Adoption of costing systems in US hospitals:
An event history analysis 1980–1990

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Abstract

Management accounting research (e.g., Khandwalla, 1972; Ewusi-Mensah, 1981; Gordon and Narayanan, 1984) suggests that organizational characteristics influence the type and use of accounting and information systems within organizations and that as environmental uncertainty increases, decision makers seek more information for planning and control. Within the hospital industry, governmental cost controls through changes in the Medicare reimbursement system and increased competition provide a unique opportunity to analyze hospitals’ reactions to these environmental uncertainties. My study investigates the impact of these factors on the adoption of hospital costing systems over the period 1980–1990. Using event history analysis, I incorporate changes in revenue reimbursement, competition, and organizational characteristics to measure the impact on hospitals’ decisions to utilize more advanced costing control systems. Empirical results suggest that the change in the Medicare reimbursement policy was a driving force in the adoption of costing systems over the 1980s. As revenue constraints increased, the rate of costing system adoption also increased. Further, competition had a smaller, but positive, impact on costing system adoption. Organizational characteristics including ownership, size, and whether the hospitals was a part of a multi-hospital system were also significant in impacting costing system adoption. However, despite the significant change in reimbursement policy, only 37.8% of responding hospitals had begun to use a costing system during the 1980s. © 2000 Elsevier Science Ltd. All rights reserved.
1. Introduction

Recent years have brought increased focus on the cost of health care in the United States. As a result of this focus, hospitals are increasingly interested in understanding and controlling their costs of providing health care. Prior research on the state of hospital accounting information systems has investigated the impact of critical variables (e.g., competition, ownership) in isolation (see, for example, Preston et al., 1988; Gilman, 1985; Counte and Glandon, 1988; Eastaugh, 1987). However, previous management accounting research in non-hospital settings provides insight for further analysis. Specifically, the relationship between the design and use of cost accounting systems and the environment and other organizational characteristics can be examined in the hospital industry. For example, prior research (e.g., Ewusi-Mensah, 1981, p. 315; Gordon and Narayanan, 1984, p. 42) finds that as environmental uncertainty increases (e.g., less predictable profits resulting from changes in the reimbursement system), decision makers seek to minimize the uncertainty through additional information for planning and control. Further, the use of management controls (such as cost accounting systems) increases as competition increases (Khandwalla, 1972, p. 282).

My study examines hospitals’ behavioral responses to changes in their environment, namely, changes in revenue reimbursement methods and increased competition, through empirical examination of the adoption of costing systems in a longitudinal study. To date, the hospital literature has not assessed changes in accounting information systems over time as a function of changes in revenue reimbursement systems. The 1980–1990 time frame chosen for the study is critical as it includes a period of major change in Medicare’s hospital reimbursement methodology. This provides a unique opportunity to examine a behavioral response, adoption of a costing system, to a measurable change in the environment.

My study fills a void by extending the research on the relationship between accounting system change and environmental uncertainty in the hospital setting in two ways. First, while measures of organizational characteristics of other types of businesses have been investigated in prior accounting studies (e.g., Gordon and Narayanan, 1984, p. 37), little published research has empirically examined the relationship between environmental variables and costing information systems in the hospital industry. ¹ Further, the majority of studies examine variables in isolation. My study provides a contribution to research on the development of hospital management accounting systems by

¹ In a small sample study, Bray et al. (1994) examined 10 matched pairs of winner and loser hospitals under the PPS and found (p. 49) that loser hospitals had higher costs per case compared with winners and in additional had weaker financial control and management systems.
investigating measures of the change in reimbursement methodology and competition (environmental variables) as well as organizational characteristics in a single model which examines the significance of each variable while controlling for the others.

Second, data over a period of 10 years are included in the analysis through the use of event history methodology. Prior empirical research on change and the adoption of innovations (e.g., Counte and Glandon, 1988, p. 375) is often based on cross-sectional methodologies and analysis. Cross-sectional analysis is appropriate when the use of a new technique in the population is in equilibrium (Tuma et al., 1979, pp. 845–846). However, the number of hospitals using more sophisticated and relatively new costing techniques may not have been stable over the 1980s. It is more likely that the use of new costing techniques was increasing over the 1980s. A more appropriate analysis which includes data collected over time utilizes a dynamic event history model. This model explicitly incorporates time-varying independent variables as well as dependent variable measures which include information on costing system adoption and the time of adoption.

The empirical results show that only 37.8% of sampled hospitals responded to the significant changes in their environment by adopting a costing system that collects procedure level costs. Further, for the 37.8% that began to use a costing system, the change in Medicare’s reimbursement methodology appears to be a driving force in that decision. Specifically, as the new reimbursement system was phased in during the 1980s, the rate of costing system adoption increased. Competition had a positive but smaller impact on adoption of costing systems. Organizational characteristics including ownership, size, and whether the hospital was a part of a multi-hospital system were also significant in costing system adoption.

Section 2 provides a brief discussion of the hospital industry. Section 3 discusses related research and develops the hypotheses. Sections 4 and 5 present the methodology and results, and Section 6 offers a discussion and summary.

2. The hospital industry

An understanding of the history of hospital regulation and the 1982 Medicare reimbursement method is key to understanding the increased financial risk hospitals faced in the mid-1980s. In the 1970s and early 1980s, hospitals were reimbursed retrospectively based on charges for specific services rendered, often referred to as fee-for-service (Guterman and Dobson, 1986, p. 97). Under this reimbursement methodology, little incentive existed to control or reduce costs for services that were directly reimbursed (e.g., laboratory, radiology, pharmacy, or nursing services). Rather, efforts to control costs were more likely
focused on services that did not provide a chargeable reimbursement (e.g., maintenance, general housekeeping).

To control rising health care costs in the 1970s, some states utilized revenue or rate regulation that governed allowable revenue increases through budget or cost reviews (Sloan, 1982, p. 196). In addition, the federal and state governments attempted to contain medical costs by limiting the number of hospital beds and decreasing duplication of medical technology through the use of Certificate of Need laws (Sloan, 1981, pp. 479–480; Cook et al., 1983, pp. 193–194). However, some research suggests these early attempts at controlling overall health care costs were ineffective, and the cost of health care continued to rise (e.g., Sloan, 1981, p. 480; Cleverley, 1986, p. 142). The 1980s brought forth a new reimbursement methodology whereby reimbursements to hospitals were not determined retrospectively based on costs, but were determined prospectively based on a pre-determined price. With the passage of Public Law 98-21 (part of the Tax Equity and Fiscal Responsibility Act (TEFRA), 1982), the federal government made the decision to control better the reimbursements of its Medicare program. This law changed the Medicare reimbursement program from a retrospective to a prospective payment system (PPS), a fixed price reimbursement system (Federal Register, 1983, p. 38754). Medicare’s PPS gave hospitals direct incentives to manage and control costs because fixed payments (reimbursements) were set to cover all services for defined diagnoses.

Although effective 1 October 1983, the Medicare PPS was phased in over five years, giving hospitals time to adjust to the reimbursement changes. The PPS reimbursements were based on Diagnosis Related Groups (DRGs) (Federal Register, 1983, pp. 39760–39761). Each DRG treated was reimbursed with a fixed payment intended to cover a package of services provided to a patient in terms of such items as medical treatment, nursing care, or laboratory tests from admission to discharge. The change to the PPS resulted in more uncertainty and financial risk for hospitals since Medicare reimbursements were predetermined regardless of the number and type of services (and costs) incurred. With hospital revenues limited by the change in the reimbursement method, contemporary hospital literature suggested that detailed cost accounting information was necessary for hospitals to understand and

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2 Prior to the prospective payment system, a retrospective payment method compensated hospitals for their full costs. This system required less utilization review and cost management effort on the part of hospitals since additional services provided to Medicare patients typically generated additional revenues. Revenues were determined retrospectively – after service had been rendered (Guterman and Dobson, 1986, p. 97).

