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THE VALUE OF MANAGEMENT CONTROL SYSTEMS: EVIDENCE ON THE MARKET REACTION TO ISO 9000 QUALITY ASSURANCE CERTIFICATION

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SHANNON W. ANDERSON
J. DANIEL DALY
MARILYN F. JOHNSON
UNIVERSITY OF MICHIGAN

The Value of Management Control Systems: Evidence on the Market Reaction to ISO 9000 Quality Assurance Certification

Shannon W. Anderson*†, J. Daniel Daly**, Marilyn F. Johnson*

* University of Michigan Business School, Ann Arbor, MI 48109-1234 USA
** Doctoral candidate, University of Michigan Business School, Ann Arbor, MI 48109-1234 USA

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Abstract

We study the link between firm value and quality management practices by examining stock price reactions to third party attestation that a firm's quality control process complies with ISO 9000 quality assurance standards. We find that ISO 9000 certification is motivated by international sales, opportunities for attaining 'preferred supplier' status with manufacturing customers, availability of alternatives for disclosing quality, and costs of obtaining certification. Our analysis of wealth effects, which addresses Lanen and Thompson's (1988) critique by controlling for investors' prior anticipation of certification, indicates that factors which explain certification also explain cross-sectional variation in abnormal returns around the certification date. Additionally, we find that firms voluntarily disclose information about ISO 9000 certification when certification is initiated by the firm, but not when certification is in response to customer demands or regulatory requirements.

Key words: ISO 9000, quality, management control systems, attestation, disclosure

† corresponding author. Phone: 313-747-3308, Fax: 313-763-5688, e-mail: shannon_anderson@ccmail.bus.umich.edu

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1. Introduction

This paper provides evidence on the link between firm value and management control practices related to process quality by examining stock price reactions to third party attestation that a firm's quality control process complies with ISO 9000 quality assurance standards. Management accountants define control systems as the processes by which performance objectives are established, actual performance is measured and evaluated relative to objectives, and corrective action is taken. Traditionally, US firms define performance in financial terms and use processes of budget setting, variance analysis and performance appraisal for management control. These management control practices have come under attack with the success of Japanese manufacturers, who use what have collectively been termed 'lean manufacturing' methods (e.g., just-in-time inventory, total quality management, cell manufacturing) and management control practices that are hallmarks of the 'high performance workplace' (e.g., self-managed production teams, team compensation, problem solving processes, supplier and customer involvement).[1]

Critics cite U.S. managers' reliance on financial performance measures and preoccupation with reducing budget variances, in contrast to Japanese managers' use of operating performance measures and focus on continuous improvement and customer satisfaction, as a factor in the decline of U.S. manufacturing firms' financial performance (Kaplan, 1983, 1984; Kaplan and Norton, 1992; Drucker, 1990, 1992; Eccles, 1991; Hiromoto, 1988; Johnson, 1992; Tanaka, 1994). They urge firms to follow the teachings of Deming and Juran, quality gurus who shaped Japanese management control practices in the 1950's and believed that 'management by fact', with the objectives of business process reliability and customer satisfaction, would yield improved financial performance. At the same time, the financial accounting community has proposed a new disclosure framework in which firms report information about management control practices, including those related to quality assurance (AICPA, 1994:143). Moreover, accounting firms are exploring new

[1] A discussion of lean manufacturing is found in Womack, et al. (1990). A discussion of the high performance workplace is found in a recent study by Gordon, et al. (1994).

markets for audit services in which the information subject to attestation extends to nonfinancial data and the scope of attestation extends to the reliability of the management control systems that generate the data (Elliott, 1994). The challenge of these initiatives lies in identifying management practices that are widely applicable to diverse industries and in standardizing the definitions of these practices to facilitate comparison across firms. For management control practices related to quality assurance, ISO 9000 certification provides a standardized, audited signal of process reliability.

Despite rhetoric to the contrary, there is little evidence that quality management practices increase firm value. Case studies show that when advanced manufacturing methods are adopted, internal performance improvements (e.g., labor productivity) depend upon the concurrent implementation of management control practices that support decentralized decision-making (Kofman et al., 1993; Young and Selto, 1993; Banker, et al., 1994; Wruck and Jensen, 1994). Large sample studies of the influence of lean manufacturing methods and new management control practices on firms' overall financial performance have yielded mixed results (GAO, 1991; Balakrishnan, et al., 1994; Easton and Jarrell, 1994; Hendricks and Singhal, 1995; Holder and Pace, 1994; Ittner and Larker, 1994). Difficulties in estimating the relation between management practices and financial performance stem from problems in establishing an adoption date, assessing the validity of adoption claims, and determining the extent of adoption.

This study overcomes these shortcomings by examining stock price reactions to the issuance by a qualified third party auditor of a certificate attesting that a firm's quality control process complies with ISO 9000 quality assurance standards. Our results indicate that there are wealth effects associated with certification; however, there is no evidence that the average wealth effect is positive. Rather, certification is "good news" for some firms, but "bad news" for others. We interpret negative returns as evidence that, for some firms, ISO 9000 certification conveys information to shareholders that quality assurance costs have been passed from the customer to the supplier.

A second contribution of the paper is providing evidence on the cross-sectional relation between stock price reactions to ISO 9000 certification and firm-specific factors that influence the decision to seek

certification. Lanen and Thompson (1988) warn of the difficulty of inferring net cash flow effects from stock price reactions to voluntary disclosures when managers' decisions to disclose depend on both observable and unobservable attributes of the firm. In these cases, stock price reactions are attenuated by prior anticipation of the event. We incorporate prior probabilities from a probit model of certification choice in cross-sectional regressions of two-day abnormal returns on firm characteristics to control for the extent to which the market is surprised by attainment of ISO 9000 certification. Results from a cross-sectional regression that includes an adjustment for selection bias and prior anticipation indicates that the wealth effects of certification depend critically upon whether the firm sells in markets that are likely to value third party certification of quality, the presence of alternative mechanisms for disclosing quality, and the costs of certification. Managers' private information about factors that motivate the certification decision is also found to be value relevant. Consistent with these results, we also find that firms voluntarily disclose information about certification when certification is initiated by the firm, but not when certification is a response to customer demands or regulatory requirements.

The next section of the paper describes the ISO 9000 standards, the certification process, and firm characteristics that influence managers' decisions to seek certification. Section 3 presents a model of managers' decision to seek ISO 9000 certification and discusses its implications for interpreting stock price reactions to certification. Section 4 describes sample selection and measurement of variables. Results are reported in Sections 5 and 6 and summarized in Section 7.

2. ISO 9000 quality assurance certification

2.1 ISO 9000 description and history

In 1979, a Technical Committee (TC 176) of the International Organization for Standardization was charged with developing "generic quality management standards for worldwide application" that would give "mutual benefit to producers and users alike" (Bureau of Business Practice [BBP], 1992:16). The committee's work culminated with publication in 1987 of the ISO 9000 Quality Assurance Standards. Since

1987, ISO 9000 has been adopted by 95 countries as a national quality assurance standard and more than 40,000 certificates have been issued worldwide (*Quality Digest* July, 1994:25). The EC was the first to embrace ISO 9000 as an import-export standard; however, other countries rapidly followed suit, including the United States, in August 1987.[2]

Compliance with ISO 9000 standards indicates consistent use of documented, standardized procedures to produce the product for which the buyer contracts. Processes that are under control (in the statistical sense) are more likely to yield defect-free products; thus, ISO certification proxies for product uniformity and conformance to specifications.[3] The ISO 9000 standards are comprised of 20 quality system elements (Appendix A) that range from assessments of management involvement in quality programs (Element 4.1) to proper use of statistical process controls (Element 4.20). Following the teachings of Juran and Deming, process control is the strategy and 'management by fact' is the tactical approach. As with other management control systems, control is achieved by quality planning and goal setting, clear assignment of authority and responsibility, adequate skills, and systems for documenting process performance and responding to process failures.

Reflecting this focus on process control, ISO 9000 certificates are issued for individual production sites. A firm may achieve certification for any or all of its production sites and certification of different sites may occur at different times. The ISO 9000 standards are a series of four nested standards--- ISO 9001, 9002, 9003 and 9004--- that accommodate differences in the scope of operations at different production sites (Figure 1). ISO 9001 is governed by all 20 quality system elements and covers activities from product design and development, through production, inspection, installation or delivery, and subsequent servicing of the

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[2] The US version of ISO 9000, called the ANSI/ASQC Q90 series, is named after the sponsoring organizations: the American National Standards Institute and the American Society for Quality Control (BBP, 1992:57).

[3] ISO 9000 does not, however, proxy for quality of design, the aspect of product quality typically associated with aesthetics or functionality. To illustrate the difference, ISO 9000 will not prevent a manufacturer from producing the Edsel, it will only insure that the Edsel is produced to specifications. Also, it is possible for two suppliers with different levels of process quality to have ISO 9000 certification as long as the level of quality assurance provided is that for which the customer contracts.

product. ISO 9002, which is governed by 18 of the 20 quality system elements, excludes design and development activities as well as after market service. ISO 9003, which is governed by 12 of the 20 quality system elements, includes only quality assurance of final product inspection and testing. ISO 9004 is not a certificate *per se*, but rather is a set of guidelines for developing quality management systems that qualify for ISO 9001, 2, or 3 certification.[4] The nested nature of the ISO 9000 standards allows firms to select the appropriate certificate for each production site. For example, large firms with multiple manufacturing sites typically seek ISO 9002 certification because product design activities and after-market service functions typically are not located at the manufacturing plant.

2.2 The ISO 9000 certification process

Although the ISO 9000 series does not stipulate third party audits, its widespread adoption prompted formation of an industry of third-party attestation services that includes professional accounting firms (Elliott 1994: 116).[5] The infrastructure to insure uniform application of and attestation to ISO standards has three components: specific country accrediting agencies, registrar companies, and individual auditors.

Accrediting agencies certify the competency of third party registrars to conduct ISO 9000 quality audits and maintain records, filed by registrars, of each certified site in the country. Each country has one government-designated accrediting agency.[6] Registrars have diverse historical roots including: government sponsored laboratories (e.g., Canadian General Standards Board); private testing organizations (e.g.,

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[4] An addendum to ISO 9004, published in August 1991, discusses applications of quality principles in service industries. While in principle ISO 9000 is applicable in both manufacturing and service settings, in practice few service firms have become certified.

[5] KPMG, through its KPMG Quality Registrar business unit, attained accreditation as an ISO 9000 registrar in November 1993. Two other firms have conducted extensive surveys of quality systems (Ernst & Young and American Quality Foundation , 1992) and ISO 9000 certification (Deloitte & Touche and Quality Systems Update, 1993).

[6] The US accrediting agency is the Registrar Accreditation Board (RAB). RAB was established in 1989 by the American Society for Quality Control as a separate corporation. RAB subcontracts maintenance of certification records and publication of a directory of certified firms to C.E.E.M. Information Services, a privately held firm. See BBP (1992: 57-66) for a description of RAB's governance relationships and accrediting procedures.

