a group of average facilities, rather than by industry leaders. The U.S. Environmental Protection Agency typically has encouraged a group of very well known and successful organizations to take the lead in adopting voluntary programs. Our findings suggest that this strategy may not always be desirable.

We organize the paper as follows: We next develop our hypothesis on how the type of initial adopters influences subsequent adoption patterns and rates. We then provide some background information on ISO 9000. We describe our research method and report the results from our analysis. We conclude the paper with a discussion of the implications for theory and practice.

THEORY AND HYPOTHESES

Scholars have long argued that the number of adopters influences a firm's propensity to adopt a new practice or technology (Rogers, 1995). Such “bandwagon theories” have received considerable attention from scholars examining the adoption of managerial practices (e.g., Abrahmson & Fairchild, 1999; Westphal et al, 1997; Staw & Epstein, 2000). A central proposition of this perspective is that the reputation of initial adopters will effect both the rate and nature of future adoption (DiMaggio & Powell, 1983; Rosenkopf & Abrahamson, 1999). Below, we review these theories and discuss the challenge that they present for the success of voluntary management standards.

Quality of initial adopters and subsequent adoption rates

Research suggests that the adoption of an innovation by ‘prestigious’ (Strang & Soule, 1998), ‘high reputation’ (e.g., Rosenkopf & Abrahamsom, 1999), or more ‘successful’ and ‘legitimate’ (DiMaggio & Powell, 1983) organizations increases future adoption rates. Some scholars suggest capturing these attributes via response data, central network position, or other proxy characteristics such as organizational size (Rosenkopf & Abrahamson, 1999). In this paper, we assess an organization's reputation or legitimacy via its 'quality', i.e., its efficiency. While an organization's quality or efficiency may not directly be observable, it underlies attributes such as success or reputation. In fact, Podolny (1993) remarks that reputation is a signal of the underlying quality of a firm's product. He furthermore argues that while a number of factors may mediate the relationship between product quality and reputation, the producer "nonetheless exercises at least some control over its status since its own past actions are important determinants of how it is perceived. Moreover, the difficulty of acquiring a reputation for superior quality is inversely associated with the general quality level of the producer". While Podolony's discussion primarily addresses the link between *product* quality and reputation, we argue that an equivalent relationship links general firm quality and reputation.

Two arguments are commonly made why a high quality (or reputation) of initial adopters should speed up subsequent adoption rates. First, high reputation might provide some information about the inherent capabilities of firms. Thus, the actions of these firms may indicate that the adopted practice is likely to be useful or profitable. Second, regardless of the actual value of adopting a practice, firms may wish to associate with organizations of high prestige or reputation.

The value of a new practice or strategy is surrounded by ambiguity. As a result, firms may use the adoption behavior of other firms as a criterion to evaluate the innovation (O'Neill et al, 1998). More specifically, managers may tend to study the adoption behavior of "ideal" organizations, and this attention will trigger quicker imitation of the adoption decisions of these ideal organizations (DiMaggio & Powell, 1983). Furthermore, "the comparison to ideal organizations should prompt less resistance within the adopting organization, thereby adding to the likelihood of speedy adoption" (O'Neill et al, 1998: 105). Haveman (1993) finds imitation of the market entry decisions of successful savings organizations, and Levitt & Nass (1989) find imitation of the decisions of successful organizations within the textbook publishing industry.

Regardless of the direct payoff of adopting a practice, firms may adopt a practice to associate with other previous adopters and thereby signal stakeholders of some inherent but unobservable attribute. As Benjamin and Podolny (1999) note, "[…] it is often easier to observe affiliations than it is to observe differences in quality" (1999: 565). If previous adopters are reputed to be of high quality, firms will be more likely to join in order to seek the benefits of association. For example, a respondent to a survey conducted on the ISO 9000 management standard noted that "what was exciting was that here we were in a rural community registered as a ISO 9000 manufacturing facility, on par with the best companies in the world!" (Naveh et al, 1999: 276). At the extreme, a firm might adopt a management standard not because it expects to improve its quality management, but because it wishes to associate with firms that have previously adopted the standard.

Just as adoption by firms of high quality should speed future adoption rates, adoption by low quality firms should slow it down. If previous adopters are of low quality, firms will wish to avoid being associated with the initial adopters, and adoption rates should slow. This situation is similar to a 'counter-bandwagon' (Abrahamson, 1991) where high quality firms may even un-adopt a practice if too many low quality firms adopt, thereby making impossible differentiation.

The adoption process of management standards may be particularly sensitive to the character of previous adopters. Standards like ISO 9000 are intended to differentiate the quality management practices of firms. If low quality organizations adopt the standard, certification may lose its signaling value or may be viewed as an attempt to cover up poor performance. Managers of ISO certified facilities are keenly aware of this problem. In a recent survey of ISO members, one remarked that “ISO continues to be perceived as no sign of quality service: i.e., poor quality performance continues to exist at companies that are registered (Naveh et al, 1999: 273)." Another one suggests that “[…] the general perception of ISO has dropped and this will do it further damage” (Naveh et al, 1999: 278).

In summary, theory predicts a positive relationship between the quality of initial adopters and the subsequent likelihood of adoption. An increase in the quality of initial adopters should increase the probability of subsequent adoptions, while a decrease in quality of initial adopters should reduce the probability of further adoption. We expect:

> *H1: The higher the quality of the initial adopters of a management standard, the higher the probability that a potential adopter will adopt the standard.*

Quality of initial adopters and subsequent adoption patterns

Research suggests that the quality of initial adopters not only affects rates of subsequent adoption but also the type of organizations that choose to adopt the innovation (Rosenkopf & Abrahamson, 1999). Adoption by high reputation firms is more likely to be emulated by low quality firms, because it is these “lower reputation organizations that assume that higher reputation organizations have the know-how to pick better innovations” (Abrahamson & Fombrun, 1994: 744). Lower quality organizations might also be more likely to imitate high quality organizations as they gain greater benefit from associating with these previous adopters. Strang & Soule summarize that “lower ranking community members aspire to be like prestigious others, find it useful to resemble powerful leaders […]" (Strang & Soule, 1998: 275). Indeed, Han (1994, in Strang) finds the choice of industry leaders was imitated by the 'regular' industry members, but that those industry leaders sought to differentiate themselves.