3 Diagnosis Related Groups (DRGs) consist of 467 categories originally developed in the late 1960s to mid 1970s at Yale University Center for Health Studies and Yale New Haven Hospital. The DRGs are a classification scheme based on type of illness, procedures for treatment, and age (Vladek, 1984, p. 578).
manage costs. Prior research assessing the status of costing systems in hospitals in the 1980s indicates, however, that many hospitals did not have the necessary costing information.

3. Related research and hypotheses

Until the 1980s, the majority of hospitals did not utilize cost management systems capable of providing costs at the procedure or treatment level (Counte and Glandon, 1988, pp. 372–373; Nathanson, 1984, p. 122). Hospitals were more likely to choose accounting information systems that facilitated the preparing of the Medicare Cost Report and financial statements. Johnson and Kaplan (1987) note that the costliness of dual accounting systems (financial versus managerial based information) and the focus on financial accounting slowed the adoption of innovative management accounting information systems. Also management accounting information has been slow to be applied to firms in the service industry due to the “obvious differences in the nature and measurability of the output of service firms” (Lowry, 1990, p. 167).

The 1983 change in the Medicare reimbursement system, however, had a significant impact on hospital revenues and overall profitability. As Medicare patient revenues make up approximately 40% of total hospital revenues, the resulting effect on revenues called for increased information and control of

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4 From 1983 to 1990, the health care financial literature contained many articles prescribing methods for gathering in-depth cost information for evaluation of hospital profitability under the PPS. These articles included recommendations that hospitals develop data based on micro-costed standards or relative value units. These methods provide data to calculate costs by DRGs, instead of the traditional charge item basis, which then allows for direct comparison of DRG costs to Medicare's pre-determined DRG reimbursements (e.g., Cleverley, 1984; Burik and Duvall, 1985a; Baptist et al., 1987; Kis and Bodenger, 1989).

5 A 1988 survey by Touche Ross (1988, p. 14) indicated that, while 48% of hospitals stated in 1986 that they planned to implement product line management, only 19% had done so by 1988. Further, 24% of hospitals in Preston et al.’s (1988, p. 16) survey had automated cost accounting systems capable of identifying costs generated in treating particular patients. Gilman (1985) discusses results of a survey conducted by the Healthcare Financial Management Association (HFMA) and the Deloitte Haskins and Sells accounting firm. The survey found 54% of responding hospitals had implemented a system capable of capturing costs by procedure of DRG (Gilman, 1985, p. 86). Counte and Glandon’s (1988, p. 376) study of hospitals in the Chicago area showed that only 43% had recently acquired a cost-accounting system. Finally, results of a study of 54 matched pair hospitals (Eastaugh, 1987, pp. 51–52) suggested that 75% of PPS participating hospitals in 1983 had acquired a higher level cost accounting system by 1986.

6 This report is submitted to the Health Care Financing Administration (HCFA) and contains financial and utilization information related to reimbursable expenditures incurred for treatment of Medicare patients (Littel and Lloyd, 1989, p. 9).
hospital costs (Vladeck, 1984, p. 576). As discussed below, prior research in management accounting information systems and health care management suggests that costing system adoption may be influenced by (1) exogenous factors, namely, the environment, and (2) endogenous factors such as characteristics of organizations themselves. The factors are labeled as environmental and organizational variables for discussion.

3.1. Environmental variables

Ewusi-Mensah’s (1981, p. 306) study of the environment and organizations defines the environment as controllable, partially controllable or uncontrollable. He argues (1981, pp. 309–310) that organizational information systems should be different depending on the particular environmental state. Further, he proposes (1981, p. 310) that an information system plays an important role in controllable and partially controllable environments, providing information to reduce or control environmental uncertainties. Anderson (1995, pp. 41–42) also found that environmental factors affect the successful implementation of the management accounting technique activity-based costing in a case study of General Motors Corporation (GMC). She states (1995, p. 42) that increased competition and environmental uncertainties were important factors in cost system innovations for the organization.

My study examines the effect of the environment of hospital behavior first through a measure of the external reimbursement constraint faced by hospitals. Cook et al. (1983, pp. 197–201) suggest that as regulations, such as the revenue and rate regulation of the 1970s and early 1980s, become more intense and place greater financial constraints on hospital revenues, hospitals may make changes at the institution level (e.g., influence the regulation process; merge with another hospital), the managerial level (e.g., change the management decision process; increase budgetary and accounting functions to deal with the regulation), or the technical level (e.g., develop new services in unregulated areas; change clinical practices to reduce costs). My study measures the impact of increased revenue constraints at the managerial level, the adoption of cost management systems. The change in the reimbursement system through PPS created uncertainty about future revenues for hospitals. Two measures of the change in revenue reimbursements include (1) the percentage of the total PPS reimbursement that was based on the federal rate from 1980 through 1990, and (2) whether and for which years the hospital was exempt from the PPS from 1980 through 1990.

The first measure captures the impact of the PPS reimbursement methodology on hospital cost system adoption. Before describing the measure, the system of reimbursement is briefly discussed. Reimbursements for Medicare patients are prospectively determined and are based on a DRG weight times the hospital’s reimbursement rate (Vladeck, 1984, p. 581). For example, assume
During the phase-in of the PPS, hospitals were reimbursed by Medicare based on a combination of their hospital-specific and federal rates times the relevant DRG weights (Vladeck, 1984, pp. 582–583). The federal rate was, in part, based on a national rate and initially captured the average rate for all hospitals (Vladeck, 1984, p. 581). The hospital-specific rate was based on each hospital’s own previous or historical costs (Potetz and Buchberger, 1985, p. 67). The federal and hospital specific percentages multiplied by the federal and hospital specific rates determined the hospitals’ reimbursement rates for the year (Federal Register, 1983, p. 39824). The federal and hospital specific percentages varied over the PPS’s five year phase-in period (Federal Register 1983, p. 39824). For my study’s observation period, from 1980 to 1983, the federal rate made up 0% of the reimbursement, so hospital-specific rates guided 100% of reimbursement (Federal Register, 1983, p. 39824).

During the phase-in period of the PPS, the federal rate made up greater percentages of the total Medicare reimbursement formula and the hospital-specific portion declined. Specifically, in 1984, 25% of total reimbursement was based on the federal rate, 50% for 1985, 55% for 1986, 75% for 1987, and 100% for 1988–1990 (Russell, 1989, p. 15). During the phase-in period, hospitals did not know, a priori, the final effect of this new reimbursement on revenues. Only after the phase-in period, post-1987, were the implications of PPS becoming clear (Smith et al., 1993, p. 152). My study uses the increasing federal rate percentage as a measure of the increasing constraint on hospital revenues.

The second measure capturing the change in reimbursement methods controls for hospitals in states that were exempt from the PPS. To be exempt, a state has to agree that all payers (Medicare and all other insurance and third party payers) will be regulated and that Medicare outlays to hospitals within the state will be less than or equal to what the expenditures would have been in the absence of the PPS (Federal Register 1983, p. 39824). Exempt states were not subject to the annual update of the federal payment rates.