Underwriters Laboratory, Inc.); firms that were early adopters of ISO 9000 standards and then developed in-house expertise (e.g., AT&T Quality Registrar); industry trade groups (e.g., Ceramics Industry Certification Scheme, Ltd.); and, most recently, professional accounting firms (e.g., KPMG Quality Registrar). Accreditation criteria are typically those elaborated in ISO Guide 40 and EN 45012. Accrediting agencies also define qualifications for ISO 9000 auditors. The commonly used international auditing standard is ISO 10011.

Auditors attest to a site's compliance with the elements of the ISO 9000 standards (Appendix A). Auditors may be qualified in up to six special fields, which correspond roughly to industries, and a registrar is qualified to audit all industries for which their auditors are qualified. The auditor classifies observations of non-conformance into one of four categories based on severity and provides the client a complete record of the audit. If the site achieves certification, the registrar reports the 'effective date' of certification, the scope of the certificate (operations certified) and other descriptive information about the site to C.E.E.M. Information Services, a privately held firm that publishes monthly and quarterly newsletters and an annual directory of ISO 9000 certified sites (See Quality Systems Update, 1994).

Registrars typically issue certificates for three year periods, with surveillance to assess continued compliance performed every six months. Approximately 35-40 percent of all sites seeking certification fail their first audit (*Small Business Reports*, Sept.1993); however, there is no public record of certification failures. Since certification is voluntary and may occur after several iterations, most firms that seek certification eventually attain it. Of those who fail, 70 percent do so because of inadequate record systems that produce discrepancies between documented quality procedures and actual practices *(Records Management Quarterly*, Oct. 1993, p. 3).

Obtaining ISO 9000 certification at a manufacturing site typically takes from nine to 28 months, depending upon the initial state of quality systems, the scope of certification sought, and the size and complexity of the site (*Chemical Week*, Sept. 22, 1993: 30). A manufacturing facility that employs 100 people and has few quality assurance procedures can expect to spend approximately $50,000 for system

development and registration (Arnold, 1994). A survey of ISO 9000 firms found that, for larger firms (sales from $100-500 million), the average total one-time cost of registration (excluding periodic review audits) was $300,000, with approximately 10 percent paid to registrars, 20 percent paid to other external parties, and the balance associated with internal costs (Deloitte and Touche and Quality Systems Update [DTQSU], 1993). The same firms reported average annual savings of $200,000, suggesting an average payback period of approximately 1.5 years. However, this belies dramatic differences across the sample; the median payback was 3.3 years, the first quartile occurs at 1.2 years and the third quartile at 21.4 years.

2.3 *Firm characteristics and ISO 9000 certification*

[Insert Table 1]

Articles in the popular press [7] and a recent survey by DTQSU (1993) of over 600 ISO 9000 certified firms that asked respondents their reasons for seeking certification (Table 1) provide guidance for identifying firm characteristics that influence the certification decision. Table 2 summarizes the factors that motivate certification: international market opportunities; regulatory requirements; opportunities for attaining competitive advantage; and internal improvement opportunities; and factors that deter certification: alternative mechanisms for meeting regulatory requirements, disclosing quality, and contracting for quality; costs of certification; and, the likelihood of certification yielding competitive disadvantage. What follows is a brief review of these factors with citations relating them to the accounting and economics literatures on standardization, market failures, transaction costs, strategic choice and quality signaling.

[Insert Table 2]

Relevance of international markets

Although ISO 9000 was not intended to be a regulatory tool or a basis for third party monitoring, the

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[7] *Records Management Quarterly*, October 1993:3-11; *Machine Design*, August 27, 1993:156; *Distribution*, August 1993:80-4; *Business America*, July 12, 1993:19-20; *Fortune*, June 28, 1993:116-20; *CMA Magazine*, June 1993:26; *Business Week*, November 1, 1993:146J; *Quality*, April 1993:37-42; May 1993:44 and October 1993:48-9; *Production*, May 1993:42; *Chemical Week*, August 4, 1993:26; September 22, 1993:30 and July 21, 1993:3; *Management Accounting-London*, October 1993:56.

emergence of a global market and the concurrent need for uniform standards to reduce the costs of transacting business in nations with different regulatory regimes[8] have caused the ISO 9000 standards to be used in these ways.[9] The 1987 introduction of ISO 9000 coincided with an initiative to remove trade barriers and create a unified European Community (EC) by 1992. ISO 9000 became a critical component in the effort to harmonize diverse regulatory environments. Harmonization had two components: creation of uniform standards against which to assess performance and creation of shared product safety regulations.

EC officials selected ISO 9000 as the "preferred standard" on which they based import-export restrictions, and other countries quickly followed suit. Use of ISO 9000 as an import-export standard yields positive network externalities to certification (Farrell and Saloner, 1985; Tirole, 1988:404-9). If costs of ISO 9000 certification are substantial and differ across firms, requirements for certification are barriers to entry, yielding competitive advantage for certified firms that gain proprietary access to regulated markets (Shapiro, 1986).

Applicability of regulations

The second component of EC harmonization was the use of ISO 9000 to define minimum quality standards in situations where the likelihood of market failure makes regulatory intervention appropriate (Coase, 1960; Darby and Karni, 1973; Spence, 1977; Leland, 1979; Smallwood and Conlisk, 1979). Policy makers created a unique marking system, designated the CE Mark, for 23 product categories that affect public safety. ISO 9000 certification is designated as a means for attaining the CE Mark in 14 of the 23 cases (Appendix B; BBP, 1992:22-8). A transition period gave firms opportunity to attain the CE Mark, with

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[8] A recent report by the National Research Council concluded that "The growing complexity of conformity assessment systems in many nations threatens to undermine future global trade expansion. U.S. exporters face high costs in gaining product acceptance in multiple export markets...wide dissemination of information to U.S. firms about standards and certification requirements in global markets is needed to improve prospects for future U.S. export expansion--- especially for small- and medium-sized firms..." (*Deloitte and Touche Review*, April 17, 1995)

[9] See Sunder (1988) for a discussion of the economics of standardization and its application to audited, uniform accounting standards.

complete implementation by 1992-1995, depending on the product category (BBP, 1992:34).

With the EC's acceptance of ISO 9000 certification as evidence of regulatory compliance, other governments began adopting ISO 9000 as a supplier standard as well. U.S. government agencies that have adopted ISO 9000 as a procurement standard include: the US Departments of Defense and Energy, the Food and Drug Administration, and the Federal Aviation Administration (The Society of Management Accountants of Canada, 1994:8). It appears that the economics of standardization motivate demand for ISO 9000 certification by U.S. government agencies. Under the headline "DOD streamlines purchasing practices", the *Deloitte and Touche Review* (July 11, 1994:3) reported:

> In August 1993, a Process Action Team (PAT) was formed to develop a strategy and a specific plan of action to decrease reliance, to the maximum extent practicable, on military specifications and standards (milspecs). The PAT's report, entitled *Blueprint for Change*, noted that DOD cannot afford to pay an increasing 'defense-unique' premium for the goods and services it buys.

In a broader assessment of product testing in the U.S. the National Research Council concluded:

> ...the nation's system for testing and certifying that products meet quality, safety, and other standards (conformity assessment) has become increasingly costly and burdensome...The nation's decentralized and elaborate system... is the cumulative result of case-by-case responses to specific marketplace or regulatory demands. Currently, assessment is performed by more than 110 private-sector product certifiers, 84 Federal certification programs, and uncounted numbers of state and local ones. To simplify the system and lower costs... the Federal government [should] immediately begin to phase out its programs--- relying on private testing and certification services... (*Deloitte and Touche Review*, April 17, 1995)

Other parties also recognize the opportunity that ISO 9000 creates for reducing transaction and search costs in the procurement function. In part, this opportunity stems from the wording of the ISO standards themselves. Requirement six of the 20-part ISO 9000 standard places responsibility for the quality of purchased materials squarely on the purchaser, stating that:

> purchased materials or components must be specified, inspected, verified and documented, *or the supplier must be ISO 9000 registered.*
> - emphasis added, *Records Management Quarterly*, October 1993:3.

The last clause of this requirement, in combination with the recent popularity of supplier management methods that promote long term partnerships and strategic alliances with key suppliers, have motivated original equipment manufacturers, who are themselves certified, to demand that their suppliers become

certified (*Fortune*, June 28, 1993:116-20; *Quality*, October 1993:48-9; *Management Accounting-London*, October 1993:56). Standard procurement practices are expected to reduce search costs and transactions costs (Tirole, 1988). In the case of ISO 9000 certification of OEM suppliers, the purchaser's direct costs of incoming inspection, the suppliers' costs of compliance with diverse customer-specific quality standards, and the joint costs of contracting, all are reduced.[10] This suggests that firms that sell primarily to other manufacturers are more likely to face customer demands for ISO 9000 certification and that certification may reduce transactions costs.

Opportunities for attaining competitive advantage

ISO 9000 certification is one means that a firm has for differentiating itself from its competitors. By virtue of its cost and attested veracity, it is a credible signal of process quality control that distinguishes the firm from uncertified competitors (Spence, 1973; Akerlof, 1970; Schmalensee, 1978; Klein and Leffler, 1981; Chan and Leland, 1982; Wolinsky, 1983; Cooper and Ross, 1984; Milgrom and Roberts, 1986). Such a signal may yield a price premium or increased sales volume. For example, a Senior Vice-President of Betz Laboratories stated, "Being certified legitimizes our quality effort and opens doors that would otherwise be closed" (*Business Week*, November 1, 1993:146J). Signaling motivations for ISO 9000 certification are most likely to obtain when firms lack alternative mechanisms for disclosing or contracting with customers for quality.

Internal improvement opportunities

A final reason that firms seek ISO 9000 certification is to realize internal improvement opportunities. The discipline of documenting and consistently applying quality assurance procedures often reduces waste and off-quality, improves productivity, and lowers costs. Certified firms also report that the process of

[10] For example, when the three US auto makers adopted ISO 9001 as their supplier quality assurance standard it replaced three separate programs that required suppliers to submit different documentation and to permit periodic audits by the auto firms. Now, evidence of current ISO 9001 certification is the only requirement for suppliers (*Chemical Week*, July 21, 1993:3; *Public Utilities Fortnightly*, April 15, 1993:15).

attaining certification increases employee involvement with and commitment to total quality management.

Deterrents to ISO 9000 Certification

The DTQSU survey polls ISO certified firms. Consequently, it focuses on reasons that firms seek ISO certification. Equally important are reasons some firms do not seek ISO certification. A review of the popular press reveals three arguments against ISO certification: better alternatives, high costs of certification and competitive disadvantage.

Better alternatives include those that allow the firm to: 1) disclose quality information that is more informative or of lower cost; 2) comply with or avoid regulatory requirements and procurement standards; or 3) directly contract for quality with customers. Firms that are likely to have alternative mechanisms for signaling quality are those with established reputations, for example, firms with established product brands that are differentiated based on quality or winners of external quality awards such as the Malcolm Baldrige Award (Kreps and Wilson, 1982; Shapiro, 1982, 1983; Allen, 1984). Firms that are likely to have alternative means to contract for quality or avenues for skirting procurement standards are those with a stable customer base and those that engage in long-term supplier relationships where repeat buying is common (Cremer, 1984).