In the case of management standards, strategic considerations might furthermore encourage low quality firms to imitate the adoption choice of high quality adopters. Low quality firms may deliberately seek to obscure their actual management performance by imitating the adoption choice of high quality organizations. In fact, King & Lenox (2000) suggest that the desire for such a smokescreen has caused more polluting firms to participate more frequently in the Chemical Industry's Responsible Care management standard. Of course, such a smokescreen argument makes sense only as long as the majority of (initial) adopters are of high quality. If too many low quality organizations adopt the standard, public perception of the standard as a sign of high quality will eventually be negated. From the above discussion we conclude:

H2: If the quality of the average initial adopters is above the quality of a potential adopter, the more likely it is that the potential adopter will adopt.

In summary, theory suggests that the probability of adoption (and therefore adoption rates) should be higher if the quality of previous adopters is high, and smaller following the adoption by low quality organizations. Theory also suggests that organizations are more likely to adopt if previous adopters are above their own quality. We next provide some information on ISO 9000 before using data on its diffusion to test our hypotheses.

THE QUALITY MANAGEMENT STANDARD ISO 9000

The diffusion of ISO 9000 provides a rare opportunity to explore how initial adopters might influence adoption rates and patterns. For over ten years, facilities from different industries have adopted ISO 9000, which allows assessing differences in adoption patterns across time and industries. Furthermore, as of the end of the year 2000, there are about 45000 ISO 9000 certifications in the U.S., Mexico, and Canada (McGraw-Hill, 2000), suggesting that 13 years after its conception in the U.S., the standard has obtained extensive diffusion. Lastly, third party verification makes adoption of ISO 9000 a visible act, which facilitates tracing the plants that have adopted ISO 9000.

The American quality management movement started in the late 1970s, as U.S. business had to respond to the Japanese quality challenge. Early quality management concepts included quality circles in the early 1980s, the Baldrige Prize in the mid 1980s, and ISO 9000 at the end of the 1980/ early 1900s (Coole, 1999). ISO 9000 is a quality management standard that the International Organization for Standardization created in 1987. The adoption of ISO 9000 is voluntary. ISO 9000 aims at ensuring consistency in the *production* of a product or service (Cole, 1999), and does not prescribe output standards. Thus, certification does not assure a specific quality of the finished product, but assures that the producing plant has implemented and is complying with a written set of rules and quality management procedures (Uzumeri, 1997).

The ISO 9000 standard embraces 20 “Quality System Elements” which address a broad range of functions such as contract reviews, production control, internal audits, and training. Third party certification is expected to ensure that certified companies have implemented and comply with all quality system. The certification process is repeated every three years, with smaller audits occurring on a yearly basis (Uzumeri, 1997).

Over the past few years, a few scholars have started exploring the adoption of ISO 9000. Some suggest that the diffusion is based on institutional pressures (Cole, 1999; Guler et al, 2000; Mendel, 1996). Guler et al (2000), for example, find that the international diffusion of ISO 9000 is shaped by coercive isomorphism (i.e., driven by large und multinational organizations), as well as by mimicry between network nodes (i.e., by the structural positions of countries in global networks). Other scholars suggest that firms might adopt ISO 9000 as they view certification as a regulatory or export requirement (Uzumeri, 1997; Anderson et al, 1999). The European Community requires firms that sell safety sensitive products in the European Community to conform to ISO 9000 standards (or alternatively submit regular samples for testing). Thus, while adoption ultimately is voluntary, there might be regulatory pressures that influence a firm's adoption decision (Coole, 1999). Furthermore, supply chain pressures are likely to influence adoption choices. Large industrial purchasers (such as Du Pont and Eastman Kodak) required ISO 9000 certification from their suppliers, who in turn started requesting certification from their sub-suppliers. (Uzumeri, 1997). Anderson et al (1999) suggest that managers seek ISO to send a signal of quality assurance to external parties (Anderson et al, 1999). This is in line with Cole (1999) who argues that "the use of ISO 9000 […] has diffused […] far beyond the originally perceived regulatory requirements' (Cole, 1999: 153).

In sum, while previous studies have uncovered some of the factors that cause might the diffusion of ISO 9000, none of these studies has taken a longitudinal perspective to investigate the role of first adopters on subsequent adoption rates and patterns. In this paper we begin filling this research gap.

RESEARCH METHOD

Sample

We performed our analysis using a longitudinal sample that contains 18703 U.S. manufacturing facilities (Standard Industry Classification (SIC) Codes 20 to 39) and covers a time period from 1988 (which was the first year of certification in the U.S.) until 2000. We used three different data sources to construct our sample – the McGraw-Hill Directory of ISO 9000 certified firms, the Dun & Bradstreet 1996 database, and the Toxic Release Inventory (TRI). Our sample contains all TRI facilities that we could identify in the Dun & Bradstreet database. We constructed our dependent variable by matching ISO 9000 facilities listed in the McGraw-Hill Directory with the TRI and Duns Databases. We used computer programs to match facilities from the three databases using their names and zip codes. We then checked these matches manually and in addition consulted street addresses when matches were uncertain.

Measures

Dependent Variable

ISO 9000 Adoption. ISO 9000 adoption is captured as a binary variable that takes on 1 if the facility adopts ISO 9000 anytime between 1988 and 2000. We use the McGraw-Hill Directory of ISO 9000 certified firms to gather this information. Of the 18703 observations in our database, 6155 adopted ISO 9000 sometime between 1988 and 2000.

Independent Variables

Quality. Measuring quality proved to be one of the biggest empirical challenges of the paper. Previous studies have used reputation rankings derived from the "most admired" survey of the Fortune magazine. Unfortunately, this survey assesses only the 10 highest-ranked firms in a few large industries and thus reduces the sample size dramatically (c.f. Staw and Epstein, 2000). Furthermore, the survey assesses reputation on the firm level while ISO adoption occurs on the facility level. Profitability might also provide a quality measure, but financial data is available only at the firm level and only for publicly held firms.