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7 During the early years of the PPS, some hospitals actually made more money than under the retrospective system (Guterman and Dobson, 1986, p. 146; Hadley et al., 1989, p. 363). For those hospitals which were already efficient and those who had a relatively low hospital specific rate (compared to the national average), the national rate portion had the potential of increasing their total hospital reimbursement rate and providing greater revenues (Potetz and Buchberger, 1985, p. 68). However, as the national rate was phased-in, Medicare limited the yearly increase in the national rate (Potetz and Buchberger 1985, pp. 64, 67), and the incentive to control the costs associated with a pre-determined reimbursement became increasingly critical for all hospitals. (See Russell, 1989, pp. 14–16 for a discussion of the annual update of the federal payment rates.)
have been under the federal payment mechanism, the PPS (Rosko, 1989, p. 48). Hospitals in states exempt from the PPS are essentially under greater revenue control as there is less ability to cost shift across patients since all payers are governed by the same reimbursement constraints. In contrast, Medicare PPS hospitals can potentially make up lost revenues, in the aggregate, by shifting costs to higher payers such as insurance companies which may reimburse based on retrospectively determined charges (Eldenburg and Soderstrom, 1996, pp. 26–27). The measure for hospitals exempt from PPS and under greater revenue constraints is a dummy variable coded as 1 for those exempt hospitals.

In addition to measures of changes in reimbursement methods, the second environmental factor considered is competition in the hospital industry. Khandwalla (1972, p. 280) examined competition and the use of management controls and found a positive association between competition and the use of nine management controls. That is, as competition increases, the expected benefits from management controls increase (Khandwalla, 1972, p. 280). Gordon and Narayanan (1984, p. 41) also found a positive relationship between characteristics of information systems and a measure called perceived environmental uncertainty (PEU). Their (1984, p. 38) measure of PEU is based on seven questions which focus on competition for customers, products, technologies, and others. Results show that as PEU increases, firms tend to seek additional information for planning (1984, p. 42). For example, as competition intensifies, decision makers consider external, non-financial, and ex ante information to be increasingly important (Gordon and Narayanan, 1984, p. 42). Gordon and Narayanan (1984, p. 42) suggest, therefore, that consideration of the (competitive) environment is critical in designing effective accounting information systems. As noted earlier, Anderson’s (1995, pp. 41–42) case study of the implementation of Activity-Based Costing (ABC) at GMC also found that ABC (one management accounting technique) was used primarily in GMC plants where competition created pressure to reduce product costs. My study measures competition as the number of short-term, general medical and surgical hospitals within a 25 mile radius of the sample hospital.

8 Four states have experimented with all-payer systems. All-payer systems utilize a prospective payment system based on defined DRGs or case-mix classification scheme, but the regulatory authority (the state) is expanded to include all payers. In addition, each payer is made responsible for an equitable share of uncompensated care. New York and Massachusetts operated under an all-payer system from 1983 until 1985 and so were exempt from the PPS during those years (Thorpe, 1987, p. 397). New Jersey employed an all-payer system from 1980 until January 1989 while Maryland’s all-payer system, originating in 1977, is still in effect (Thorpe, 1987, p. 397; Zuckerman, 1987, pp. 324–343; Rosko, 1989, p. 48).
Research in the hospital industry frequently examines whether revenue constraints and competition are effective in cost containment and quality.\(^9\) My study, however, explores whether changes in reimbursement methods (revenue constraints) and competition influence hospital behavior, that is, management’s adoption of more sophisticated costing techniques. In sum, as revenues are reduced through competition or constrained through reimbursement policies over time, hospitals face decreasing profits. To maximize profits, hospitals therefore may be likely to adopt a cost control system aimed at cost minimization.\(^{10}\) Further, following Khandwalla (1972, p. 280), it is suggested that hospitals with more competition are more likely to adopt a costing system for additional management planning and control. However, since hospitals operate in dynamic, competitive, and regulated environments of different intensities, it is not expected that all hospitals have the same probability or likelihood of adopting costing systems. Hypotheses for the change in reimbursement methods and competition variables are stated in the alternative below.

H1\(_a\): Hospitals are more likely to adopt costing systems as hospital reimbursement methods increasingly constrain revenues.

H2\(_a\): Hospitals in more competitive environments are more likely to adopt costing systems than hospitals in less competitive environments.

\(^9\) Research on the effect of revenue and rate setting constraints on hospital costs shows conflicting results. For example, Schramm et al. (1986, p. 25) found that hospitals in states with rate setting had annual cost increases 3–4% below cost increases in other nonregulated hospitals. In contrast, Cleverley (1986, p. 142) reported that operating margin, return on assets, and current ratio were lower for rate regulated hospitals than non-regulated which suggests that decreased revenues are not accompanied by a relative decrease in costs. An earlier study by Sloan (1981, p. 487) found that two rate regulatory programs of the 1970s had some positive impact on slowing the rate of increase of hospital costs. Finally, research investigating the impact of the PPS on hospital costs shows reduced costs in the early years of the PPS ( Guterman and Dobson, 1986, p. 113; Feder et al., 1987, p. 869) suggesting that hospitals were reacting by using cost cutting measures.

Research on competition reports differing results due to time period and type of service. In general, prior to the 1982 PPS, increased hospital competition was associated with higher costs, lower occupancy rates, and more service offerings (see Nguyen and Derrick, 1994, pp. 37–39 for discussion). Empirical research examining data during and after 1982 (e.g., Zwanziger and Melnick, 1988, pp. 313–314) found that as competition increased, hospitals in more competitive areas had lower rates of increase in costs as compared to hospitals in less competitive areas. Fournier and Mitchell (1992, p. 632) found that increases in competition were associated with decreased costs for some service (e.g., obstetrical services), but increased costs for others (e.g., radiation therapy). Robinson et al. (1988, p. 699) found that as competition increased, length of stay for surgical patients increased, implying higher costs.

\(^{10}\) Union Pacific Railroad is a specific example of a company that responded to regulation and deregulation by redesigning their cost systems (see Cooper, 1985).
3.2. Organizational variables

Organizational factors are also posited to have an impact on costing system adoption. Organizational factors include form of ownership, multi-hospital system membership, area location, bed size, and occupancy rates. First, studies in the health care literature reveal differences in services offered, hospital expenditures, budgeting techniques, financial performance and productivity due to ownership. The three ownership groups identified in the present study include not-for-profit, investor-owned and government (non-federal) hospitals. Although all hospitals may benefit from costing techniques for control and cost management, the costs of implementing a costing system may not outweigh the benefits. Not-for-profit hospitals serving a broad range of patients may benefit from cost information that would allow them to evaluate and control costs of Medicare patient services as well as influence physician behavior and practice patterns.

In contrast, investor-owned hospitals driven by the profit motive may choose to offer more marketable and profitable services (referred to as cream-skimming) and/or may reduce the expense of charity care by simply denying access to their facilities for the uninsured. If such marketing is successful and results in increased revenues and occupancy rates, an investor-owned hospital may have comparatively fewer financial constraints and, therefore, have less incentive to change costing systems. On the other hand, if top level management perceives greater uncertainty in future revenues, investor-owned hospitals may well seek to control costs and invest in costing systems. Further, the demand for profit maximization may incite investor-owned hospitals to adopt new management techniques, such as costing systems, to meet their profit goals. A recent finding by Carter et al. (1997, p. 75) suggests that for-profit hospitals can be efficient in containing expenses. However, results from Woolhandler and Himmelstein (1997, p. 770) suggest that for-profit hospitals are less efficient than nonprofit and government hospitals because they spend more of their budgets on administration.