A second deterrent to ISO 9000 certification is the cost of certification. These costs vary with the scale and scope of manufacturing operations as well as with the initial state of quality control practices when certification efforts begin (Weightman, 1994). The DTQSU Survey (1993) documents a nonlinear, negative relation between estimates of ISO 9000 certification costs per unit of sales and total firm sales. This relation suggests economies of scale in certification; large firms have lower costs of certification per unit of output and hence greater motivation to pursue ISO certification than small firms. DTQSU also documents a negative relation between costs of certification and the level of sophistication of initial quality control practices.

A final argument against certification is the focus of ISO 9000 on documenting *existing* procedures. Some quality experts argue that time spent codifying existing practices detracts from more important

"continuous improvement" quality efforts. Their opponents counter that continuous improvement is based on a thorough understanding of existing processes. Despite these philosophical differences, it seems clear that the benefits of attaining ISO 9000 certification for a particular production process are related to the stability and maturity of the process. Firms that compete on the basis of developing innovative processes and products have less incentive to seek certification.

3. A model of managers' decision to seek ISO 9000 certification

ISO 9000 certification is a voluntary, costly means of disclosing information about firms' quality assurance systems to external parties. We assume that managers act to maximize the net present value of expected future cash flows and predict that managers will seek ISO 9000 certification when the difference between the expected benefits of certification and the expected costs is sufficiently large. Net benefits of ISO 9000 certification are assumed to be a function of two sets of firm characteristics. One set of characteristics, X, is observable by external parties and managers (e.g., firm size) at time t=1. A second set of characteristics, Z, is revealed only to managers (e.g., internal quality system improvement opportunities) at time t=2.

We model the net benefits of ISO 9000 certification , y^* , as a linear function of the observable firm characteristics, X, and a random error term, ϵ, which includes, but is not limited to, the manager's private information, Z:

$$y^* = \alpha + X'\beta + \epsilon \qquad (1)$$

The error term is assumed to be normally distributed with zero mean.

Managers seek and attain certification if the net benefit exceeds a certain level, k. Representing certification as a binary variable, y, this can be expressed:

$$y = \begin{cases} 1 & \text{if } y^* \geq k \\ 0 & \text{if } y^* < k \end{cases} \qquad (2)$$

where k is greater than or equal to zero.

In period t=1, investors use observable firm characteristics, X, to form rational expectations of the probability a firm will obtain certification and the net benefits of certification. In period t=2, investors observe ISO 9000 certification and react. A problem of inferring wealth effects from stock price reactions to voluntary events, such as ISO 9000 certification, is that certification has been partially anticipated in period t=1. In this circumstance, stock price reactions will be attenuated because there is a positive correlation between the market's assessment of the prior probability of the firm attaining certification and the net benefits to certification (Lanen and Thompson, 1988:311).

Investors' anticipation of certification at time t=1 can be expressed as the product of the probability of receiving certification and the expected net benefit of certification, conditioned on X:

$$\begin{aligned} E[y^* \mid X] &= \text{Prob}[\text{ISO} \mid X]\ E[y^* \mid \text{ISO}, X] \\ &= N\left(\frac{\alpha - k + X'\beta}{\sigma_\epsilon}\right)\left[\alpha + X'\beta + \sigma_\epsilon \frac{n\left(\frac{\alpha - k + X'\beta}{\sigma_\epsilon}\right)}{N\left(\frac{\alpha - k + X'\beta}{\sigma_\epsilon}\right)}\right] \end{aligned} \tag{3}$$

where n(·) is the normal density function and N(·) is the normal distribution. The ratio, n(·)/N(·), known as the inverse Mills ratio, adjusts the expected value of y* to account for truncation at k.[11] The stock price reaction to certification at time t=2 is the product of two terms: the 'surprise' that certification was sought and the expected benefit of certification, both conditioned on X:

$$AR = \left[1 - N\left(\frac{\alpha - k + X'\beta}{\sigma_\epsilon}\right)\right]\left[\alpha + X'\beta + \sigma_\epsilon \frac{n\left(\frac{\alpha - k + X'\beta}{\sigma_\epsilon}\right)}{N\left(\frac{\alpha - k + X'\beta}{\sigma_\epsilon}\right)}\right] + \nu \tag{4}$$

[11] Truncation of k occurs because the date on which uncertified firms decide not to seek certification is unknown. Truncation leads to selection bias in the sample selection process. See Heckman (1979) for a discussion of the problem.

The 'surprise' is the difference between the revised probability of certification --- one--- and investor's prior assessment of the probability of certification based on X. Greater levels of X imply greater expected benefits of certification and higher probability that management will seek certification; hence less 'surprise' is associated with actual certification.[12]

The problem that Lanen and Thompson identify --- inability to estimate unambiguously the sign and magnitude of wealth effects associated with ISO 9000 certification based on stock price reactions alone--- depends upon the range and relative magnitude of X and Z. In Section 6, we incorporate estimates of the prior probability of ISO 9000 certification obtained from a probit model of ISO 9000 certification in cross-sectional regressions of abnormal returns on firm characteristics (Equation 4) to control for the extent to which the market is surprised by certification.

4. Research method

4.1 Sample selection

To investigate the wealth effects of ISO 9000 certification, we examine stock price reactions surrounding the date that a firm first receives an ISO 9000 certificate. Our sample consists of all public firms with ISO 9000 certificates issued for U.S. or Canadian manufacturing sites during the period January 1, 1990, to December 31, 1993. Certified firms are identified from the *ISO 9000 Registered Company Directory* (Quality Systems Update, 1994), a complete database of U.S. and Canadian ISO 9000 certified sites. The original database contained 4,096 ISO 9000 sites (Canadian: 793; US: 3,303). Compustat covers 279 of the firms that own these sites; however, data availability limits the certified sample to 221 firms and their 1034 certified sites. For these 221 firms, the decile distribution of the total number of certificates for each firm (Table 3, Panel A) indicates that most firms in the sample have only one certificate. Outliers include firms such as Dupont, with 75 certificates, and General Electric, with 64 certificates.[13]

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[12] This model was employed by Eckbo et al. (1990) in their study of the wealth effects of mergers.

[13] Of the 221 certificates, 46 (20.8%) are ISO 9001 certificates, 170 (76.9%) are ISO 9002 certificates, and 5 (2.3%) are ISO 9003 certificates. We can not determine differences between firms in the

The certification event that we examine is the 'effective date' of the first ISO 9000 certificate issued to a firm as reported by the registrar to C.E.E.M. Information Services. The effective date is the date on which the auditor certifies compliance with ISO 9000. The distribution of all certifications (N=1034) and all first certifications (N=221) by year, is provided in Table 3, Panel B. This distribution indicates an exponential increase in both the number of certificates and the number of firms obtaining initial certification over time.

[Insert Table 3]

To ensure that voluntary disclosure by the firm does not preempt disclosure through C.E.E.M. Information Services' publications, we conducted a Lexis/Nexis search using the phrase 'ISO 9000' to identify 213 press releases issued by 164 firms between 1990-93. Of these 213 press releases, 94 were issued by 64 of the 221 firms in our final sample. Comparing the press release date to the effective date of certification, we find no evidence that firms issue press releases that preempt the effective date of their first certificate. The 94 press releases follow the effective date of the firm's first certificate by an average of 83.48 days (median = 43 days), by which time notice of certification would have been published in the monthly update to C.E.E.M.'s *ISO 9000 Registered Company Directory*. While eight of the 94 press releases were issued prior to the effective date of the firm's first U.S. ISO certificate, each of these releases discussed certification at a non-U.S. site.

The control sample of uncertified firms that is required to estimate the market's prior probability of a firm receiving ISO 9000 includes all uncertified firms in primary 4-digit SIC codes in which at least one firm attained certification during the period 1990-1993. Firms that are designated by Standard and Poor's to be foreign domiciled or that Compustat indicates to be ADRs are eliminated to minimize the probability of including firms with non-North American, certified sites in the uncertified control sample. The uncertified control sample contains 670 firms, yielding a complete sample of 891 firms for estimating the probit model

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actual scope of operations certified versus the potential scope of operations certified (e.g., whether ISO 9002 was obtained because the site was ineligible for the more comprehensive ISO 9001, or whether it chose to seek a more limited certificate in spite of eligibility for ISO 9001). Thus, we do not incorporate differences in certificate type in our subsequent analysis.

of ISO 9000 certification.

4.2 *Measurement of factors that influence investors' assessment of the prior probability of ISO 9000 certification*

In Section 6, we assess the significance of cumulative abnormal returns surrounding ISO 9000 certification and examine the cross-sectional association between wealth effects of certification and firm characteristics. The cross-sectional tests use estimates from a statistical model of the prior probability of ISO 9000 certification to proxy for shareholders' prior assessment of the likelihood of certification. To estimate prior probabilities, we use a set of independent variables to proxy for observable firm characteristics that were identified in Section 2.3 and summarized in Table 2 as influential factors in the ISO 9000 certification decision. Table 4 summarizes the relation between these underlying factors and the independent variables and describes how each variable is constructed.

[Insert Table 4]

The importance of international markets to the firm is measured by two indicator variables that reflect the presence of existing sales in European (EC) and other international markets (INTNL). We separate European and non-European sales in an effort to examine the commonly voiced opinion that ISO 9000 is a barrier to entry adopted by policy makers to insulate EC markets from outsiders and thus, has little value outside of EC markets. The applicability to the firm of government regulations associated with quality certification is measured with variables that indicate whether the firm is in an industry subject to EC regulations (ECREG), whether it is both in a regulated industry and has sales in the EC that are threatened in the absence of compliance (EC*ECREG), or whether it has as a major customer the U.S. government (GOVT). A related variable, used to capture the likelihood that the firm faces customer procurement standards is the extent to which the firm sells to other manufacturers (EXMNF).

Alternative mechanisms for disclosing quality which may deter certification are captured by three variables. An indication of long term customer relationships in which reputation may substitute for third party certification of quality is the presence of a major, non-government customer (MAJOR). The presence of

strong brand awareness that may substitute for certification is measured using the advertising to sales ratio (ADSALE). The presence of alternative public signals of quality are measured with a variable that indicates whether the firm has won a quality award (AWARD) from either a customer or a third party organization (e.g., Malcolm Baldrige Quality Award). Costs of certification--- another deterrent to certification--- are measured using three variables that capture *low* costs of certification. Two variables measure the state of initial quality control processes: winning a quality award (AWARD) and commitment to a total quality management program (TQM) as assessed by Easton and Jarrell (1994). A third variable, the natural logarithm of the market value of equity, is a measure of firm size. DTQSU (1993) documented lower costs of certification per manufacturing site for large firms and hypothesized that this reflected either internal economies of scale or greater bargaining power when negotiating audit service fees. Finally, environments in which certification would lead to competitive disadvantage are measured with two variables that capture the importance of product and process innovation: a measure of patent activity (PATSAL) and a measure of R&D spending intensity (RDSALE).