Since we wished to measure the performance of each facility, we chose to use government information (i.e., the TRI dataset) about the degree to which each facility generated 612 different types of waste material. These materials include chemicals as diverse as isopropyl alcohol and hydrochloric acid, and valuable metals such as copper, lead, and zinc. For industrial processes, waste generation is the inverse of input yield. Thus, these data provide a direct measure of a facility's efficiency in using physical material. The more a firm generates waste as part of its production process, the less efficient are its operating procedures and technology. Reduction of waste is a central element of modern quality management. Reduction of waste can also provide evidence of other management capabilities. In the last few years, many firms have discovered that many waste materials can be sold as inputs to other companies. For example, steel companies now sell a byproduct from the steal pickling process (Ferrous Sulfide) for use in the creation of odor removal compounds. When byproducts are sold, they are no longer classified as waste and thus removed from our sample. Thus, relative waste generation measures both the efficiency of the process and the efficiency with which managers respond to new market opportunities. Numerous previous studies have found that for industrial companies waste generation is correlated with stock price and reputation (e.g., White, 1996; Dowell et al, 2000; Russo and Fouts, 1997).[1]

To assess the degree to which a facility generates waste, we used standard OLS multiple regressions analysis to estimate the average relationship between facility size and waste generation for each four digit SIC code in each year. The derived coefficients for each SIC code and year allow us to predict how much waste a facility 'should' generate given its size, SIC code, and year. The difference between this prediction and its actual waste generation (normalized by the standard error of the regression residuals) then provides an assessment of the facilities relative performance, i.e., its quality. Previous studies have shown that this measure correlates with higher financial performance (King & Lenox, 2001), as well as with proxies for management quality and quality management practices (Florida, 1996)

Formally, we estimate the following quadratic function between facility size and total waste generation for each SIC code within each year:

$$\ln W_{it} = a_{jt} + b1_{jt} * s_{it} + b2_{jt} * s^2_{it} + \varepsilon_{jt}$$

$$QUALITY_{it} = -\varepsilon_{jt} / \sigma_{\varepsilon jt}$$

where s_{it} is the size of the facility (log employees), $\ln W_{it}$ is waste generation for facility i in year t, ε_{jt} is the residual, and $\sigma_{\varepsilon jt}$ is the standard error of the residual. $QUALITY_{it}$ is the standardized relative performance for facility i in year t. The sign is reversed in recognition that more waste generation is evidence of poor performance.

---

[1] This is not to say that waste reduction necessarily causes financial improvement. Substantial debate continues about this point. Indeed, the causality might sometimes run the opposite direction: well managed firms might reduce their waste to safeguard their reputation. Whatever the direction of the effect, there is extensive evidence of a strong correlation.

Quality of Previous Adopters. We construct three additional variables from this measure. QUAL_ISO_SIC is the mean of QUALITY for all facilities that have adopted ISO in a given SIC code. When predicting adoption, this measure is used for all non-adopters in the same SIC code. We recalculate the values of this variable for each year. Therefore, this variable captures the mean quality of *all the previous* - and not only the initial – adopters in each SIC code. To capture only the impact of initial adopters, we create QUAL_ISO_FIRST. This variable equals the QUALITY value of the first ISO adopter in an SIC code. In the case where more than one facility adopted ISO in the first year of adoption, we take the mean of QUALITY of these initial adopters. We use a dummy (MULTI_ADOPT) to indicate where this is the case. Our third variable, QUAL_COMP, is a binary variable that indicates the quality of the potential adopters compared to the quality of the previous adopters in the same SIC code. It takes on 1 if the quality of the potential adopter is below the mean quality of the previous adopters in the same SIC code.

Control Measures

Number of Previous Adopters. Bandwagon theory suggests that not only the type, but also the number of previous adopters impact the probability of subsequent adoption choices (DiMaggio & Powell, 1983). We capture the extent of industry certification (IND_CERT), or, more specifically, the percentage of ISO facilities in each 4 digit SIC code by combing the Duns database (containing all manufacturing facilities) with the McGraw-Hill directory (containing all ISO 9000 certifications). Note that for the construction of this variable, we considered all ISO manufacturing facilities, and not only those that also reported to TRI. Because the percentage of industry certification does not specify how many industry members have not yet adopted – it might be 5 or 500- we create IND_SIZE, which indicates the number of facilities in each 4 digit SIC code.

Distance to Previous Adopters. Spatial proximity among adopters and initial non-adopters also influences adoption rates (Strang & Soule, 1998). For all TRI facilities, we used longitude & latitude information to calculate the great circle distance in standard miles between each facility and the nearest adopting facility for each year. The log of this measure is the variable DISTANCE. For facilities not in the TRI database, we used the longitude and latitude coordinates that facilities report to TRI to assign 'median coordinates' to zip codes. Matching 'median coordinates' and zip codes allowed us to estimate longitude & latitude coordinates for those ISO facilities not in the TRI database.

Supply Chain Pressure. Previous research on ISO 9000 suggests that supply chain pressures are an important factor governing adoption processes (Uzumeri, 1987). To capture these pressures, we created a variable (SUPPLY_CHAIN) that indicates the probability of a facility (according to its four digit SIC code) to sell its outputs to an ISO certified buyer, thus reflecting its probability to be exposed to supply chain pressures. We used the Input-Output (IO) tables from the U.S. Bureau of Economic Analysis for the construction of this variable[2]. For the time period that is relevant for our analysis, IO tables are available for 1992 and 1997. We use the 1992 IO tables to calculate the probability for each 4 digit SIC code to sell to an ISO certified firm in 1992, and the 1997 IO tables for the corresponding probabilities in 1995 and 1998. We used linear interpolation and extrapolation to estimate values for missing years.

Export Pressure. Firms might view ISO certification as an export requirement, and we control for this factor by calculating the percentage of exports of shipments (EXPORT) for each four digit SIC code. Shipment data classified by year and SIC code is available from the Bureau of

Economic Analysis Bureau, and we acquired export data for 1992 and 1997 (classified by SIC code) from the US Census Bureau. To account for special exports requirements imposed by the European Union, we also calculate EU_EXPORTS, which captures the percentage of exports into the EU (from total exports) for each SIC code. We used linear interpolation and extrapolation to estimate values for missing years.