Finally, it may be argued that government hospitals, which comparatively provide a greater percentage of indigent care (US Congressional Budget Office, 1993, p. 9), would be less likely to have available resources to commit to the development of cost information systems. Further, it may be more likely that any additional funds obtained through state and government grants

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11 See, for example, Coyne (1982, p. 320), Levitz and Brooke (1985, pp. 326–333), Shortell et al. (1986, p. 101), and Friedman and Shortell (1988, pp. 257–263).

12 Federal hospitals such as Veterans Administration (VA) hospitals are excluded since they operate in a totally different, non-competitive structure where reimbursements are not based on DRGs.
would be directed toward patient care services. In fact, the 1988 Touche Ross survey of hospitals found that a majority of government hospitals stated they needed state-of-the-art medical equipment, yet, given their financial condition, were unlikely to be able to meet this need (Touche Ross, 1998, p. 23). Thus, of the three ownership types defined herein, government hospitals may be least likely to invest in new costing information systems as noted in the hypothesis.

H3a: Not-for-profit hospitals and investor-owned hospitals are more likely to adopt a costing system than non-federal government-owned hospitals.

Multi-hospital system membership may also influence adoption of new costing methodologies. Levitz and Brooke (1985, pp. 331–332) show that system member hospitals are more effective price setters and more profitable than independent hospitals. The relative profitability may provide additional resources to invest in costing systems. Additionally, since multi-hospital system members can potentially share in the costs and benefits of adopting one system, they may be better able to afford a change in costing system (Nathanson, 1984, p. 128). The hypothesis for multi-system member hospitals is stated below.

H4a: Multi-hospital system members are more likely to adopt a costing system than independent hospitals.

Prior research also suggests that hospital size is related to costing system adoption. Blau (1973, p. 29) and Baldridge and Burnham (1975, pp. 55–56, 172) suggest that size is an indicator of available resources and can also be considered as a facilitator of organizational innovation and change. Prior health care studies include number of hospital beds as a measure of size and find that as number of beds increases the likelihood of costing system adoption is greater (Counte and Glandon, 1988, p. 379; Gilman, 1985, p. 86; Lawrence, 1989, p. 107). The hypothesis follows.

H5a: Hospitals are more likely to adopt costing systems as hospital size increases.

The next organizational variable considered is area location (urban, rural, or inner-city). Counte and Glandon (1988, pp. 375, 379) found no difference in location (city versus outlying and suburban hospitals) for adopters versus non-adopters of cost accounting systems. However, I argue that since inner-city hospitals are relatively more likely to have a greater percentage of indigent patients, it is likely that resources for investments in more sophisticated costing systems are limited. Therefore, inner-city hospitals would be less likely than urban hospitals, for example, to adopt or change accounting systems. Rural hospitals may also be less likely than urban hospitals to adopt sophisticated systems. Preston et al.‘s (1988, pp. 12–13) study based on a telephone survey of US hospitals reported that the majority of hospitals with neither a cost accounting system nor any future plans to develop one were predominately small rural hospitals. Since rural hospitals are typically smaller (American Hospital Association, 1990–1991, p. xxxii), a sophisticated costing system may not be
worth the extra cost in developing, implementing, and managing such a system. The hypothesis follows.

H6a: Urban hospitals are more likely to adopt a costing system than rural and inner-city hospitals.

Finally, the hospital’s occupancy rate has potential impact on costing system adoption. Guterman and Dobson (1986, p. 103) report that during the early years of the PPS, both admissions and length of stay decreased and led to occupancy rates that were lower than rates reported prior to the PPS. Since revenues derive from the number of beds actually used at any given time, an increasing occupancy rate may indicate financial risk for the hospital. As the occupancy rate rises, the increased patient flow and associated revenues may result in greater ability to cover fixed costs, e.g., software development for sophisticated costing systems. Further, higher occupancy rates may result in more discretionary income to invest initially in more costly systems. The hypothesis follows.

H7a: Hospitals with higher occupancy rates are more likely to adopt costing systems.

4. Methodology and research design

4.1. Selection of sample hospitals

A random sample of 1662 hospitals was selected from the 5,583 non-federal, acute care, short-term, general medical and surgical hospitals listed in the 1989 American Hospital Association’s (1989) Guide to the Health Care Field with four exceptions. Excluded from the sample were hospitals not in operation for at least three years prior to 1983, hospitals with fewer than 50 beds, hospitals not accredited by the Joint Commission on Accreditation of Hospitals, and hospitals outside the contiguous United States.

4.2. Data sources for dependent and independent variable measurements

Responses from a mail questionnaire directed to the hospital chief financial officers (CFOs) and publicly available information provided data from 1980 to 1990. An overall mail questionnaire responses rate of 35.4% (589 usable questionnaire responses out of 1662) was achieved.  

13 The first wave of 1662 questionnaires was followed one week later with a reminder post-card. A second wave of questionnaires was sent three weeks after the first questionnaires was posted. From the first wave, 401 questionnaires were returned. The second wave provided an additional 227 questionnaires. Due to missing data, only 589 usable questionnaire are included in the analysis.
The dependent variable in my study is a dichotomous variable measuring whether the hospital has a costing system which can determine or identify costs at the procedure level and then aggregate and analyze cost information by DRGs. In the mail survey, hospital CFOs indicated whether their hospitals had adopted or approved adoption of a costing system, the date of adoption, and also reported which of four costing methods were used in various hospital departments. The four costing methods include ratio of costs to charges (RCCs), actual costs, relative value units (RVUs), and standard costs.\footnote{14}

Measurement of the independent variables comes from the mail questionnaire, the American Hospital Association (AHA) and AHA publications.\footnote{15} Table 1 summarizes and defines the coding information for the independent variables.

\footnote{14} The first and most unsophisticated method for costing procedures is ratio of costs to charges (RCCs) where total costs in a department are compared to total department gross revenues (see Baptist et al., 1987, pp. 32–33). The resulting ratio is multiplied by the amount charged for each service to imply a unit cost. Under this method, costs per procedure or service are based on total department costs which may result in imprecise procedure or service costs.

Actual costs trace specific costs at the treatment level. Material and labor costs of a procedure are determined as the service is being performed and overhead is applied at the time of service.

As suggested in the health care literature (see, e.g., Baptist et al., 1987, p. 48; Burik and Duvall, 1985b, pp. 60–61; Bennett, 1985, pp. 46–47), relative value units (RVUs) and standard costs are two methods of calculating costs. RVUs and standard costs measure component costs (i.e., material, labor, and overhead) on a procedure level basis by applying RVUs or standards to actual volumes. For the RVU method, RVUs are used to measure the relative amount of resources consumed by each procedure. Costs are allocated to major components (materials, labor, and departmental overhead), and RVUs are developed that give a weight to each cost component per procedure. The RVUs are then applied to the actual costs of the major components to determine the cost of each procedure (see, e.g., Baptist et al., 1987, p. 48).

The standard cost collection method is similar to RVUs in that it determines the dollar amount of resources required by a procedure for each cost component. Instead of a relative weight of each cost component for every procedure, industry standards, hospital specific time and materials studies or estimates are used to develop a standard for each cost component. These standards are an expectation of the resources needed for a procedure or service (see, e.g., Burik and Duvall, 1985b, pp. 60,61; Bennett, 1985, pp. 46,47).