A comparison of these proxy variables with the underlying determinants of the ISO 9000 certification decision (Table 2) indicates a gap between 1) what is observed by the market and what is known by the manager and 2) what influences ISO 9000 certification and what is measured. Factors that are either not observable or for which we found no proxy measures include: international growth potential, first mover advantages in quality signaling, recent market entry in the presence of established competitors, internal quality system improvement opportunities, alternatives for meeting regulatory requirements, product warranty provisions and the likelihood of writing fully specified, contingent contracts with customers.

4.3 Sample descriptive statistics

Table 5 provides descriptive statistics and univariate tests of the difference in means (and where appropriate, medians) between certified and uncertified firms for variables that proxy for observable firm characteristics that influence the decision to seek ISO 9000 certification. With two exceptions (ECREG,

PATSAL) the differences between means of the certified and uncertified sample are as predicted; and in only one of these cases (PATSAL) is the unexpected sign of the difference significant. The variable GOVT differs between the two samples as predicted; however the difference is not significant at the .10 level. No sign of the difference of means for the variable, AWARD, was predicted. While winning an external award suggests that existing quality practices are sufficiently sophisticated to make ISO 9000 certification a low cost alternative, winning an award such as the Malcolm Baldrige Quality award is also a credible external signal that may obviate the need for additional proof of superior quality practices. The results of the univariate analysis indicates that award winners are indeed more likely to be ISO 9000 certified than firms that have never received such recognition--- low costs of attaining certification outweigh the value of substituting another quality signal for ISO 9000 certification.

[Insert Table 5]

Overall, the univariate tests indicate that the difference between certified and uncertified firms is of the predicted sign and is significant at the .10 level or better. Certified firms have higher incidence of variables that motivate ISO 9000 certification (e.g., international sales, sales to customers with regulated or standardized procurement processes, lower costs of obtaining certification), fewer alternatives for contracting for quality (e.g., major customers, product brand reputation), and are less likely to compete in environments that are not conducive to process standardization (e.g., rapidly changing processes). The Pearson correlation matrix for the variables predicted to influence the certification decision (Table 6) indicates that correlations between the independent variables are unlikely to cause serious multicollinearity problems for the analysis that follows.

[Insert Table 6]

To provide additional evidence about managers' motivations for certification, we analyze our sample firms' voluntary disclosure strategies. Verrecchia (1983) models voluntary disclosure as occurring when the benefits to providing a more precise signal outweigh the proprietary costs of disclosure. Under the assumption that the proprietary costs of disclosing information about ISO 9000 are constant across our 221

firms, Verrecchia's model implies that managers with better news are more apt to voluntarily disclose their news. Thus, an analysis of the frequency with which various motivations for obtaining certification appear in press releases gives direct evidence of managers' perceptions of the benefits to ISO 9000 certification.

A content analysis for the complete sample is reported in Table 7.[14] Consistent with the relevance of international markets as a factor motivating ISO 9000 adoption, 19 (20.3%) of the 94 releases discuss certification at a site outside of the U.S. 23 (24.5%) of the releases discussed growth opportunities as the motivation for obtaining certification, while 5 (5.3%) stated that certification efforts were driven by the demands of current customers. None of the releases discuss regulation or internal improvement opportunities as a motivation for obtaining certification. We also find that 31 (33.0%) of the releases contain references to more than one certified site. Thus a common disclosure strategy is to issue a press release only after successful certification of several plants.

[Insert Table 7]

Since early disclosure can be viewed as evidence of "good news", Table 7 also contains a subsample analysis formed by splitting the 64 releases that reference a specific site into releases that preceded (n = 8) and followed (n = 57) the effective date of the referenced certificate.[15,16] Firms with preemptive press releases are more apt to refer to certification of non-U.S. sites, are more apt to discuss growth opportunities and are less apt to discuss specific customer demands as motivations for obtaining certification than are firms that issue releases following the referenced certificate's effective date.

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[14] In results not tabled, we also examined the association between the issuance of a press release and the factors described in Table 4 as motivating ISO 9000 certification. We find no evidence that any of these factors is associated with the decision to issue a press release.

[15] In results not tabled, we examined the association between the timing of a press release (before versus after the effective date of the referenced certificate) and the factors described in Table 4 as motivating ISO 9000 certification. With the exception of the fact that firms issuing preemptory press releases are larger than firms whose releases follow the effective date of the referenced site, we find no evidence that any of these factors is associated with the decision to issue a press release.

[16] These 64 releases contain references to certification of 116 (11.21%) of the 1034 sites in our sample. On average these press releases follow the effective date of the referenced site's certificate by 22.87 days (median = 7 days). In only 18 (15.51%) of the 116 cases does the press release precede the effective date of the certificate.

We interpret the content analysis as evidence of managers' beliefs as to the benefits of certification. Our results suggest that managers view access to international markets and growth opportunities as providing greater benefits to the firm than the benefits that accrue from meeting regulatory requirements, meeting customer demands, or internal improvements.

5. Evidence on the information content of ISO 9000 certification

Table 8 reports results from tests which use mean abnormal returns and standardized squared abnormal returns to assess the information content of ISO 9000 certification. Daily abnormal returns are examined over the seven-day period beginning four days prior to the effective date of the certificate (t=0) and are calculated using coefficients from a market model regression of firm returns on the value-weighted market index, estimated over the 200-day period ending 10 days prior to the effective date of the certificate. The Patell (1976) Z-statistic is used to assess the significance of daily abnormal returns, and a p-value from Rohrbach and Chandra's (1989) test, which compares the squared standardized value of the event period abnormal returns to the empirical distribution of squared standardized market model residuals, is used to test for a variance shift.

For the complete sample of 221 first certificates, our results provide no evidence of a positive wealth effect associated with ISO 9000 certification. Mean (median) abnormal returns are negative on four (six) of the seven days, and none are significant. However, we do find evidence of a variance shift on days t= -1 (p = 0.040) and t=-3 (p=.055).[17] From the day t=-1 and t=-3 variance shift, we conclude that there is a wealth effect associated with ISO 9000 certification.[18]

We offer two comments on our complete sample results. First, in light of the fact that ISO 9000 certification is a plant-level, as opposed to a firm-level phenomenon, it is not surprising that an analysis of

[17] In results not reported, we find that inferences are qualitatively similar when we use absolute returns scaled by mean absolute deviation to calculate the p-value from the Rohrbach and Chandra test.

[18] Additional analysis indicates that the variance shift is cause by negative skewness in the abnormal returns distribution, as opposed to a clustering of observations in the tails of the distribution. The proportion of significant (positive or negative) individual firm Z-statistics does not differ from that expected by chance.

firm-level data provides only modest evidence of a shift in the variance of abnormal returns at the time a particular site is certified.[19] Second, the absence of a positive wealth effect is not inconsistent with ISO 9000 certification being a value-maximizing decision on the part of incentive-aligned managers. ISO 9000 increases suppliers' costs of providing quality assurance. For firms with sales in EC-regulated industries, these costs take the form of a larger regulatory burden. For certified firms responding to customer demands, ISO 9000 implies that at least some costs of quality assurance have been shifted from the customer to the supplier.[20] The adoption of ISO 9000 by rational managers implies that, ex ante, the manager, who is aware that quality assurance costs have increased, believes that the costs of ISO 9000 certification are exceeded by the lost profits resulting from a decrease in market share if certification is not obtained.

In contrast, prior to the effective date of the certificate, market participants may not be fully informed of the increase in the firm's quality assurance costs. The negative market reaction reflects the market's impounding of these increased costs and does not necessarily reflect a disagreement with managers' assessments of the net benefits of obtaining certification. Our content analysis of the motivations for certification disclosed by firms in press releases provides evidence in support of this argument. While 20.3% of the releases (12.5% of "early" releases) cited international sales and 24.5% of the releases (50% of "early" releases) cited domestic growth opportunities as motivations for seeking certification, only 5.3% of all releases (0% of "early" releases) cited customer demands and no releases cited regulatory requirements as motivating the certification decision. Thus, we find no evidence that firms facing increased regulatory requirements or customer demands voluntarily disclosed the fact that their quality assurance costs have increased.

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[19] While a first certification may provide some indication of a firm's intention to certify at other sites, there is considerable variation across sites in the preferences and needs of the customer base and in the cost of obtaining certification.

[20] For example, the decision by the Big Three U.S. auto manufacturers to require that suppliers adhere to ISO 9000 was made with the explicit intent of shifting quality assurance costs to the suppliers.

6. Evidence on the association between wealth effects of ISO 9000 certification and firm Characteristics

6.1 Probit analysis of ISO 9000 certification choice

Table 9 presents the maximum likelihood estimates from a probit model of the combined effect of observable firm characteristics on investors' assessment of the prior probability of ISO 9000 certification.[21] Model 1 includes all variables predicted to influence the ISO adoption decision. Model 2 excludes variables from Model 1 that do not predict ISO 9000 certification.[22]

[Insert Table 9]

Consistent with the univariate tests of Table 5, sales in EC-regulated industries (ECREG) and to U.S. government customers (GOVT) provide no predictive power in identifying firms that are likely to attain ISO 9000 certification. Contrary to the univariate results, when the variables are considered simultaneously, the historical presence of sales to European customers in EC-regulated industries (EC*ECREG) and sales to non-government major customers (MAJOR) do not discriminate between certified and uncertified firms. Patent activity (PATSAL), which differed significantly but in an unpredicted manner in the univariate tests, does not enter significantly in the probit model.

Model 2 repeats the analysis including only those variables from Model 1 that are significant. Variables that provide significant discriminatory power between certified and uncertified firms are: international sales (INTNL and EC); sales to external manufacturers (EXMNF); advertising-to-sales and R&D-to-sales ratios (ADSALE and RDSALE); evidence of high levels of existing quality control (TQM and

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[21] For a discussion of models using limited-dependent variables see: Kmenta (1986, 547-57); Palepu (1986); Maddala (1991). As these sources indicate, in the case of dichotomous variables, there is little to distinguish the probit and logit models. Kmenta indicates that logit is more appropriate if the actual y*s are concentrated in either tail of the distribution. Our empirical results do not indicate that this is the case for either of the decision variables that we examine; consequently we use the probit model. The results that follow are substantively unchanged with a logit formulation.

[22] In an unreported model that included indicator variables for 2-digit SIC code industries, industry effects were not jointly significant and did not alter the significance of the remaining variables when excluded. This is not to suggest that industry does not influence ISO 9000 certification. Rather, it suggests that our sample, which includes the 14, 2-digit industries in which at least one firm attained certification in 1990-93, precludes examining this question.

AWARD); and, firm size (Ln(MVE)).

As predicted, the firm's exposure to international markets--- both European and non-European--- increases the likelihood of ISO 9000 certification. The conclusion that firms with sales in any international country are more likely to certify, as opposed to Europe only, contradicts the widespread belief that ISO 9000 is strictly a European phenomena--- a tariff designed to protect "fortress Europe".