Firm Pressure and Characteristics. Lastly, we control for firm internal pressures to adopt ISO 9000 (FIRM_PRESS) as well as for the number of facilities within one firm (FAC_NUM), and the size of the facilities (SIZE). Adoption of ISO might be a decision on the firm level that then is imposed onto the facility level. To control for this possibility, we calculate the percentage of ISO certification within each firm (FIRM_PRESS). Facilities report their parent's Duns number in the TRI and in the Duns database, and we use this information to construct firm trees that group the facilities into firms. We use the McGraw-Hill database of certified facilities to calculate the percentage of certification in each firm. FAC_NUM serves to control for the log of the number of facilities in each firm. We approximate size of facilities (SIZE) with the natural log of the number of employees provided in the Dun& Bradstreet database.

Year. We performed our analysis using a year variable to pick up the effects of the S-shaped diffusion curve and to control for other potential year effects. In combination with our other trend variables (i.e., industry certification and supply chain pressures), this time variable is important for taking out the effects of time on adoption probability. Adoption rates vary according to time, and ignorance of this time effect could lead to confounding the effect that initial adopters have on adoption processes with the effect that time has on adoption processes.

---

[2] Input tables provide the values of the different commodities that each industry used in a particular year. Output tables

Method

We analyze adoption of ISO 9000 using a random effect logistic model. For each adopting plant, we predict the first adoption of any ISO standard.[3] As soon as a facility has adopted an ISO 9000 standard, we no longer consider it in our sample, as it no longer is at risk to adopt. The model uses a Maximum Likelihood procedure (based on a Gauss-Hermite quadrature approximation) to estimate the likelihood for an independent unit to adopt ISO 9000. The model is specified as:

$$P_{it+1} = F(Z) = F(a_i + b\mathbf{X}_{it}) = e^{(Zit)}/(1 + e^{(Zit)})$$

where P is the probability that facility i will adopt ISO 9000 in the next year (t + 1). The vector $\mathbf{X}_{it}$ represents the characteristics of the ith facility or its industry in year t. The facility individual or random effects are measured as a_i. We chose a random effects model to correct for unobserved heterogeneity among units and a lack of independence across observations of the same firm. We use the random, rather than the fixed effect model as the fixed effect model would disregard all observations that did not adopted ISO within our panel period. As a result, a large part of our database would be removed from our sample.

Because the random effect model makes some assumptions about the distribution of a_i, we performed a number of tests to ensure its robustness for our analysis. We ran fixed effect logit models (which do not have the same distribution assumption) and found that our main results — the inverted U-shape — were robust. However, in order to run fixed effects models we had to reduce both model specification and sample since we could not include any variables that had constant values across groups or time. Therefore, we also ran linear probability models that allowed a more

---

provide the value of the different commodities that each industry produced in a certain year. To construct our variable, we converted the industry classification used in IO tables into 4 digit SIC classifications.

complete sample and model specification. We recognize that such linear specification is highly unsuitable for binary dependent variables, but pursued the approach to test the robustness of our findings. We found confirming results for our main effects. In a further attempt to be conservative, we used Leamer's formula for large sample inference (rather than the conventional $p<0.05$ cutoff) to assess the significance of our variables (Leamer, 1978). [4]

We present the descriptive statistics of our variables in table 1a. Table 1b provides a correlation table. Note that our trend variables - i.e., the extent of industry certification or supply chain pressures – are variables that naturally increase as time and thus certification increase. Thus, we observe some correlation among the year these trend variables, as well as correlation between supply chain pressures and the extent of industry certification. As we discuss our results below, we also explain how we adjusted our models in order to respond to this correlation issue.

Insert Tables 1a & 1b about here

RESULTS

Table 2 reports the results of our models. Model 1 presents our base model in which we only consider our control variables. Consistent with previous research, we find strong support that the probability of adoption increases with an increase in the probability of supplying ISO certified firm (SUPPLY_CHAIN), as well as with an increase in the extent of industry certification (IND_CERT).

---

[3] Some facilities received multiple certifications or adopted multiple versions of the standard. In such a case, we only consider the first adoption in our analysis.

[4] Leamer's formula for accepting significance is $F_{r,n-K} > [(n-K)/r]*(n^{r/n} - 1)$, where r is the number of restrictions in the test, n is the sample size, and K is the number of coefficients that are estimated in the specification (including the intercept). For tests of the individual coefficient estimates, r equals 1. In order to calculate the t-value cutoff, we take advantage of the relationship that the square of the t distribution with x degrees of freedom equals the F distribution with 1,x degrees of freedom.

Furthermore, the probability of adoption increases as the distance to the nearest adopters decreases (i.e., the closer the nearest adopter), as the percentage of certification within the firm increases, and as a facility exports more. We also find evidence that an increase in facility size increases the probability of ISO adoption. The coefficient for FAC_NUM, the number of facilities within a firm, is also significant. As expected, this suggests that ISO 9000 participation is in part a function of a firm's size.[5]

Insert table 2 about here

In Model 2a, we test our hypothesis that previous adoption by high quality organizations increases the probability of subsequent adoption. The coefficient for QUAL_ISO_SIC is positive and almost significant on the Leamer level (t-value of 3.31). However, the analysis also reveals a strong and significant curvilinear the relationship between QUAL_ISO_SIC and adoption, suggesting an inverted U-shaped relationship between the quality of previous adopters and the probability of subsequent adoption by potential adopters. As shown in Figure 1 below, this curvilinear relationship is strong enough to make the probability of adoption decrease as the quality of previous adopters becomes high.

Insert Figure 1 about here

---

[5] To address the high correlation between SUPPLY_CHAIN and IND_CERT, we ran the base model including only one of the two variables at a time. Both variables remain significant and retain the same sign, suggesting that while correlation exists, it does not cause a spurious interpretation of our results. To explore the correlation issue between SUPPLY_CHAIN and YEAR, we ran the base model with individual year dummies (that have a smaller correlation) as well as including only one of the two variables at a time. All retained all results from the original base model. Detailed model estimations for these robustness tests can be obtained from the authors.

In Figure 1, the ‘undotted’ line represents the probability distribution of adoption given the quality of previous adopters. To plot this line, we used the mean values of all the control variables reported in table 1a. Recall that we constructed the quality variable from the residuals of the regression predicting how much waste a facility ‘should’ generate given its size and industry. Therefore, the mean of our quality variable is close to zero (-0.18). Quality values below this value indicate lower quality then the average and values greater indicate better quality. The figure shows that the probability of adoption is highest when the quality of previous adopters is about average. The probability of adoption decreases when the quality of previous adopters is either higher or lower than the middle level of quality.[6] Thus, the results of model 2a suggest that we find support for hypothesis 1 only when previous adopters are below the industry average.