\footnote{15} Independent variables including number of beds, occupancy rate and hospital ownership were obtained from the data published in AHA Guide to the Health Care Field (1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990) for each year 1980–1990. Questions concerning area location and system membership were included in the mail questionnaire. System membership was further verified by the AHA Guide to the Health Care Field (1980–1990). The competition measure was calculated as the natural log of the total number of hospitals within a 25 mile radius of the responding hospital. The Hospital Market Atlas (1983, 1987, 1989) provided state maps which noted hospitals and reported hospital names, addresses, type, and other information. The responding hospital was identified on the state map, and the number of hospitals in a 25 mile radius were counted and recorded.
4.3. Event history analysis

The event history method utilizes dynamic models which explicitly incorporate occurrence and time of an event (Tuma et al., 1979, pp. 825–827). These statistical models were developed in engineering and the biomedical sciences (Kiefer, 1988, p. 647). The models are used to describe survival rates for medical research and useful lives of various machines (Kiefer, 1988, p. 647). The event history method is also used in economic and sociological research examining such issues as duration of unemployment, the rate of adoption of

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| PPS                        | For hospitals participating in Medicare’s PPS, the percentage of Medicare reimbursement rate based on the federal rate is\(^a\)
|                            | 1980–83 = 0.00, 1984 = 0.25, 1985 = 0.05                                            |
|                            | For hospitals in states exempt from Medicare PPS, the rate is 0.00 for the exempt years |
| PPS exempt                 | 1 = hospitals in states exempt from the PPS                                          |
|                            | 0 = otherwise                                                                       |
| Competition                | Natural log of the total number of short-term, general medical and surgical hospitals in a 25 mile radius\(^b\) |
| Organizational factors     |                                                                                     |
| Ownership                  |                                                                                     |
| Investor-owned             | 1 = investor-owned hospitals, 0 = otherwise                                         |
| Not-for-profit (NFP)       | 1 = for NFP hospitals, 0 = otherwise                                                |
|                            | Since there are three categories of hospital ownership                               |
|                            | (investor-owned, NFP, and government), \(N - 1\) dummy variables were constructed to avoid the problem of multi-collinearity (Pindyck and Rubinfeld, 1981, pp. 112–113) |
| Multi-hospital system      | 1 = hospitals in a multi-hospital system, 0 = otherwise                              |
| Hospital size              | Natural log of total number of beds\(^b\)                                            |
| Rural                      | 1 = rural, 0 = otherwise                                                            |
| Inner-city                 | 1 = inner-city, 0 = otherwise                                                       |
|                            | Since there are three categories of area location (rural, inner-city, and urban), \(N - 1\) dummy variables were constructed to avoid the problem of multi-collinearity (Pindyck and Rubinfeld 1981, pp. 112–113) |
| Occupancy rate             | Ratio of average daily census to the average number of beds times 100              |

\(^a\) Federal Register, 1985, p. 35713.
\(^b\) The logarithmic transformation allows for a more normally distributed variable and reduces the variance in the distribution.
new technologies, and firm survival (see, for example, Amburgey and Miner, 1992; Amburgey et al., 1993).

Previous research in costing system adoption utilizes cross-sectional analysis which can supply useful information about the adoption of costing systems if the situation is one where the process has been operating a comparatively long time so that the distribution of the population across alternatives (e.g., adopt or not-adopt) is in equilibrium (Carroll, 1983, p. 425; Tuma et al., 1979, pp. 845–848). Using cross-sectional models, prior management accounting studies (Khandwalla, 1972; Ewusi-Mensah, 1981; Gordon and Narayanan, 1984) investigated the impact environmental and organizational variables have on cost management systems and assumes the process of adoption of these systems is in equilibrium. However, the adoption of costing techniques may not be in equilibrium for the hospital industry during 1980–1990. The five year phase-in period of the PPS from 1983 to 1987 gave hospitals the opportunity to ease into this new stage of fiscal constraint. Hospitals may have chosen to wait for the full hospital-specific impact of the PPS (where their hospital rate was 100% determined by the federal rate) before changes in information systems proceeded. Also, decisions for sophisticated costing systems involve research of available systems, evaluation, adoption, purchase and implementation, all of which can take an extensive amount of time and money. Cross-sectional analysis, based on a snap-shot in time, therefore, may not identify critical and significant factors in the decision to adopt a costing system.

In contrast, event history analysis takes into account both the occurrence and the timing of the event (e.g., adoption of a costing system) allowing for an investigation of the adoption process (Tuma et al., 1979, pp. 825–827; Carroll, 1983, p. 426). The central concept in the statistical models is the hazard rate (Carroll, 1983, p. 429; Allison, 1984, p. 16). This rate is based on the conditional probability of a hospital adopting a costing system given that hospital’s has not yet adopted such a system (see Tuma et al., 1979, pp. 827–828). In other words, the models account for whether or not the hospital is still at risk of adopting. Cross-sectional analysis includes non-adopters at the end of the observation period as hospitals which will never adopt a costing system (see Carroll, 1983, p. 437; Allison, 1984, pp. 11–13). Event history analysis, however, includes these hospitals as censored observations – hospitals that have not yet adopted a costing system by the end of the defined observation period (1990), but for which there is some probability of adopting a system.

In addition to explicitly allowing for censored observations, event history analysis has another important advantage over cross-sectional analysis (Allison, 1984, p. 36). The statistical model used for analysis allows for time-varying explanatory variables (Allison, 1984, p. 36). The changing independent variables include measures of revenue constraints, competition, system membership, occupancy rate and hospital size. The event history models are presented and discussed in Appendix A.
5. Results

Of the 589 usable responses from the mail survey, only 37.8% of hospitals indicated they had adopted or approved adoption of a costing system by 1990. This is surprising given the amount of information that I found appearing in the health care practitioner journals in the 1980s advocating the importance of procedural level costs in effective cost control. Table 2 reports the number of sample hospitals that adopted costing systems from 1980 to 1990. For example, in the period 1984 to 1985, 38 hospitals adopted a costing system, from 1986 to 1987, 60 hospitals adopted a costing system, and from 1988 to 1990, over 100 additional hospitals adopted a costing system. As can be seen, the number of adopters increases dramatically over the defined periods, but, in total, only 222 of the 589 hospitals adopted a costing system.

Table 3 describes the independent variables for the sample hospitals. In the sample, only 18 hospitals operated in PPS exempt states. Note, however, that 77.8% of those 18 hospitals adopted costing systems. This is a statistically significant greater percentage than found for hospitals in PPS states where only 36.4% adopted costing systems. 16 This result lends support to Hypothesis 1:

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16 A chi-square test of hospitals which adopted/not adopted costing systems versus hospitals in PPS exempt states/PPS states reveals a chi-square statistic of 12.70 and a probability of 0.001.
greater revenue constraint is associated with increased costing system adoption. Table 3 also reports the number of competing hospitals as defined by five categories. As the number of competitors increases, a greater percentage of hospitals adopt costing systems as suggested by Hypothesis 2. Other interesting results in Table 3 include the size and occupancy rate variables. As suggested in Hypotheses 5 and 7, as size and occupancy rate increase, the percentage of hospitals adopting costing systems also increases.