Interestingly, firms that face government regulations and procurement requirements (ECREG and GOVT) are no more likely than other firms to be ISO 9000 certified; however, firms that are more likely to face private customers' procurement requirements (EXMNF) are more likely to be certified. This may reflect skepticism on the part of firms in regulated industries about the ability of government policy makers to adhere to and enforce the scheduled implementation of regulations. Alternatively, it may indicate that firms in regulated industries have found alternative mechanisms for meeting requirements. In either case, this result provides further evidence that ISO 9000 certification is not simply a European phenomenon.

Among the variables that were hypothesized to capture alternatives to certification for demonstrating a reputation for quality (MAJOR, ADSALE), only advertising is a significant deterrent. Of the two variables that were hypothesized to reflect environments in which process standardization would not be valuable (PATSAL, RDSALE), only the R&D to sales ratio discriminates between certified and uncertified firms. A closer investigation of the required scope and content of patent applications may explain the irrelevance of patent activity to ISO 9000 certification:

> The Patent Act requires that the patent application sufficiently disclose the invention *in its best mode* to enable a person skilled in the applicable art to repeat the invention... The Act further requires that the specification be an *enabling disclosure*.... The specification cannot be so inexact as to require a practitioner to experiment until success is reached. (emphasis original, Miller and Davis, 1990:106-7)

Fully specifying the process, a necessity for patent application, is the first step in ISO 9000 certification. Thus process and product innovations that are patented may be more easily standardized and certified than processes that are not yet patented.

The two variables that capture existing high levels of quality control and thus lower costs of ISO

9000 certification (TQM, AWARD), enter significantly. Similarly the variable used to capture firm size (Ln(MVE)) enters significantly, which provide additional evidence that large firms obtain economies of scale in certification or have bargaining power in negotiating lower audit fees (DTQSU, 1993).

Table 9 includes the log likelihood statistic, a measure of the statistical significance of the estimated model, and the likelihood ratio index, a measure of the model's explanatory power that is analogous to the R^2 statistic in ordinary least squares regressions (Kmenta, 1986:556). The results indicate that the estimated model is statistically significant; and, atypical of many limited dependent variable models, the estimated pseudo R^2 of .35 is relatively high.[23]

The default value used by most researchers to separate continuous, estimated probabilities into dichotomous categories and to assess whether the model correctly discriminates between certified and uncertified firms, is .5. However, Palepu (1986:14) argues that if the expected costs of Type I and Type II errors are equal, the optimal cutoff probability is the point at which the conditional probability density of observing a choice, y, given that the firm in fact attains ISO 9000 certification, is equal to the conditional probability of observing choice, y, given that the firm does not attain ISO 9000 certification. Plotting the distribution of estimated probabilities of ISO 9000 certification for certified and uncertified firms (Figure 2) indicates that the optimal cutoff probability for discriminating between the two groups is .264 . When this convention is adopted, 80 percent of the full sample and 77 percent of certified firms are correctly classified. Another measure of the model's classification accuracy is the percent concordant. A pair of firms with different certification status is defined as concordant if the certified firm has a higher predicted probability of certification than the uncertified firm. The concordance statistic indicates that 85 percent of all possible certified-uncertified pairs are concordant.

[23] For example, Palepu (1986) models a firm's probability of becoming a takeover target and obtains likelihood ratio indices ranging from .0695 to .1245.

6.2 *Wealth effects of ISO 9000 certification, controlling for investors' assessments of prior probability of certification*

As indicated in Table 8, we find modest evidence of a variance shift, but no evidence of a net positive wealth effect associated with ISO 9000 certification. In light of the large number of ISO certified firms and the variety of reasons motivating the adoption, we also conduct a cross-sectional analysis of the relation between firm characteristics and wealth effects. In this analysis, we regress abnormal returns cumulated over the two-day period (t= -1, 0) on the variables associated with certification choice as well as controls for selection bias and prior anticipation. For all first certifications (N = 221), results from these regressions are reported in Table 10. The OLS estimates from the standard linear model (Model 1) are reported in the first column. None of the variables are significant and model fit is poor. The OLS estimates from the linear model corrected for selection bias (Model 2), are reported in the second column. In contrast to Model 1, coefficients for three variables that influence the ISO 9000 certification decision are significant and of the predicted sign. The coefficient on the inverse Mill's ratio, which measures the estimated standard deviation of unobservable information that is relevant to the ISO adoption decision but is not captured in the probit model, is not significant.

[Insert Table 10]

The OLS estimates from the linear model corrected for selection bias and prior anticipation (Model 3) are reported in the third column. Coefficients for all of the variables predicted to influence ISO 9000 certification are significant and of the predicted sign, and there is a modest improvement in model fit.

In Model 3 the coefficient on the intercept is negative and significant. With the exception of R&D/Sales and Advertising/Sales, our independent variables capture the benefits to certification and have positive coefficients. Because our variables primarily capture certification benefits, yet we find no overall evidence of a positive wealth effect, it is not surprising that the coefficient on the intercept is negative and significant. We interpret the negative intercept to imply that on the certification date, the market learns that costs of quality assurance have been transferred from the customer to the supplier. Of course, it is also possible that the market assigns a lower value to certification than does the firm or that the variables,

RDSALE and ADSALE, do not fully capture deterrents to certification.

The coefficient on the inverse Mill's ratio, which measures the standard deviation of unobservable information about firm characteristics that influence the ISO 9000 certification choice, is positive and significant. The fact that it is significant indicates that E[y*|y* > k] significantly differs from E[y*] --- the event of certification conveys value-relevant information about unobservable characteristics to market participants (Figure 3). By analogy, if non-financial disclosures such as those proposed by the Jenkins Committee (AICPA, 1994) about quality, innovation, vendor satisfaction, and the strength of vendor relationships also have elements that are unobservable to market participants, they may be informative.

Our analysis also indicates that ignoring selection bias produces misleading results, an inference that is counter to that implied by previous accounting research. For example, Schrand (1994) finds no evidence that the inverse Mill's ratio from a probit model of hedging choice explains hedging levels, and Shehata (1991) finds no evidence that the inverse Mill's ratio from a probit model that explains the decision to capitalize versus expense R&D expenditures is associated with the magnitude of R&D expenditures. Underlying the selection model is the notion that firms choose one of two groups based upon the expected benefits of belonging to the two groups. Our specification differs from that of Schrand and Shehata in that, like Eckbo et al. (1990), the dependent variable in our second stage regression--- abnormal returns around the effective date of ISO 9000 certificates--- captures the benefits of ISO 9000 certification. Thus, it is not surprising that, like Eckbo et al. (1990), the inverse Mill's ratio is significant in our second-stage regression but is not significant in the second-stage regressions of Schrand and Shehata, where the dependent variable measures something other than the expected benefits of the policy choice.

7. Conclusion

ISO 9000 quality assurance standards are a set of documented, standardized procedures that have as their goal the assurance of product uniformity and conformance to specifications through superior management control practices. Using a sample of the first ISO 9000 certificates earned by North American

manufacturing facilities of 221 U.S. and Canadian firms over the four year period 1990-93, this paper provides evidence on factors associated with the decision to obtain third party attestation to the ISO 9000 quality assurance standards and the wealth effects of certification.

Using a probit model of ISO 9000 certification choice, we find that the certification decision is positively associated with a firm's presence in international markets, the proportion of its sales to external manufacturers, economies of scale or bargaining power in obtaining low costs of certification, and the sophistication of its existing quality systems. In contrast, firms with alternative mechanisms for demonstrating quality and firms in environments in which products and processes change rapidly are less likely to obtain certification. Despite claims that ISO 9000 is a tariff designed to insulate European markets from competition, we find no evidence that EC-regulations motivate ISO 9000 certification at U.S. and Canadian sites. Furthermore, we find no evidence that the U.S. government's efforts to mandate ISO 9000 certification has influenced government suppliers to seek certification. We also find no evidence that firms with major customers are seeking certification, unless those customers are themselves manufacturers. In this case, we suspect a "value-chain reaction" with manufacturers that attain certification subsequently demanding certification of their suppliers.

Although our evidence indicates that ISO 9000 certification is value relevant, we find no evidence that the net wealth effect is positive. Certification is "good news" at some manufacturing facilities, but "bad news" at others. Given this result and the variety of motivations for obtaining certification, we also examine the cross-sectional association between wealth effects and firm characteristics. Our results indicate that a firm's presence in international markets, the proportion of its sales to external manufacturers, the existence of economies of scale or bargaining power in obtaining low certification costs, and the sophistication of its existing quality systems are positively associated with two-day abnormal returns around the ISO 9000 certification date. In contrast, firms with alternative mechanisms for demonstrating quality and firms in environments in which products and processes change rapidly receive fewer benefits from certification.

Our study makes two contributions. First, our analysis of how the wealth effects of certification vary

cross-sectionally with the factors motivating certification incorporates controls for selection bias and prior anticipation. As Lanen and Thompson (1988) point out, there is a positive correlation between a manager's decision to take a particular course of action and the expected net benefits from the action. In a setting in which rational investors anticipate the action based on observable factors that influence the decision, it is impossible to sign the coefficients obtained from a regression of stock price reactions on firm-specific characteristics. We address the Lanen and Thompson critique by using a probit model of ISO 9000 certification choice to proxy for the market's assessment of the prior probability of a firm obtaining certification. We then use the estimated probabilities from the probit model in second-stage regressions of abnormal returns surrounding certification dates on the firm-specific characteristics motivating certification and Heckman's (1979) correction for selection bias.

Second, we contribute evidence to a growing body of literature on the association between firm value and quality management practices. Existing beliefs about the role of ISO 9000 in quality assurance lead to contradictory predictions as to its value. On the one hand, ISO 9000 is argued to be valuable because standardization reduces transactions costs and increases the frequency with which units conform to specifications. On the other hand, there may be other, lower cost mechanisms for reducing transactions costs, and codification of existing practices may detract from "continuous improvement" quality efforts. Our evidence indicates that ISO 9000 provides the greatest benefits to firms who face low costs of certification and whose certification decision is motivated by a presence in international markets or a desire to obtain "preferred supplier" status with customers who are themselves manufacturers. In contrast, firms in rapidly changing environments and firms that have other alternatives for disclosing quality to customers obtain fewer benefits from certification.

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Appendix A

The ISO 9000 Series includes 20 quality assurance system elements. Companies are audited for compliance against each element. ISO 9001 is comprised of all 20 elements, ISO 9002 is comprised of 18 of the elements and ISO 9003 is comprised of 12 of the elements.