However, it is possible that the finding of an inverted U-shape relationship between the quality of initial adopters and subsequent adoption rates is driven by the S-shaped diffusion curve and the central limit theorem. Recall that QUAL_ISO_SIC considers the mean of the quality of *all* previous adopters, and that the number of previous adopters increases as time progresses. With an increase in the number of adopters, we should – according to the central limit theorem – observe that the mean quality of ISO adopters shifts towards the true population mean. This tendency might coincide with a *time-induced* increase in probability of adoption, i.e., a shift towards the middle part of the S-shaped diffusion curve. Put differently, as time increases, we may *simultaneously* observe (a) an increase in adopters, which causes their average quality to move towards mean, and (b) an increase in the probability of adoption caused by a time-induced movement along the diffusion

---

[6] To test the robustness of this finding, we also looked at each side of the inverted U. When predicting adoption considering previous adopters that were *above* average quality only, we find a negative and significant coefficient for QUAL_ISO_SIC, which reflects the negative slope in the right hand side of the graph. When predicting adoption given

curve. While we attempt to control for such time effects with our year and our trend variables, we recognize that QUAL_ISO_SIC itself is dynamic, which makes difficult telling apart the effect of time and adopter's quality on adoption rates.

To address this problem, we run Model 2b, in which we consider the impact of QUAL_ISO_FIRST on subsequent adoption rates. Recall that QUAL_ISO_FIRST captures only the quality of the *first* adopter in each SIC code. In the cases where there was more than one adopter in the first year of adoption, we take the mean quality of these initial adopters. In Model 2b, the coefficient of the square term of QUAL_ISO_FIRST - while smaller than the one of square term of QUAL_ISO_SIC - remains negative and significant, suggesting that the inverted U-shape relationship still holds if we only allow the quality of the very first adopters to impact adoption rates. The dotted line in Figure 1 represents the probability distribution of adoption given the quality of the first adopters.

Note that in Figure 1 we have rescaled the X-axis for the probability distribution of adoption given the quality of the first adopters. However, even when taking out the trend effect in the quality variable and considering the impact of only the first initial adopters, we find that an average quality of these first adopters is associated with a probability of adoption of up to 10%, while the probability of adoption is much lower if the quality of first adopters is either very high or very low.

However, there is an issue associated with the procedure with which we created QUAL_ISO_FIRST. In industries with more than one adopter in the initial year of adoption, diffusion rates seem – for whatever reason - to be higher than in other industries. Since for these industries we take the mean quality of the first adopters, we again are confronted with the problem

---

previous adopters with *below* average quality only, we find a positive and significant coefficient for QUAL_ISO_SIC, that a tendency towards the mean quality might be associated with a higher rate of adoption, *independent* of the quality of initial adopters. While previously the association of tendency towards the quality mean and high adoption rates was time induced, it now might be induced by some underlying industry characteristic. To pick up the effect of this underlying industry feature, we include in model 2c a dummy (MULTI_ADOPT) to mark the cases in which an industry had more than one adopter in the year that adoption occurred first. Model 2c suggests that while inclusion of MULTI_ADOPT further weakens the inverted U-shape relationship, it remains significant (the coefficient for the square term of QUAL_ISO_FIRST is significant). Having performed these tests of the robustness of the inverted U-shape relationship, we conclude that we do not find full support for hypothesis 1. We find that an increase in quality of initial adopters increases adoption probability only to a certain extent. After a threshold is passed, a further increase in quality of initial adopters reduces subsequent adoption probability.

In Models 3a, b, and c, we test the adoption pattern (rather than rates) of ISO 9000. In Model 3a, we test our hypothesis (H2) that organizations will be more likely to adopt if they have lower quality than those that previously adopted. To do this, we include a binary variable (QUAL_COMP) that takes a value of 1 if the quality of the potential adopter is below the quality of the previous adopters in the industry. The coefficient of this variable is positive and significant. It is possible, however, that QUAL_COMP is simply a rough approximation of a direct effect of a plant's quality relative to its industry (QUALITY). To test this, we included both QUAL_COMP and QUALITY. We find that QUAL_COMP remains significant while QUALITY is not significant. Finally, because QUAL_COMP and QUALITY are highly correlated, we compared a restricted model with just QUALITY (Model 3c) to the unrestricted model with both QUALITY

---

reflecting the positive slope in the left hand side of the graph.

and QUAL_COMP (Model 3b) to investigate whether QUAL_COMP adds significant explanatory power. We find that QUAL_COMP adds explanatory power suggesting evidence that the degree to which a firm has higher (or lower) quality than previous adopters indeed influences adoption probability. Thus, we conclude that we find support for Hypothesis 2.

Note that we performed models 3a – 3c using QUAL_ISO_SIC (rather than QUAL_ISO_FIRST), and that QUAL_COMP compares the quality of the potential adopter to the quality mean of all previous adopters. We chose this comparison rather than the one to the quality of only the first adopter (QUAL_ISO_FIRST), as it seems plausible that when an organization decides about adoption, it evaluates the average quality of all previous and not only the first adopter.

In summary, we do not find support for Hypothesis 1 that the probability of adoption *increases* with an *increase* in quality of the previous adopters. Instead, we find that an inverted U-shape describes best the relationship between quality of initial adopters and subsequent adoption rates. Our results confirm Hypothesis 2, and we support the proposition that potential adopters are more likely to adopt if previous adopters in their industry have higher quality than they have. We next discuss the implications of these finding for theory.

DISCUSSION

Our finding of an inverted U-shape relationship between quality of previous adopters and subsequent probability of adoption challenges current theory. Our research suggests that above a medium level of quality, a marginal increase in the quality of previous adopters actually decreases the propensity of other firms to adopt.

When average quality is below the middle level, the relationship between the average quality of initial adopters and the propensity of other organizations to adopt follows existing intuition. The lower the quality level of initial adopters, the less other organizations are likely to adopt. This finding follows suggestions that firms may avoid adopting a standard if they feel that association with other adopters will sully their reputation. Future empirical research should explore if such a 'legitimacy suppression effect' reduces the likelihood for participation even in cases where the potential adopters could have realized large returns from adoption.