Table 4, panel A reports means for the size, occupancy rate, and competition variable measures. (The means for the independent variables coded with
dummy measures are not reported.) The measures for size, occupancy rate, and competition all show statistically significant higher means for the adopters versus non-adopters. Competition is examined further in Panel B where the sample is grouped by adoption year as follows: 17 hospitals adopted costing systems by 1983, 98 hospitals adopted during 1984–1987, 107 hospitals adopted during 1988–1990, and 367 hospitals had not adopted any costing system by 1990. Specifically, during the phase-in period of the PPS (1984–1987) the hospitals adopting costing systems had, on average, 18 competing hospitals. Note that the average number of competitors for these 98 hospitals does not
change significantly over the ten year period (18.9, 18.4, and 18.2, respectively). After the full implementation of the PPS, hospitals adopting during 1988–1990 had, on average, 16 competing hospitals. In contrast, the hospitals that had not yet adopted a costing system as of 1990 had only 14 competing hospitals, on average. These results suggest that competition alone is not a critical variable in costing system adoption. However, the combination of revenue constraints and competition does appear to drive hospitals in more competitive environments to adopt costing systems earlier.

The above examination considers the variables in isolation. The following analysis uses event history methodology to examine the independent and dependent variables together over time. A multi-event model is used to investigate the impact of the environmental and organizational variables on costing system adoption. The dependent variable is coded for non-adopters and adopters, and the adopters are further defined by the method used to derive costs. The RCC and Actual Cost methods for deriving procedural level costs are defined in this study as relatively unsophisticated costing systems. In contrast, hospitals that adopted RVUs or Standard Cost methods are considered to have more sophisticated methods of costing. This distinction is important because it measures the depth of the response to the changes in the environment. To be included in this analysis, hospitals were required to use the same type of costing method in the four major revenue generating departments: nursing, laboratory, radiology, and operating room. This requirement reduced the sample to 520 for the multi-event model.

The multi-event model results, Table 5, show that environmental factors, revenue constraints and competition, are related to costing system adoption in the 1980s. First, the coefficients for the PPS measure (the percentage of total reimbursement based on the federal rate) indicate that the PPS had a significant and positive influence on adoption of both relatively unsophisticated and sophisticated costing systems. This suggests that as PPS affected a greater and greater percentage of hospital revenues, the probability a hospital would adopt either a relatively unsophisticated or sophisticated costing system also

---

17 The 17 sample hospitals that adopted costing systems prior to the PPS can be thought of as a baseline group. That is, prior to 1983, only 2.9% (17/589) of the sample hospitals had invested in costing systems. It appears that this percentage increased due to the change in reimbursement method combined with higher competition for some hospitals.

18 Sixty respondents indicated that they (1) used different cost methodologies for the four revenue generating departments, (2) were still implementing a new system and had not yet converted every department to the same method, or (3) had only enough resources to use a sophisticated method in a few departments and continued to use relatively unsophisticated methods or no costing system in others. Another nine hospitals indicated that they had adopted a costing system but had not begun to implement it. Because one costing system type was not identified, these 69 hospitals were excluded in the multi-event model.
increased. In addition to the sign and statistical significance of the PPS coefficients, the coefficient itself can be interpreted as follows. The antilog of the coefficient for those hospitals adopting relatively unsophisticated costing methods, 8.71 ($=\exp(2.165)$, the exponential of the estimated coefficient), indicates that as the unit measure of the PPS increased, the likelihood of adopting a relatively unsophisticated costing system increased by a multiple of 8.71 over the phase-in period (from the time of no PPS, coded 0, to full implementation of PPS, coded 1). Specifically, when the federal rate percentage made up 50% of the total reimbursement rate, the probability of adopting a relatively unsophisticated costing method increased by a multiple of

### Table 5

Event history analysis multi-event model

<table>
<thead>
<tr>
<th>Variables</th>
<th>Relatively unsophisticated costing methodology</th>
<th>Sophisticated costing methodology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue constraints</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPS</td>
<td>2.165$^b$ (0.181)</td>
<td>2.772$^b$ (0.170)</td>
</tr>
<tr>
<td>PPS exempt</td>
<td>1.808$^b$ (0.228)</td>
<td>1.129$^b$ (0.272)</td>
</tr>
<tr>
<td>Competition</td>
<td>0.151$^c$ (0.061)</td>
<td>0.111$^c$ (0.051)</td>
</tr>
<tr>
<td>Organizational factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ownership$^d$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investor-owned</td>
<td>−0.283 (0.387)</td>
<td>−2.081$^b$ (0.725)</td>
</tr>
<tr>
<td>Not-for-profit</td>
<td>0.796$^b$ (0.185)</td>
<td>0.490$^b$ (0.151)</td>
</tr>
<tr>
<td>Multi-hospital system</td>
<td>0.588$^b$ (0.115)</td>
<td>0.249$^b$ (0.102)</td>
</tr>
<tr>
<td>Hospital size</td>
<td>0.419$^b$ (0.108)</td>
<td>0.725$^b$ (0.094)</td>
</tr>
<tr>
<td>Area located$^e$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>0.573$^b$ (0.162)</td>
<td>−0.339$^b$ (0.160)</td>
</tr>
<tr>
<td>Inner-city</td>
<td>−1.020$^b$ (0.253)</td>
<td>0.004 (0.135)</td>
</tr>
<tr>
<td>Occupancy rate</td>
<td>−0.010$^c$ (0.005)</td>
<td>−0.008 (0.005)</td>
</tr>
<tr>
<td>Intercept</td>
<td>−12.88$^b$ (0.593)</td>
<td>−14.16$^b$ (0.522)</td>
</tr>
<tr>
<td>Number of adopters$^e$</td>
<td>63</td>
<td>90</td>
</tr>
<tr>
<td>$−2 \times (\log$ of the likelihood ratio)</td>
<td>325.2$^b$</td>
<td>659.6$^b$</td>
</tr>
<tr>
<td>Degrees of freedom</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

$^a$ Dependent variable is coded for the 3 states of costing system adoption: no adoption, adoption of a relatively unsophisticated costing method (RCCs or Actual Costs), or adoption of a sophisticated method (RVUs or Standard Costs).

$^b$ Significant at an $\alpha$ of less than 0.01 (two-tail test).

$^c$ Significant at an $\alpha$ of less than 0.05 (two-tail test).

$^d$ The use of dummy variables requires that 1 group be omitted in the models. Here the government (ownership) and urban (area location) hospitals are omitted.

$^e$ Hospitals included in this analysis adopted the same type of costing method in the four major revenue generating departments (nursing, laboratory, radiology, and operating room) or used no costing method. Of the 520 hospitals who met this requirement, 153 (29.4%) adopted costing systems and 367 had not adopted a costing system by the end of the study period.
When the federal rate percentage increased to 75% of the total reimbursement rate, the probability of adoption increased by a multiple of 5.07 ($= \exp(2.165 \times 0.75)$). However, notice that the largest PPS coefficient occurs for the sophisticated costing methods. This indicates that hospitals were even more likely to adopt a standard or RVU cost system than use a relatively unsophisticated method or no cost system when revenue constraints increased. Indeed, over the phase-in period, results indicate that it was 16 ($= \exp(2.772)$) times more likely that hospitals would adopt a sophisticated costing system.

The results also confirm the hypothesis that hospitals operating in PPS exempt states were significantly more likely to adopt costing systems than hospitals in PPS participating states. For PPS exempt states, the largest coefficient in absolute value is for the relatively unsophisticated methods of costing. This result is intuitively appealing for two reasons. First, PPS exempt hospitals did not have the benefit of a phase-in period prior to the regulation. Rather, the impact of the immediate and state wide revenue constraint forced hospitals to choose cost control systems that could be implemented quickly and with comparatively little cost. Second, for those hospitals in states exempt from the PPS in the early 1980s, the choice of costing methods was limited. That is, the use of RVUs and standard costing for hospitals was, in general, new to the industry at that time and not well developed. As a result, for PPS exempt states, the relatively unsophisticated methods were 6.10 ($= \exp(1.808)$) times more likely to be adopted as compared to adopting no cost system at all.