ISO 9000 Section	Element	Subsection elements
4.1	Management Responsibility	clearly defined policy and objectives; presence of organization with responsibility and authority over quality; management review
4.2	Quality System	quality plans; identification and acquisition of controls, processes, equipment, production resources and skills necessary to achieve required quality; revisions and update process; quality records
4.3	Contract Review	processes to insure requirements are defined and documented; evidence that supplier is capable of meeting requirements; records of contract review
4.4	Design Control	Design and development planning; activity assignments; communications between groups; clear statement of design input requirements and output requirements; design verification; design changes
4.5	Document Control	procedures to control all documents and data related to ISO 9000 certification; document changes and updates; document approval
4.6	Purchasing	purchase part requirements; selection of suppliers; receiving inspection and quality records; provisions for dispute settlement
4.7	Purchaser-supplied product	verification of supplier quality; storage and maintenance of purchased parts inventory
4.8	Product Inspection and Traceability	systems for identifying and tracing parts in all stages of production, delivery and installation
4.9	Process Control	work instructions; monitoring and control; approval processes; clear performance criteria; records
4.10	Inspection and Testing	define responsibility and authority for inspection; determine scope of product inspections; define how results are documented and evaluated
4.11	Inspection, measuring and test equipment	determine whether inspection equipment is properly identified, maintained, selected and calibrated
4.12	Inspection and test status	methods for readily identifying whether parts have passed inspection and testing
4.13	Control of nonconforming product	identification of type and extent of nonconformance; disposition of nonconforming product; notification of appropriate parties about nonconformance; reinspection if reworked or repaired
4.14	Corrective action	programs for systematically reducing nonconformance through reaction to failure and prevention of failures; root cause analysis, corrective actions, controls to verify corrective action

Appendix A (continued)

ISO 9000 Section	Element	Subsection elements
4.15	Handling, storage, packaging, and delivery	processes to insure that no damage occurs during storage and handling; methods of packaging, preserving and marking inventory.
4.16	Quality Records	Procedures to identify, collect, file, store and maintain quality records in easily retrievable form
4.17	Internal Quality Audits	methods for systematically auditing quality program to prevent system failures; audits scheduled, conducted in accordance with procedure, results documented and reviewed by management
4.18	Training	systematic approach to training and documentation of adequacy of employee training or experience relative to job assignments
4.19	Servicing	procedures to insure that servicing meets contractual requirements
4.20	Statistical Techniques	procedures to identify when statistical process control is warranted and to insure proper implementation in appropriate situations

Source: Arnold (1994). See "ISO 9000: An Opportunity for Records Management Professionals", Records Management Quarterly, October 1993, p. 3.; and "Elements of ISO 9000 Quality Systems", Chemical Engineering, April 1993, p. 130; for a summary of the 20 components.

Appendix B

U.S. 4-digit SIC codes for products regulated by the European Community

ISO ADOPTED as a means of demonstrating compliance

1. Construction Products

3462 Construction and mining equipment forgings
3531 Construction machinery & equipment, except mining-- mfg of
3272 Building materials: Concrete products
3429 Builders hardware, including lock and lock sets
3275 Building board, gypsum
3211 Building glass, flat
3274 Building lime
3292 Building materials, asbestos
2679 Building paper, laminated
2621 Building paper : sheathing
3822 Building services monitoring controls
3281 Building Stone
3251 Building Tile
2451 Mobile homes
2452 Prefab wood homes
3448 Prefab metal homes

2. Personal Protective/ Safety Equipment

3851 Protectors, eye
3949 Protectors, sports
3842 Safety appliances & equipment
2399 Safety belts (except leather) automotive
3199 Safety belts, leather

3. Gas Appliances

3433 Gas Room heaters
3638 Gas lighting fixtures
3631 Gas ranges (domestic)

4. Weighing Instruments/ Scales

3596 Weighing machines and apparatus, excepr laboratory
3545 Scales, (machinists' precision)

5. Telecommunications terminal equipment

3661 Telephone central office equipment, dial & manual
3643 Terminals & connectors for electrical services
3575 Terminals, computer

ISO PROPOSED and implementation date established

6. Medical Devices

3069 Medical sundries, rubber
3221 Medicine bottles
3231 Medicine droppers, glass
3061 Surgical and medical tubing
3842 Surgical appliances and supplies, except instruments
2211 Surgical fabrics, cotton
3841 Surgical instruments and apparatus, except electromedical; surgical knife blades, surgical stapling devices
3845 Surgical support systems: heart-lung machines and blood flow systems

7. Elevators

3534 Elevator fronts, elevator equipment: passenger & freight
3446 Elevator guide rails
3523 Elevators, farm
3728 Elevators, aircraft

Appendix B (continued)

ISO PLANNED REGULATION but no established date of implementation

8. Cableways Equipment (ie. ski lift cable)

3355 Cable, aluminum
2298 Cable, fiber
3357 Cable, nonferrous: bare, insulated or armored
3315 Cable, Steel: insulated or armored
3496 Cable, uninsulated, made from purchased wire

9. Flammable Furniture

2211 Furniture denim
2426 Furniture dimension stock, hardwood for upholstery
3429 Furniture hardware, including casters
2499 Furniture inlays (veneers)
2396 Furniture trimmings, fabric
2599 Furniture, factory: stools, work benches & cabinets
2511 Furniture, household, wood
2519 Furniture, household, glass, wicker, rattan, fiber & plastic
2514 Furniture, household, uphostered on metal frame
2512 Furniture, household, upholstered on wood frame
2521 Furniture, offfice, wood

10. Amusement & Fairground Equipment, Sporting Equipment

3599 Amusement rides for carnivals
3949 Sporting goods, except clothing, footwear, small arms and ammunition

11. Recreational Craft

3732 Boat kits, not a model
3441 Boat sections, prefabricated metal
3799 Boat trailers
3732 Boats, fiberglass, building and repairing: motorboats, rowboats & canoes
3089 Boats, nonrigid: plastics
3647 Bicycle & Motorcycle lamps
3751 Bicycles, Motor scooters, Motorcycles & parts

12. Pressure Equipment

3365 Pressure cookers: cast aluminum
3469 Pressure cookers: stamped or drawn
3589 Pressure cookers: steam
3321 Pressure Pipe
3443 Pressure Vessels

13. Measuring and Testing Equipment

3825 Test equipment for electronic and electrical circuits, Measuring instruments and meters, electric
3829 Testers for checking hydraulic controls on aircraft. Testing equipment for abrasion, shearing strength, tensile strength and torsion
3569 Testing chambers for altitude, temperature, ordnance & power
3545 Measuring tools and machines, machinists metalworking type
3824 Measuring wheels

14. Fasteners

3965 Fasteners: glove, slide, snap and hook & eye

Source: 1) US SIC codes: Standard Industry Classification Manual, 1987; Executive Office of the President, Office of Management and Budget

2) EC regulated industries for which ISO 9000 is a prescribed method of compliance: BBR 1992:28.

Table 1
Commonly cited reasons for seeking ISO 9000 certification [a]

Reason	Percent citing 'most important'	Percent citing 'second most important'	Percent citing 'third most important'	Item Total
Customer Demands/ Expectations	27.4	17.6	15.2	60.2
Internal Quality Benefits	21.8	21.3	19.0	62.1
Market Advantage (preferred Supplier Status)	15.6	22.9	21.0	59.5
EC Regulations	9	6.5	8.2	23.7
Corporate Mandate	8.9	6.6	7.3	22.8
Part of a global competitiveness strategy	8.9	11.1	9.7	29.7
Competitive Pressures	2.4	6.1	9.0	17.5
Reduced Costs of Production	1.5	4.4	6.9	12.8
Non-EC government requirements	0.8	0.2	.5	1.5
pooling of 'Other' response and No answer	3.7	3.3	3.2	
TOTAL ALL RESPONSES	100	100	100	

[a] A summary of 620 survey respondents' selections from a list of 10 alternatives in response to the questions:

1) What is the MOST IMPORTANT reason for attaining ISO 9000 registration at your company?

2) What is the SECOND MOST IMPORTANT reason for attaining ISO 9000 registration at your company?

3) What is the THIRD MOST IMPORTANT reason for attaining ISO 9000 registration at your company?

SOURCE: Deloitte & Touche Management Consulting and Quality Systems Update. ISO 9000 Survey. (Fairfax, VA: C.E.E.M. Information Services) September 1993. pp. 1-2.

Table 2
A summary of reasons advanced in the literature for why firms pursue or do not pursue ISO 9000 certification

Motivatations for seeking ISO 9000 Certification [a]	Deterrents to seeking ISO 9000 Certification [a]
Relevance of international markets - secure existing international sales (*) - reduce transactions costs of selling in international markets (*) - sales growth opportunities **Applicability of regulations** - regulated products (*) - procurement standards (*) **Opportunities for attaining competitive advantage** - first mover advantage in providing quality signal - market entry in industries with competitors with established reputations - 'preferred supplier' status (*) **Internal improvement opportunities** - reduce poor existing quality	**Alternatives for meeting or avoiding regulatory requirements** - other avenues for meeting requirements - circumventing import-export rules with local production facilities **Alternatives for disclosing quality to customers** - warranty provisions - strong existing relationships (*) - fully specified contingent contracts - quality awards (*) - product reputation (*) **Costs of Certification** - initial state of quality control system (*) - economies of scale in certification (*) **Competitive disadvantage** - avoid premature technology 'lock-in' in rapidly changing environments (*)

[a] DTQSU, 1993; Records Management Quarterly, October 1993, 3-11; Machine Design, August 27, 1993, 156.; Distribution, August 1993, 80-4.; Business America, July 12, 1993, 19-20.; Fortune, June 28, 1993, 116-20.; CMA Magazine, June 1993, 26.; Quality, April 1993, 37-42.See: Business Week, November 1, 1993, 146J; Quality, May 1993, 44 and October 1993, 48-9; Production, May 1993, 42; Chemical Week, August 4, 1993, 26, September 22, 1993, 30 and July 21, 1993, 3; Management Accounting-London, October 1993, 56.

(*) Indicates a variable for which proxy measures are developed for use in subsequent analysis.

Table 3
Distribution of ISO 9000 certificates by firm and by year of certification

Panel A: The decile distribution of the number of ISO certificates for each of the 221 publicly held firms covered by Compustat with at least one certificate.

Decile Range	Average Number of Certificates per Firm	Range of Observations
0-.10	1	1-1
.11-.20	1	1-1
.21-.30	1	1-1
.31-.40	1	1-1
.41-.50	1.59	1-2
.51-.60	2	2-2
.61-.70	3.08	2-4
.71-80	4.84	4-6
.81-.90	8.40	6-11
.91-1.0	25.2	11-75

Panel B: The distribution of ISO 9000 certificates issued to sites owned by 221 publicly held US companies covered by Compustat, 1990-1993

	1990	1991	1992	1993	TOTAL
All Certificates	10	75	312	637	1034
First Certificates	7	22	75	117	221

Table 4
A description of dependent variables used to proxy for factors that influence managers' decision to seek ISO 9000 certification.