Explaining the results in the case where initial adoption by high quality firms reduces the likelihood of future adoption is more challenging. It is possible that the adoption by very high quality organizations sends a signal to managers of average facilities that adopting and exploiting the innovation requires special capabilities or arduous effort. Consequently, the average plant might shy away from adoption. Alternatively, it is possible that in some cases high quality adopters are able to prevent adoption by low quality plants, thereby impeding a race to the bottom that would destroy the signaling value of the standard.

To explore these issues we performed an initial comparison of the industries at both extremes of our inverted U relationship. We found evidence that industries where the quality of the initial adopter is extremely high are significantly smaller (in terms of employees in this SIC code) and significantly more concentrated (as measured by the industry's Herfindahl index) than industries where the initial adopter is of low quality. Furthermore, the initial high quality adopter had a significantly greater market share. The smaller size of the industry may reduce the value of trying to send a false signal through association. High quality adopters may also be able to use their higher market share to prevent future adverse selection. On the other hand, it is possible that important high quality adopters are only motivated to pioneer the introduction of a management standard if other unobserved conditions prevent adverse selection. It is also possible that if the initial high quality adopter has a dominant position in the industry, other industry members do not consider this player as an immediate competitor. Clarification of these results requires further analysis.

We recognize that there are some limitations to our study. First, our measure for quality might sometimes incorrectly measure a facility's performance. Because we measure size with the log of the number of employees, a plant that employs labour very efficiently might look like low quality plant. When comparing to an otherwise identical plant, the labour efficient plant will generate an equal amount of waste with less employees, and our measure would indicate that this facility has a lower quality. Note, however, that this situation occurs only if the plant has a higher efficiency regarding the use of labor *only*. If a facility with high labor efficiency is also efficient with respect to other inputs and operations, our measure will correctly assign a higher quality to the plant.

We furthermore recognize that an organizations' efficiency or quality may not be directly observable for other organizations. Therefore, our measure does not directly capture an organization's reputation. However, we argue before that characteristics such as efficiency should underlie attributes like reputation and success, and that our measure can therefore serve as an approximation of the attributes that make an organization desirable for imitation. The challenge for our study is to find an approximation for reputation on the *facility* level and for a large longitudinal dataset. To our knowledge, there so far are no other measures available that could give an indication of the facilities' reputation. While our dataset includes a proxy for facility size and while some scholars have suggested using size as an assessment for reputation, we believe that quality or efficiency is a closer approximation for what may underlie an organization's reputation and success.

In this study, we have not clearly differentiated between imitation as "an organizational and network learning process" that involves innovation and creativity (Coole, 1999: 13) and imitation as a "ritualistic copying process" (Coole, 1999), which may still involve learning, but of a different nature. Put differently, we only focused on the adoption decision of ISO 9000 and did not investigate further if adoption caused plants to undergo a learning process that changed their quality management practices. Scholars emphasize that true imitation – imitation of successful *implementation* of a practice – often is difficult because the conditions of the initial adopter and the imitator may differ or because implementation require tacit skills (Nelson & Winter, 1982). Future research might clarify our findings by exploring the conditions under which adoption of ISO is a ritualistic copying process and when it indeed triggered learning and changes in the organizations.

Future research on how voluntary industry standards diffuse among organizations may also benefit from considering how the returns from adoption of previous adopters influence subsequent adoption rates. There are a few studies that have assessed the benefits from ISO certification (e.g., Rao et al, 1997; Simmons & White, 1999; Terziovski et al, 1995), but these have taken a cross sectional perspective. More generally, we hope that future research further combines the quality of initial adopters with other factors that impact adoption – e.g., returns from adoption as well as the institutional structures in which the organizations operate - to fully explore the adoption patterns of industry standards.

CONCLUSION

Our study is one of the first attempts to use a large longitudinal database to explore the diffusion of a management standard such as ISO 9000 from a dynamic perspective. It also empirically investigates a central issue for management standards – how the quality of previous adopters influences future adoption. Our study extends the existing empirical literature by offering a simultaneous comparison of the adoption patterns of a single practice across numerous industries. Our finding of an inverted U-shape relationship between quality of initial adopters and subsequent adoption rates suggests that existing theories may need refinement. It also suggests that the signal value of management standards need not be sullied by adverse selection.

Since the 1980s, scholars and practitioners have recognized that the adoption of new practices can be path dependent (Nelson & Winter, 1982). Initial conditions can critically determine the eventual path. In this research, we find that such initial conditions are indeed vital to determining the eventual diffusion and meaning of a management standard. Depending on the initial conditions, bandwagons need not ruin the investment made by high quality firms. In some industries, initial conditions prevent the development of a bandwagon race to the bottom. In future research, we plan to map these conditions.

REFERENCES

Abrahamson, E. & Rosenkopf, L., (1993). Institutional and competitive bandwagons: Using mathematical modeling as a tool to explore innovation diffusion. Academy of Management Review, 18(3): 487-517.

Abrahamson, E. and C. J. Fombrun (1994). "Macrocultures: Determinants and consequences." Academy of Management Review 19(4): 728 - 755.

Abrahamson, E. and G. Fairchild (1999). "Management Fashion: Lifecycles, Triggers, and Collective Learning Processes." Administrative Science Quarterly 44: 708-740.

Abrahamson, E., (1991). "Managerial Fads and Fashions: The Diffusion and Rejection of innovations." Academy of Management Review, 16(3): 586-612.

Anderson, S.W., Daly, J.D., and M.F. Johnson, (1999). "Why firms seek ISO 9000 certification: Regulatory compliance or competitive advantage?" Production & Operations Management, 8(10): 28-43.

Benjamin, B., A. and J. M. Podolny (1999). "Status, quality, and social order in the California wine industry Administrative Science Quarterly." Administrative Science Quarterly 44(3): 563-589.

Brown, L. A. (1981). Innovation Diffusion: A new Perspective. New York, Methuen.

Burt, R. (1987). "Social Contagion and Innovation: Cohesion versus Structural Equivalence." American Journal of Sociology 92: 1287-1335.

Burt, R.S., (1973). "The Differential Impact of Social Integration on Participation in the Diffusion of Innovations." Social Networks, 4: 337-355.