The coefficients for the competition measure indicate that competition also had a statistically significant and positive impact on the use of costing methods. As competition increased, hospitals were more likely to adopt relatively unsophisticated or sophisticated costing systems as opposed to no system. Recall that the competition measure used in the model is the log of the number of competing hospitals (see, Table 1). Therefore, to calculate and interpret the coefficients for competition, first multiply the coefficient by the log of the level of competition and then exponentiate. For example, it was 1.27 times more likely that a hospital operating in an area with five hospitals would adopt a relatively unsophisticated costing system as opposed to no system ($1.27 = \exp(0.151 \times (\ln(5)))$). As the number of competing hospitals increased, the likelihood of adopting a costing system also increased, but not to the same degree as the increases for the revenue constraint measures (PPS and PPS exempt). In sum, increased revenue constraints and competition are significant and positively related to costing system adoption.

Many of the included organizational variables are related to costing system adoption. For example, the ownership variable coefficient for investor-owned hospitals is negative and significant for the use of a sophisticated cost system. As compared to the omitted ownership variable (government hospitals), investor-owned hospitals are significantly less likely to adopt a costing system.
Perhaps as suggested earlier, investor-owned hospitals were better able to endure Medicare's revenue constraints of the 1980s. However, as additional revenue constraints continue into the 1990s, e.g., managed care contracts and HMO agreements, investor-owned hospitals may be more likely to adopt costing systems to control costs.

The findings confirm the hypothesis that not-for-profit hospitals are more likely than government hospitals (the omitted group) to use either relatively unsophisticated or sophisticated systems. As noted earlier, government hospitals would typically have less discretionary resources with which to invest in new costing systems.

Hospitals that are part of a multi-hospital system are also more likely to adopt a costing system than independent hospitals, as hypothesized, and more likely to chose RCCs or actual costs over RVUs or standard costs (0.588 versus 0.249, respectively). The coefficients for hospital size are also positive and significant for both the relatively unsophisticated and sophisticated costing methodologies and the coefficient for the sophisticated system is larger. This intuitive finding supports prior research (Nathanson, 1984, p.128) which suggests that larger hospitals are likely to have more resources to afford sophisticated cost systems. Further, larger hospitals can benefit from economies of scale since a significant part of the investment in a new costing system is typically a fixed cost.

For area location, rural hospitals are significantly more likely to use relatively unsophisticated methods than urban hospitals (the omitted group) while inner-city hospitals are more likely to have no costing system. Inner-city hospitals likely have a higher percentage of indigent care and, therefore, discretionary resources are minimal compared to rural or urban hospitals. Without adequate revenues to cover basic care costs, inner-city hospitals may not have additional funds for improved information systems or available personnel for implementation of new systems.

Finally, as a hospital’s occupancy rate increases, results indicate it is less likely that the hospital will use a relatively unsophisticated cost method compared to no costing system. This does not confirm the hypothesis. The antilog of the coefficient, however, is very close to 1 (a multiple of 0.99 (= \exp(-0.01))) and although the coefficient is significant, the impact on the probability of no adoption as occupancy rates increase is very small. Results show no statistical significance for the adoption of sophisticated costing methods.

6. Discussion and summary

Adopting new costing systems is an action that all service organizations, including hospitals, are reluctant to do given the costliness of dual accounting systems and the difficulty in applying well-accepted manufacturing accounting
techniques to a service setting. The increasing magnitude of health care costs, however, necessitates that hospitals adopt costing systems to provide better data and greater insights for cost control and cost management. The revenue constraints imposed by Medicare preclude hospitals from maximizing profits today as they did in the past by simply increasing the number of services. Hospital revenues were severely constrained in the 1980s and continue to be so through the 1990s. In response, one would suspect that hospitals would react to this by changing their cost accounting systems since their control over the revenues provided by third-party payers, particularly Medicare, has decreased significantly. When prices are dictated by external parties, profit maximization can only come through managing and controlling costs. Yet, as of 1990, a surprising number of hospitals still lacked a costing system able to provide data on the costs of procedures. The ability to monitor the cost of procedures, rather than merely aggregating costs, is critical because it allows hospitals to track the costs by patient. This is important since Medicare’s change in reimbursement methodology means that hospitals are reimbursed per patient rather than per service.

Clearly, as suggested in prior research on management accounting systems (e.g., Khandwalla, 1972; Ewusi-Mensah, 1981; Gordon and Narayanan, 1984), environmental variables and uncertainty in the 1980s drove some hospital administrators (37.8% of the sample) to adopt a costing system capable of reporting procedural level costs. As suggested by Khandwalla (1972, p. 28), my study found that increased competition was associated with greater use of one method of accounting and management control- a costing system. The measure of competition used herein (number of competing hospitals) furthers the research on competition and management controls. However, the results indicate that competition played only a secondary role in the decision to change costing systems. In contrast, revenue constraints played the dominant role in influencing hospital behavior. For example, over the PPS phase-in period, hospitals were eight times more likely to adopt a relatively unsophisticated costing method and sixteen times more likely to adopt a sophisticated system. These findings support prior research which suggests that perceived environmental uncertainty is positively associated with the need for additional information for planning, i.e., costing systems (Gordon and Narayanan, 1984, pp. 41–42).

The effect of organizational variables is less dramatic. However, the implications may still be useful. In general, the results indicate that not-for-profit hospitals, hospitals in multi-hospital systems, and larger hospitals were more likely to adopt costing systems. While hospitals have little control over environmental factors, they are relatively more able to choose internal organizational factors. For example, independent hospitals which are in competitive environments may benefit from joining multi-hospital chains giving them access to new costing and management techniques. However, this may not be a
palatable choice for all independent hospitals. In this case, hospitals which wish to retain their independence and simply out manage multi-hospital chain hospitals must eliminate the relative disadvantage they currently have in managing their cost environment.

Further, hospitals with given organizational characteristics can compare their response to changes in the environment to the probable response by their competitors and plan accordingly where possible. For example, the results indicate that inner-city hospitals are very unlikely to use any costing system much less a sophisticated one. Given real-world revenue constraints, it seems unlikely that such hospitals will be able to choose to afford the costing systems necessary to make informed decisions. If keeping inner-city hospitals is desirable from a public policy point of view, this may indicate that grants and/or budget support for management systems may be just as, if not more, critical than grants and budgets for improved medical care and medical facilities.

Several other implications flow from the study findings. From the hospital administration’s viewpoint, understanding and managing costs is important. In the short-term, it means that the hospital can remain viable. In the long-term, the tracking of costs per patient is necessary to determine whether the amount of reimbursement received truly covers the costs incurred. Armed with a more accurate cost of patient care, the hospital may be better able to present an informed case to the public, regulatory agents, and governments. This knowledge will allow for more enlightened price setting which stands to benefit the hospital and the public. Further, cost information at the procedural level is a prerequisite for tracking costs at the doctor level. This is crucial in the hospital setting because the physician, in effect, determines the type of and amount of care (e.g., the number of X-rays, length of stay). It may be that, all else being equal, some doctors are better able to provide quality and cost efficient care. In essence, hospitals that are incented by increased revenue constraints and competition to adopt a costing system will be better able to weather further changes in the health care system.