Construct (from Table 2)	Variable Name and Description	Data Source
Relevance of international markets	INTNL: An indicator variable, assigned a value of one if non-European international sales > 0 and zero otherwise.	Compustat's geographic segment data; defined to exclude sales in North America and the European Community.
	EC: An indicator variable, assigned a value of one if European sales > 0 and zero otherwise.	Compustat's geographic segment data; defined as all countries in the EC or by reference to the European continent.
Applicability of Regulations	ECREG: An indicator variable assigned a value of one if a firm has significant business in any of the seven product groups for which there are established implementation dates for EC regulation.	Significant business in regulated products is defined using Compustat primary and major business segment 4-digit SIC codes and product groups with EC-regulation 'Adopted' or 'Proposed' (Appendix B).
	GOVT: An indicator variable assigned a value of one if the US government is a major customer.	Firm disclosure of US government as a major customer, as listed on Compustat
Procurement Standards and opportunities for attaining competitive advantage as a 'preferred supplier'	EXMNF: Average percent of sales to external manufacturers for all firms in the same primary 2-digit SIC code.	1987 US Census of Manufactures Subject Series--- Distribution of Sales
Alternatives for disclosing quality	MAJOR: An indicator variable assigned a value of one if the firm has a non-government major customer	Firm disclosure of a major customer, as listed on Compustat
	ADSALE: Advertising expense to sales ratio in year certified (ISO firms) or first year between 1990-1993 that complete financial data is available (control sample)	Compustat data
	AWARD: An indicator variable assigned a value of one if the firm won an external quality award prior to 1992.	Lexis/ Nexis. We are grateful to Singhal and Hendricks (1994) for providing access to their data.

Table 4 (continued)
A description of dependent variables used to proxy for factors that influence managers' decision to seek ISO 9000 certification.

Construct (from Table 2)	Variable Name and Description	Data Source
Costs of certification, economies of scale	AWARD: An indicator variable assigned a value of one if the firm won an external quality award prior to 1992.	Lexis/ Nexis. We are grateful to Singhal and Hendricks (1994) for providing access to their data.
	TQM: An indicator variable assigned a value of one if the firm had a significant total quality management program, defined as reference to a quality program in a 1987-93 annual report and verified by a Vice-president or Director of Quality.	Firms designated as TQM firms by Easton and Jarrell (1994)
	Ln(MVE): The natural logarithm of the market value of equity in year certified (ISO firms) or first year between 1990-1993 that complete financial data is available (control sample)	Compustat data
Competitive disadvantage	PATSAL: the number of design, utility and plant patents issued to the firm from 1987 to 1993, deflated by sales in year certified (ISO firms) or first year between 1990-1993 that complete financial data is available (control sample)	LEXIS/ NEXIS and Compustat
	RDSALE: Research and development expense to sales ratio in year certified (ISO firms) or first year between 1990-1993 that complete financial data is available (control sample)	Compustat data

Table 5

Univariate analysis of the relation between observable firm characteristics likely to motivate ISO 9000 certification and actual certification for the sample of certified (N=221) and uncertified (N=670) firms

Variable	Statistic	(A) Certified Firms	(B) Uncertified Firms	p-value of Difference of Means	Predicted Sign of (A) - (B)	Actual Sign of (A) - (B)
INTNL	Mean	.674	.200	.0001	+	+
	Std. Dev.	.470	.400			
EC	Mean	.700	.231	.0001	+	+
	Std. Dev.	.461	.422			
ECREG	Mean	.176	.200	.4437	+	-
	Std. Dev.	.382	.400			
EC * ECREG	Mean	.122	.030	.0001	+	+
	Std. Dev.	.328	.170			
GOVT	Mean	.050	.025	.1253	+	+
	Std. Dev.	.218	.157			
EXMNF	Mean	.295	.270	.0096	+	+
	Median	.32	.24	.0011		
	Std. Dev.	.119	.121			
MAJOR	Mean	.226	.434	.0001	-	-
	Std. Dev.	.419	.496			
ADSALE	Mean	.008	.019	.0104	-	-
	Median	0	0	.5177		
	Std. Dev.	.014	.112			
PATSAL	Mean	15095.3	236.2	.0003	-	+
	Median	.062	.031	.0005		
	Std. Dev.	60099.9	5920.1			
RDSALE	Mean	.053	1.10	.0081	-	-
	Median	.035	.037	.4974		
	Std. Dev.	.054	10.23			
TQM	Mean	.240	.018	.0001	+	+
	Std. Dev.	.428	.133			
AWARD	Mean	.457	.106	.0001	[a]	+
	Std. Dev.	.499	.308			
Ln(MVE)	Mean	6.33	3.72	.0000	+	+
	Median	6.56	3.63	.0001		
	Std. Dev.	2.00	1.99			

[a] The sign of the difference between columns (A) and (B) was not predicted for the variable AWARD. Winning and external quality award is expected to cause subsequent ISO 9000 certification to be less costly, and thus to positively influence certification. However, the external quality award may also serve as a substitute for ISO 9000 certification, and thus deter certification.

Table 6
Pearson Correlation Coefficients, N=891(p-values in parentheses) [a]

VARIABLE NAME	INTNL	EC	ECREG	EC * ECREG	GOVT	EXMNF	MAJOR	ADSALE	PATSAL	RDSALE	TQM	AWARD	Ln (MVE)
ISO	.440 (.000)	.422 (.000)	-.026 (.444)	.178 (.000)	.060 (.072)	.087 (.010)	-.185 (.000)	-.050 (.132)	.207 (.000)	-.051 (.128)	.369 (.000)	.384 (.000)	.493 (.000)
INTNL		.769 (.000)	-.055 (.104)	.270 (.000)	-.026 (.435)	.060 (.074)	-.195 (.000)	-.018 (.602)	.182 (.000)	-.059 (.078)	.291 (.000)	.326 (.000)	.456 (.000)
EC			-.077 (.021)	.324 (.000)	-.064 (.058)	.015 (.660)	-.224 (.000)	-.012 (.715)	.148 (.000)	-.063 (.060)	.249 (.000)	.295 (.000)	.442 (.000)
ECREG				.481 (.000)	-.007 (.832)	-.158 (.000)	-.030 (.365)	-.028 (.403)	-.023 (.493)	-.036 (.279)	.030 (.439)	-.068 (.044)	-.034 (.309)
EC * ECREG					.015 (.654)	-.066 (.052)	-.062 (.065)	-.014 (.684)	.039 (.240)	-.021 (.532)	.127 (.000)	.088 (.009)	.213 (.000)
GOVT						-.032 (.339)	-.142 (.000)	-.025 (.465)	.072 (.033)	-.012 (.718)	.098 (.003)	.075 (.025)	.020 (.551)
EXMNF							-.042 (.207)	-.015 (.645)	-.035 (.303)	.071 (.033)	.003 (.925)	-.047 (.165)	.141 (.000)
MAJOR								-.050 (.134)	-.100 (.003)	-.008 (.809)	-.097 (.004)	-.093 (.006)	-.194 (.000)
ADSALE									-.007 (.836)	.014 (.675)	-.026 (.433)	-.046 (.175)	-.025 (.451)
PATSAL										-.011 (.742)	.232 (.000)	.244 (.000)	.254 (.000)
RDSALE											-.025 (.458)	-.044 (.187)	-.017 (.618)
TQM												.355 (.000)	.348 (.000)
AWARD													.419 (.000)

[a] All variables are defined in Table 4.

Table 7
Content analysis of press releases related to ISO 9000 by certified firms

Panel A: Proportion of the 94 press releases by 221 ISO 9000 certified firms citing specific reasons for seeking certification or referring to multiple certification sites

	----Reason for seeking ISO 9000 certification----			
	International Sites	Growth Opportunities	Customer Demands	Reference to Multiple Sites
Mean	.203	.245	.053	.330
Median	0	0	0	0
Standard Deviation	.404	.432	.226	.473

Panel B: Proportion of the 65 press releases by 221 ISO 9000 certified firms that refer to a specific certification site and specify reasons for seeking certification or refer to multiple certification sites, by timing of press release date relative to the effective date of the certificate.

	----Reason for seeking ISO 9000 certification----							
	International Sites		Growth Opportunities		Customer Demands		Reference to Multiple Sites	
	Pre-effective date	Post effective date	Pre effective date	Post effective date	Pre effective date	Post effective date	Pre effective date	Post effective date
Mean	.125	0***	.500	.263**	0	.053	.750	.246***
Median	0	0	---	0	0	0	1	0
Standard Deviation	.353	0	.518	.444	0	.225	.462	.434
N	8	57	8	57	8	57	8	57

*,**,***, indicates difference in means is significant at the .10, .05, .01 level in a two-tailed test.

Table 8
Abnormal returns over the seven day period beginning four days prior to the effective date of the first ISO 9000 certificate obtained by the 221 sample firms

Event Day	Mean Abnormal Returns	Median Abnormal Returns	Patell (1976) Z-statistic	Mean Squared Standardized Residual	Rohrbach & Chandra (1989) p-value
-4	.25	.01	0.83	1.06	.180
-3	-.24	-.28	-1.02	1.09*	.055
-2	-.05	-.05	0.20	.98	.790
-1	-.01	-.17	-0.69	1.11*	.040
0	-.29	-.18	-0.93	1.06	.160
1	.21	-.03	0.42	.93	.865
2	-.17	-.09	-0.32	1.05	.210

*, ** signification in a one-tailed test at the p=.05, .01 level, respectively

Table 9
Probit model of ISO 9000 certification as a function of observable firm characteristics (1= certified [N=221], 0= uncertified [N=670])

VARIABLE [a]	PREDICTED SIGN	MODEL 1 COEFFICIENT (χ^2 value) [b]	MODEL 2 COEFFICIENT (χ^2 value) [b]
INTNL	+	.330 (3.70)*	.342 (4.05)**
EC	+	.430 (5.82)**	.477 (8.02)***
ECREG	+	-.223 (1.19)	
EC * ECREG	+	.322 (1.12)	
GOVT	+	.366 (1.21)	
EXMNF	+	1.01 (5.15)**	.991 (5.10)**
MAJOR	-	-.114 (.821)	
ADSALE	-	-8.65 (8.51)***	-8.54 (8.47)***
PATSAL	-	3.12 E-6 (.884)	
RDSALE	-	-.570 (3.45)*	-.587 (3.61)*
TQM	+	.770 (12.4)***	.775 (13.0)***
AWARD	+	.384 (7.51)***	.407 (8.73)***
Ln (MVE)	+	.206 (42.9)***	.217 (50.8)***
Constant		-2.26 (108.6)***	-2.38 (154.2)***

Table 9 (continued)
Probit model of ISO 9000 certification as a function of observable firm characteristics

MODEL FIT		
Log-likelihood statistic	352.4	347.0
p-value of log-likelihood statistic	(.0001)	(.0001)
Likelihood ratio index (pseudo R^2)	.353	.348
CLASSIFICATION ACCURACY		
Percent Concordant	85.5%	85.2%
Total Percent Correctly Classified [c]	79.8%	79.8%
Percent ISO=1 Correctly Classified [c]	76.4%	77.3%

[a] All variables are defined in Table 4.
[b] *, **, *** = p-value of chi-squared test is significant at the 0.10, 0.05, 0.01 level, respectively
[c] A .264 cutoff is used to classify predictions of certification versus non-certification. See Figure 2.