Cole, E. R. (1999). Managing quality fads: How American Business Learned to Play the Quality Game. New York, Oxford University Press.

DiMaggio, P. and W. Powell (1983). "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields." American Sociology Review 48: 147-160.

Dowell, G., S. Hart, and B. Yeung. (2000). "Do corporate global environmental standards create or destroy value?" Management Science. 46(8):1059-1074.

Florida, R. (1996). "Lean and Green: The Move to Environmentally Conscious Manufacturing". California Management Review, 39(1): 80-105.

Fombrun, C. J. and M. Shanley (1990). "What's in the name? Reputation Building and Corporate Strategy." Academy of Management Journal 33: 233-258.

Guler, I., M. F. Guillen, et al. (2000). "Global Competition, Institutions, and the Diffusion of Organizational Practices: The International Spread of the ISO 9000 Quality Certificates." Working Paper, The Wharton School, University of Pennsylvania.

Havemann, H. A. (1993). "Follow the leader: Mimetic Isomorphism and Entry into New Markets." Administrative Science Quarterly 38: 593 - 627.

Howard, J., J. Nash, et al. (2000). "Standard or smokescreen? Implementation of a voluntary environmental code." California Management Review 42(2): 63-82.

King, A. A. and M. J. Lenox, (2000) "Industry self-regulation without sanctions: The chemical industry's responsible care program." Academy of Management Journal, 43(4): 698-716.

King, A. & Lenox, M. (2001). "Lean and Green? An Empirical Examination of the Relationship Between Lean Production and Environmental Performance" Forthcoming in Production and Operations Management

Leamer, E. E. (1978). Specification Searches. New York: Wiley.

Levitt, B. and C. Nass (1989). "The lid on the garbage can: Institutional constraints on decision making in the technical core of college-text publishing." Administrative Science Quarterly 34: 190 - 207.

Litsikas, M. (1997). "Companies choose ISO certification for internal benefits." Quality 36(January): 20, 22, 24, 26.

Mansfield, E., (1961). "Technical Change and the Rate of Imitation." Econometrica, 61: 741-766

McGraw-Hill, (2000) ISO 9000 Registered Company Directory North America. 3(4).

Mendel, Peter (1996). "The Institutional Development of Global Production: The case of ISO 9000 International Management Standard." Paper presented at the Third Annual European Academy of Standardization Conference, Stockholm, Sweden, May 3-5.

Nash, J. and J. Ehrenfeld. (1996). "Code Green". Environment, 38(1): 16.

Naveh, E., Marcus, A., Allen, G., and Moon, H.K. (1999). IS0 9000 Survey '99. An Analytical Tool to Assess the Costs, benefits and Savings of ISO 9000 Registration. New York, San Francisco: MacGrawHill.

O'Neill, H. M., Pouder, R. W., et al., (1998). "Patterns in the diffusion of strategies across organizations: Insights from the innovation diffusion literature". Academy of Management Review, 23(1): 98-114.

Nelson, R. and Winter, S. (1982) An Evolutionary Theory of Economic Change. Cambridge: Belknap Press.

Podolony, J.M. (1993). "A status-based model of market competition". American Journal of Sociology, 98(4): 829 – 872.

Rao, S.; T. S. Ragu & L. E. Solis. (1997). "Does ISO 9000 Have an Effect on Quality Management Practices? An International Empirical Study." Total Quality Management 8(6):335-346.

Rees, J. (1997). "The development of communitarian regulation in the chemical industry." Law and Policy,17(4).

Rogers, E., (1995). The Diffusion of Innovations. New York: NY, Free Press.

Rosenkopf, L. and E. Abrahamson (1999). "Modeling Reputational and Informational Influences in Threshold Models of Bandwagon Innovation Diffusion." Computational & Mathematical Organization Theory, 5(4): 361-384.

Russo, M. & Fouts, P. (1997). "A resource-based perspective on corporate environmental performance and profitability." Academy of Management Journal, 40(3): 534-559.

Simmons, B. L. White, M.A. (1999). "The relationship between ISO 9000 and business performance: Does registration really matter?" Journal of Managerial Issues. 11(3): 330-343.

Staw, B. M. and L. D. Epstein (2000). "What Bandwagons Bring: Effects of Popular Management Techniques on Corporate Performance, Reputation, and CEO pay." Administrative Science Quarterly 45: 523-556.

Strang, D. & Soule, S.A., (1998). "Diffusion in Organizations and Social Movements: From Hybrid Corn to Poison Pills." Sociological Annual Review, 24: 265-290.

Terziovski, M. S., & D. Dow, (1995). "The impact of ISO 9000 certification on customer satisfaction." Asia Pacific Journal of Quality Management. 4(2): 66-68.

Uzumeri, M. V. (1997). " ISO 9000 and other metastandards: Principles for management Practice?" Academy of Management Executive (11): 21-36.

Westphal, J.D., Gulati, R. and S.M. Shortell, (1997). "Customization or Conformity? An Institutional and Network Perspective on the Content and Consequences of TQM adoption." Administrative Science Quarterly, 42: 366-394.

White, M. (1996). "Corporate environmental performance and shareholder value." Working paper, University of Virginia.

Winter, S.G. (1994). "Organizing for continuous improvement: Evolutionary theory meets the quality revolution."

TABLE 1a

Descriptive Statistics for Independent Variables

Variable	Description	Mean	Standard Deviation	Min.	Max.
QUALITY	Relative waste generation compared to sector and size	0.02	1.01	-4.35	7.35
QUAL_ISO_SIC	Relative waste generation (compared to sector and size) of *all* ISO adopter in the same SIC code as the current non-adopter	-0.18	0.56	-2.73	3.19
QUAL_ISO_FIRST	Relative waste generation (compared to sector and size) of *first* ISO adopter in the same SIC code as the current non-adopter	-0.41	0.72	-2.73	3.16
QUAL_COMP	Binary Variable taking on 1 if the relative waste generation of potential ISO adopter is greater than the relative waste generation of previous adopters in the same SIC code.	0.48	0.49	0	1
MULTI_ADOPT	Binary Variable taking on 1 if more than one ISO adopter in the first year of adoption in an industry.	0.40	0.49	0	1
SUPPLY_CHAIN	Probability for a 4 digit SIC code to supply ISO certified buyers	0.04	0.05	0	0.31
IND_CERT	Percentage of 4 digit SIC code that is ISO certified	0.05	0.07	0	0.62
DISTANCE	Natural log of distance to nearest ISO adopters	1.58	1.30	0	8.46
EXPORT	Percentage of exports of shipments in 4 digit SIC code	0.08	0.09	0	0.99
EU_EXPORTS	Percentage of exports into the EU of exports in 4 digit SIC code	0.20	0.11	0	0.78
FIRM_PRESS	Percentage of facilities within firm that is ISO certified	0.05	0.12	0	0.90
FAC_NUM	Natural Log of Number of facilities within firm	1.73	1.55	0	5.76
IND_SIZE	Number of facilities in 4-digit SIC code	395	346	3	1320
SIZE*	Natural log of employees	4.71	1.47	0	9.97
YEAR	Year	1995	2.3	1988	1999