From a public policy point of view, hospitals without adequate detailed cost information may make uninformed choices that reduce quality of care and/or net income and threaten hospital survival. For example, if the existing accounting system can only provide total (aggregate) costs versus total reimbursements, hospitals may attempt to reduce costs (respond) in a blunt fashion. Patients in general may be sent home quicker and sicker and/or patient services may be cut across the board. This undoubtedly will reduce total costs but it may also unwittingly reduce net income and/or patient care. Furthermore, those hospitals which do not know the detailed cost of each DRG may assume that the costs of Medicare patient care are not fully reimbursed. For these hospitals, it becomes more likely that they may engage in cost shifting (i.e., increasing the price or charge for services to other third-
party payers) (Dranove, 1988, p. 56; Lambert and Larcker, 1995, p. 7) since they have relatively little information to engage in the effective control and management of detailed costs. Finally, those hospitals which do not move toward more sophisticated cost systems will be less able to argue their case for additional reimbursement and will be uninformed about the practice patterns of their physicians. These responses to revenue constraints and competition may reduce total costs, but they do not appropriately control or manage the overall costs of health care and should be of concern to the public. Without changes in costing system methods, negative responses to any future changes in revenue reimbursements, as noted above, are likely to result.

In summary, my paper assesses one part of the management accounting system, the costing system, within the hospital industry. Through empirical examination of 589 short-term, general medical and surgical hospitals, the study investigates the impact of the environmental and organizational factors on costing system adoption over the 1980s. The principal revisions in the reimbursement mechanism, never before prospectively determined, provided incentives to hospitals for cost containment and cost management. Results show that environmental changes, specifically revenue constraints, indeed had the greatest effect on costing systems adoption.

As health care costs continue to rise, it is likely that revenue constraints for health care providers will be the norm. In fact, the PPS has been extended to include not only in-patient services, the focus of my study, but also out-patient hospital services (Russell, 1989, pp. 17, 84). The extension of the PPS to include physicians and physician services has been widely discussed (Berki, 1985, pp. 73–74; Russell, 1989, pp. 76, 89). In addition, while the PPS only affects Medicare patients, further controls on all hospital revenues have been introduced on a variety of fronts such as managed care programs, cutbacks in state-run Medicaid programs, and additional state all-payer programs (see, e.g., Berger and Abendshien, 1992, p. 54; Berki, 1985, pp. 71–73). Results here suggest that hospitals did react to constraints in revenues by implementing costing systems but perhaps not as quickly as one would have expected. As additional revenue controls are introduced, the hospital environment promises to become less and less certain. Further research on the rate of change in costing system utilization and design and an examination of factors driving the change may be warranted.

**Acknowledgements**

I would like to thank three anonymous reviewers, Kevin Stevens, and Stephen Loeb for their helpful comments and suggestions. I would also like to thank in particular Werner Frank and Terry Amburgey.
Appendix A. Event history research models

A.1. Hazard rate and the exponential dynamic model

The exponential dynamic model in my study specifically considers conditional probabilities (i.e., whether or not the hospital has already adopted a costing system) in estimating the future probability that a hospital will adopt a given costing system. The probability function stated below follows Carroll (1983, p. 429).

\[ P_{jk}(t_1, t_2) = \text{Prob}[Y(t_2) = k | Y(t_1) = j], \tag{A.1} \]

where \( Y \) is the hospital’s choice of a costing system; \( t \) the time, for each year 1980–1990; \( j, k = 1 \ldots j_k \ldots \), the alternative choices of costing systems.

The probability function noted above is different from the choice probability model used in cross-sectional analysis in that it calculates the probability that a hospital will adopt a costing system at time \( t_2 \), conditional upon the hospital’s choice, \( j \), of a costing system at time \( t_1 \) (see, Carroll, 1983, p. 429).

For event history models, the dependent variable, commonly referred to as the hazard rate, captures both the occurrence and timing of costing system adoption (see, Carroll, 1983, p. 429; Allison, 1984, p. 16). The hazard rate is the unobserved rate at which adoption occurs. The hazard rate, \( r_{jk} \), using Carroll’s notation (cf. Carroll, 1983, p. 429) is given by:

\[ r_{jk}(t) = \lim_{\Delta t \to 0} \frac{p_{jk}(t, t + \Delta t)}{\Delta t}, \tag{A.2} \]

In my study, I used the exponential model. The exponential model is one of many classes of dynamic models that are based on different distributions of the dependent variable and make different assumptions about if and how the hazard rate changes over time \(^{20}\). The model used in this current study, the exponential model, is based on a log-linear distribution of the hazard rate and allows me to include changing independent variables. This model uses the hazard function as discussed in Yamaguchi (1991, pp. 18–19; also, see Hill et al., 1996, p. 69) as the dependent variable and the \( X_i \) hospital characteristics as independent variables.

\[ r(t) = e^{\beta X_i}, \tag{A.3} \]

where \( r(t) \) is the rate of adoption (hazard rate) over the years 1980–1990; \( X_i \) the vector of variables which measure exogenous characteristics for hospital \( i \) over

\(^{19}\) A similar explanation of the hazard rate and exponential model appears in Hill et al. (1996, p. 69).

\(^{20}\) See, for e.g., Carroll (1983, pp. 433–434, 450–451) and Allison (1984, pp. 22–33).
the years 1980–1990; $\beta$ the vector of estimated parameters for the independent variables, $X_i$.

The method of maximum likelihood is used to estimate the parameters. It combines censored and uncensored observations in such a way as to produce estimates that are asymptotically unbiased, normally distributed and efficient (Allison, 1984, p. 26; Tuma et al., 1979, pp. 831–833).

A.2. Data organization and discussion of event history analysis

Data for event history analysis are assembled in the form of event histories. For each hospital, a series of spells (durations between events) are compiled. The first spell begins at the start of the observation period, 1980, and ends at the time of the first event (e.g., a change in an independent variable measure such as hospital size). The second spell begins one day after the first event and ends at the time of the second event. This process continues until the end of the observation period, 1990. Since many of the independent variables change, they are collected or measured yearly. The variables PPS, system-membership, hospital size, and occupancy rate are measured yearly and competition is measured about every three years. The spells for the hospitals, therefore, are typically one year long. Shorter spells occur when a hospital adopts a costing system in mid-year. The adoption date as reported by the hospital ends a spell and a new one begins the next day.

Event history analysis also records the dependent variable in each spell. As long as the hospital has not adopted a costing system, it is coded as 0 for each year or spell. The coding represents the state of no adoption. For the multiple event model, 1 represents the state of adopting a relatively unsophisticated costing system and 2 represents the state of adopting a sophisticated costing system. Event history analysis makes use of the length of time each hospital is in a particular state before any transition to a different state occurs (i.e., adoption of a cost system). As noted in the text, the hazard rate, is calculated based on the conditional probability of a hospital adopting a costing system given that hospital has not yet adopted such a system. The event history analysis also allows for what is called right censoring (see, e.g., Allison, 1984, p. 29). Some hospitals do not adopt a costing system by the end of the observation period and therefore do not move to a new state. Event history analysis does not assume, as does cross-sectional analysis, that these right censored hospitals will never adopt a costing system. Instead, the models are based on conditional probabilities to make appropriate use of the information.

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21 The analysis of my data were conducted using the RATE program developed by N.B. Tuma and DMA Corporation (see, Tuma, 1982).
that the hospital did not transcend to another state (Tuma et al., 1979, pp. 845,847).

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