Table 10

Cross-sectional regressions of abnormal returns surrounding ISO 9000 certification (absolute value of *t*-statistics in parentheses [a,b], sample size=221)

Model (1)	Standard Linear Model	$AR = \alpha + X'\beta + \nu$
Model (2)	Linear model corrected for truncation bias	$AR = \alpha + X'\beta + \sigma_\epsilon [n(z) / N(z)] + \nu; \quad z = (\alpha - k + X'\beta)/\sigma_\epsilon$
Model (3)	Linear model corrected for truncation bias and prior anticipation	$AR = [1-N(z')] \{\alpha + X'\beta + \sigma_\epsilon [n(z) / N(z)]\} + \nu$

Independent Variables	Expected Sign	Model (1)	Model (2)	Model (3)
INTNL	+	.003 (.468)	.009 (1.10)	.046 (1.88)**
EC	+	-.005 (.667)	.004 (.415)	.055 (1.57)*
EXMNF	+	.002 (.139)	.020 (.872)	.117 (2.24)**
RDSALE	-	-.025 (.562)	-.044 (.935)	-.131 (1.58)*
ADSALE	-	-.122 (.813)	-.260 (1.39)*	-1.29 (1.98)**
TQM	+	.003 (.581)	.012 (1.35)*	.084 (1.70)**
AWARD	+	-.000 (.081)	.006 (.813)	.045 (1.70)**
Ln (MVE)	+	.001 (.388)	.004 (1.30)*	.027 (1.83)**
Inverse Mills Ratio	+		.027 (1.25)	.179 (2.03)**
Constant		-.004 (.414)	-.067 (1.30)	-.455 (2.01)**
R^2		-.024	-.020	.010

[a] Reported *t*-statistics are calculated using White's heteroscedastic-consistent covariance matrix estimation method.

[b] *, **, *** = *t*-statistic is significant at the 0.10, 0.05, 0.01 level (one-tailed test), respectively

Figure 1

ISO 9000 Series: Scope of Certificates

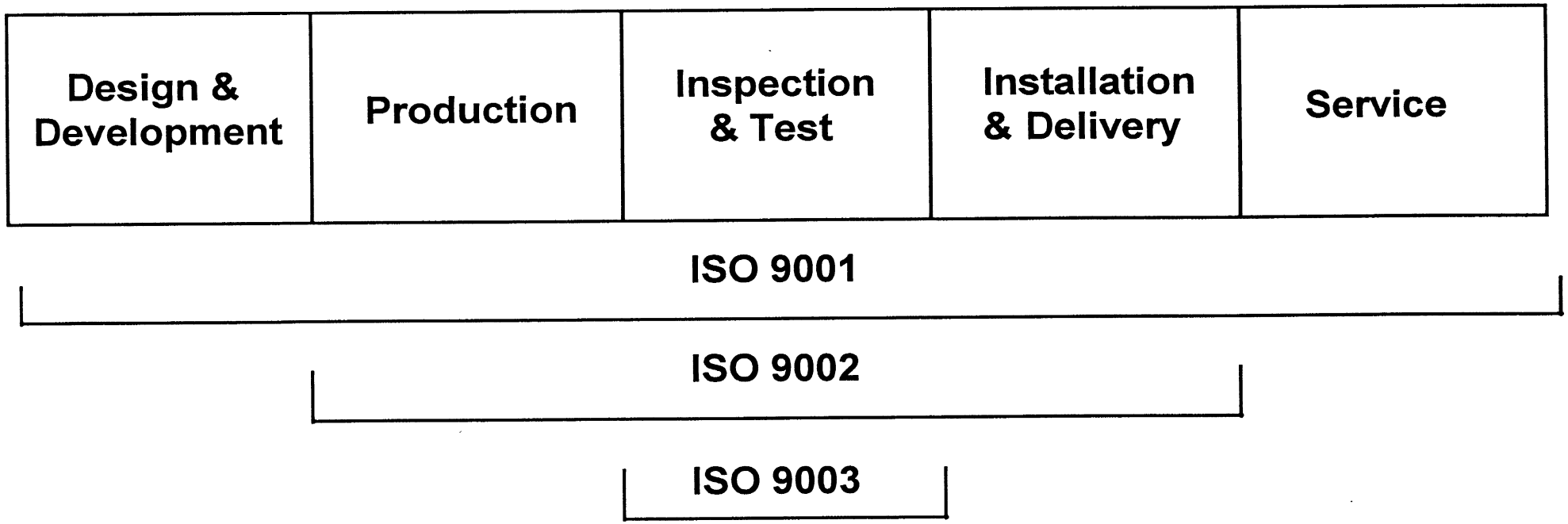


Figure 2
Estimated Probability Density Function
of ISO 9000 Certification

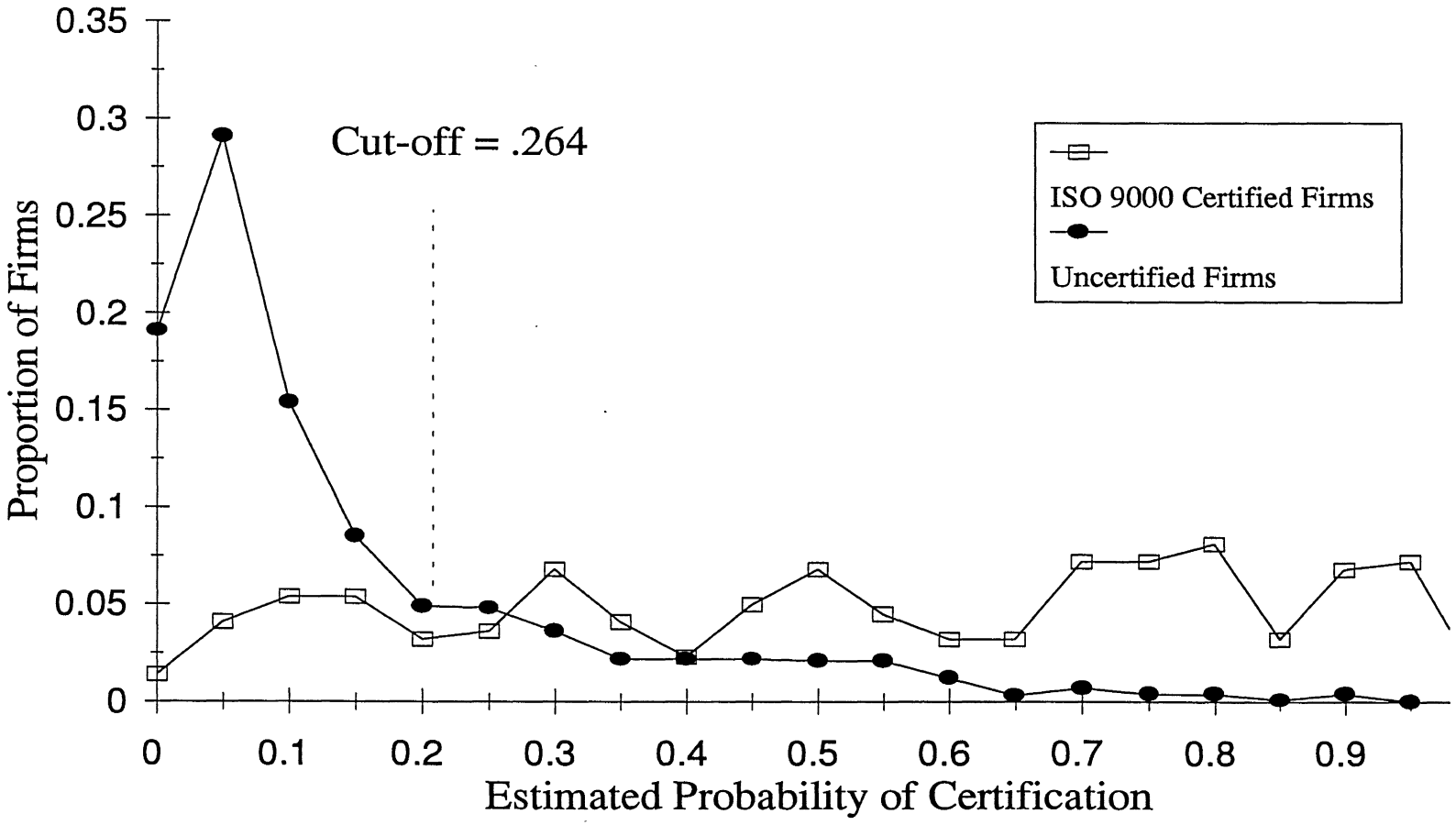
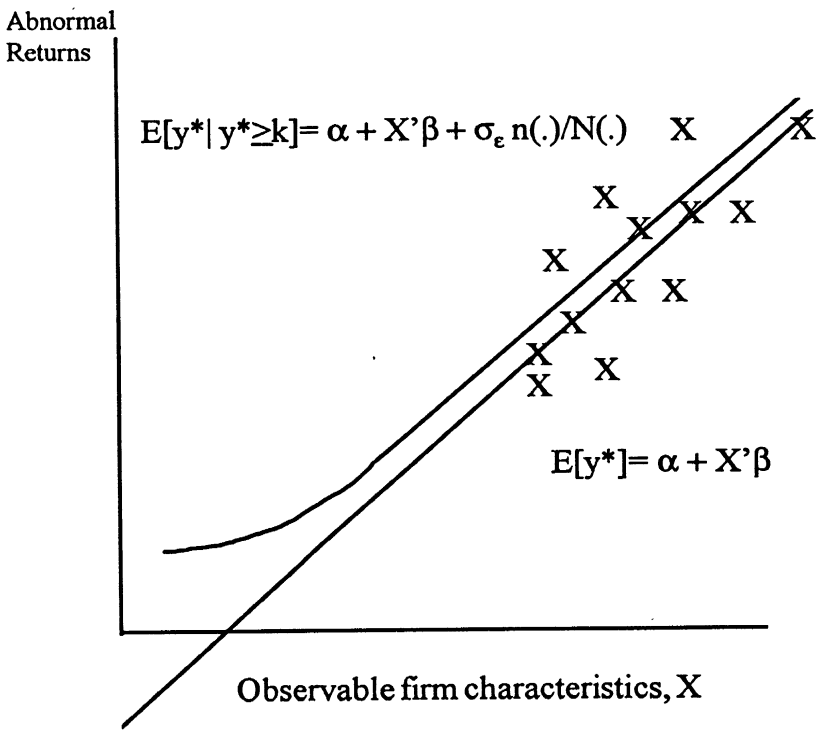


FIGURE 3
The Information Content of ISO 9000 Certification

$y^* = \alpha + X'\beta + \varepsilon$ $\quad$ $y = 1$ if $y^* \geq k$; 0 if $y^* < k$

CASE I: Certification conveys little information

$E[y^*]$ is approximately equal to $E[y^* | y^* \geq k]$



CASE II: Certification conveys information

$E[y^*]$ differs significantly from $E[y^* | y^* \geq k]$