N= 88839

* Note that facilities have 0 size if they are closed at the end of the year but have some remaining operations (waste generation) during some part of the year.

TABLE 1B:

Correlation Among Independent Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. QUAL_ISO_SIC	1.00																
2. (QUAL_SIO_SIC)^2	0.09	1.00															
3. QUALITY	-0.03	0.00	1.00														
4. QUAL_COMP	0.38	-0.04	-0.64	1.00													
5. QUAL_ISO_FIRST	0.63	0.03	-0.02	0.24	1.00												
6. (QUAL_ISO_FIRST)^2	-0.10	0.40	0.01	-0.07	-0.25	1.00											
7. MULTI_ADOPT	-0.01	-0.16	0.00	0.02	0.07	-0.20	1.00										
8. SUPPLY_CHAIN	0.10	-0.22	0.01	0.09	-0.02	-0.04	0.06	1.00									
9. IND_CERT	0.11	-0.19	0.01	0.09	0.01	-0.08	0.16	0.67	1.00								
10. DISTANCE	-0.07	0.11	0.00	-0.05	0.02	-0.03	-0.03	-0.34	-0.23	1.00							
11. FIRM_PRESS	0.05	-0.08	-0.03	0.07	0.02	-0.02	0.06	0.27	0.32	-0.15	1.00						
12. EXPORT	0.08	-0.07	0.00	0.05	0.05	-0.06	-0.02	0.03	0.13	0.05	0.12	1.00					
13. EU_EXPORTS	-0.03	0.04	0.00	-0.02	0.05	-0.03	0.10	-0.02	0.01	0.09	0.03	0.27	1.00				
14. FAC_NUM	0.04	0.06	-0.07	0.06	0.03	0.03	0.01	-0.06	0.06	0.07	0.34	0.10	0.05	1.00			
15. IND_SIZE	-0.16	-0.13	0.00	-0.06	-0.28	0.02	0.06	0.07	0.04	-0.01	-0.09	-0.18	-0.23	-0.11	1.00		
16. SIZE	0.06	0.04	0.00	0.04	0.12	-0.05	-0.01	-0.05	-0.02	0.02	0.16	0.11	0.03	0.31	-0.20	1.00	
17. YEAR	0.22	-0.10	0.01	0.10	0.10	0.03	-0.03	0.67	0.47	-0.48	0.23	-0.03	-0.17	-0.05	-0.09	0.00	1.00

N = 88839

TABLE 2
Maximum Likelihood Estimates predicting the probability of ISO 9000 adoption

VARIABLE	Model 1	Model 2a	Model 2b	Model 2c	Model 3a	Model 3b	Model 3c
QUAL_ISO_SIC		0.15			0.04	0.05	0.14
		(0.05)			(0.05)	(0.05)	(0.05)
(QUAL_ISO_SIC)^2		-0.35*			-0.33*	-0.33*	-0.35*
		(0.04)			(0.04)	(0.04)	(0.04)
QUAL_COMP					0.28*	0.24*	
					(0.04)	(0.06)	
QUALITY						-0.03	-0.11*
						(0.03)	(0.02)
QUAL_ISO_FIRST			-0.07	-0.08			
			(0.04)	(0.04)			
(QUAL_ISO_FIRST)^2			-0.12*	-0.10*			
			(0.02)	(0.02)			
MULTI_ADOPT				0.31*			
				(0.05)			
CONTROLS							
SUPPLY_CHAIN	5.91*	5.44*	5.69*	5.73*	5.37*	5.39*	5.45*
	(0.71)	(0.73)	(0.72)	(0.71)	(0.73)	(0.73)	(0.73)
IND_CERT	1.75*	1.54*	1.64*	1.41*	1.54*	1.56*	1.59*
	(0.35)	(0.36)	(0.35)	(0.36)	(0.36)	(0.36)	(0.36)
DISTANCE	-0.20*	-0.19*	-0.20*	-0.19*	-0.19*	-0.19*	-0.19*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
FIRM_PRESS	1.79*	1.76*	1.80*	1.77*	1.75*	1.75*	1.76*
	(0.17)	(0.18)	(0.17)	(0.17)	(0.18)	(0.18)	(0.18)
EXPORT	0.58*	0.47*	0.55*	0.63*	0.47*	0.48*	0.48*
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
EU_EXPORTS	-0.32	-0.20	-0.29	-0.46	-0.20	-0.20	-0.20
	(0.21)	(0.21)	(0.21)	(0.22)	(0.21)	(0.21)	(0.21)
FAC_NUM	0.07*	0.08*	0.08*	0.08*	0.07*	0.07*	0.07*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
IND_SIZE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SIZE	0.23*	0.23*	0.23*	0.23*	0.23*	0.23*	0.23*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
YEAR	-0.14*	-0.14*	-0.13*	-0.12*	-0.14*	-0.14*	-0.14*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
CONSTANT	273.45*	280.35*	255.76*	241.90*	278.46*	278.31*	279.31*
	(28.74)	(29.44)	(29.23)	(29.52)	(29.55)	(29.59)	(29.56)
N	88839	88839	88839	88839	88839	88839	88839
Wald Chi2	544.22	574.73	551.73	569.52	597.00	595.17	584.39

Standard errors in parentheses
* t-value of estimate exceeds Leamer’s suggested t-value (3.35)

FIGURE 1

Probability distribution of adoption given the quality of all previous and first adopters in the industry