ANALYSIS OF CORPORATE ACQUISITIONS BY MEDICAL DEVICE MANUFACTURERS

Robert A. DeGraaff

A DISSERTATION

in

Health Care Systems

For the Graduate Group in Managerial Science and Applied Economics

Presented to the Faculties of the University of Pennsylvania

in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

2006

Supervisor of Dissertation

Graduate Group Chairperson

DEDICATION

To Lisa and Robert, with love and gratitude.

ACKNOWLEDGEMENTS

I thank the members of my dissertation committee, Drs. Lawton R. Burns, Patricia M. Danzon, Daniel A. Levinthal, Mark V. Pauly, and Harbir Singh, for their expertise, direction, and insights.

I also recognize and appreciate the Agency for Healthcare Research and Quality for its financial support of this project through grant number R03 HS010800-01.

ABSTRACT

ANALYSIS OF CORPORATE ACQUISITIONS BY

MEDICAL DEVICE MANUFACTURERS

Robert A. DeGraaff

Supervisor: Lawton R. Burns, PhD, MBA

This doctoral thesis draws on the financial economics, strategic management, product innovation, and health technology literatures to investigate and explain conditions under which corporate acquisitions in the medical device industry have enhanced or eroded shareholder wealth and financial accounting performance. Specifically, the research aims to advance understanding of (a) the economic impact of externally sourcing product innovation capability via corporate acquisitions, (b) the distinction and use of patent awards, premarket application (PMA) approvals, and 510(k) clearances as indicators of innovation capability among medical device manufacturers, (c) similarities and differences in predictor variables of short-run (stock market reaction to acquisition announcement) versus longer-term (four years of post-acquisition cash flow performance) acquisition-related financial outcomes, and (d) financial results of other motives for acquisition activity (e.g., buying or selling corporate assets as a response to organizational distress). The medical device industry is defined as firms manufacturing products in SIC codes 3841, 3842, 3844, or 3845. The unit of analysis is the acquirer-target dyad. Acquisitions announced during the 16-year period 1984-1999 are

investigated (n = 273, averaging one every three weeks). For each corporate combination, post-acquisition financial performance data were collected for four fiscal years following the effective date of the deal. Because the study sample includes acquisitions announced during 1999 but completed in 2000, the data under study extend through 2004 (most recent available). The results indicate that, on average, shareholders benefited from acquisitions among medical device makers. The correlation coefficient between the short-run and longer-term dependent variables was .36 ($p < .0001$). Multivariate analyses demonstrate that buying innovation capability via corporate acquisition is, overall, a value-creating strategy among medical device makers. The strongest predictors of shareholder wealth creation and improved financial accounting performance were (a) the target organization's pre-acquisition product innovation record, (b) the interaction of acquirer and target innovation measures (indicating that the overall impact of product innovation capability on financial outcomes is jointly determined), and (c) purchasing inefficiently producing and financially distressed targets. The short-run and longer-term models also agreed that being a high-frequency acquirer was a value-destroying approach. Stock price increases were further related, although more marginally, with acquiring the entire target firm (compared with purchasing only a portion of the target's assets such as a division or product line) and use of cash as a method of payment. Shareholder wealth diminution followed announcement of acquisition targets with (a) high 510(k) clearance counts relative to R&D expenditures (indicating a non-innovative target organization) and (b) collar provisions on high-technology acquisitions. Unlike short-run stock price revaluations, positive changes in longer-term financial accounting performance were associated with building product lines within medical specialty areas.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1: INTRODUCTION

Research Objective and Potential Contributions

The fundamental objective of this dissertation research is to investigate and explain conditions under which corporate acquisitions in the medical device industry have enhanced or eroded shareholder wealth and financial accounting performance. The work offers a unique combination of seven contributions to both the medical device and general strategy literatures.

First, among the questions addressed by the thesis is the unresolved issue of whether buying product innovation capability via corporate acquisition has been a value-creating approach among medical device makers. Dushnitsky and Lenox (2005) observe that "Historically, the innovation literature has focused on the role of internal research and development on firm innovation. However, internal R&D expenditures play only a partial role in firm innovation rates...While the decision to commit resources towards internal innovative inputs has received much scrutiny, there remains a need to study firms' decisions to commit resources towards external innovative inputs" (pp. 947, 948).

Second, medical device innovation capability among acquiring firms and target organizations is operationalized in an original way by distinguishing and measuring a triad of product innovation indicators: (a) U.S. patent awards, (b) premarket application (PMA) approvals from the U.S. Food and Drug Administration (FDA), and (c) FDA 510(k) clearances. Whereas patents and PMA approvals "tend to represent new, often breakthrough technologies," medical products "cleared through a 510(k) are, by definition, 'substantially equivalent' to an earlier, legally marketed device" (Littell, 1994,

p. 231). To date, no published empirical research has evaluated the differential impact of buyer and seller pre-acquisition patent, PMA, and 510(k) yields on acquisition financial outcomes.[1]

Third, besides investigating externally sourcing product innovation capability via corporate acquisitions, the thesis writes to both the medical device and general strategic management literatures in developing and evaluating four additional hypothesized predictors of acquisition-related financial performance (acquirer and target production efficiency, building product lines along medical specialties, post-acquisition scale, and prior acquisition experience) and six major control variables (relative size of target to acquirer, presence of a collar provision, use of cash as a method of payment, market concentration, purchase of 100 percent of the target organization [compared with a partial acquisition comprising only a division or subsidiary], and acquisition propensity).

Fourth, prior evidence on corporate acquisitions indicates that on average (a) shareholders of target firms benefit, (b) shareholders of acquiring firms breakeven, and (c) combined equity revaluations are positive (Jensen and Ruback, 1983; Paulter, 2003). However, considerable performance heterogeneity surrounds these mean values, and the dissertation seeks to exploit this variability to identify conditions under which corporate

---

[1] One study—reported in the August 1998 issue of Medical Device & Diagnostic Industry Magazine and updated in a December 1998 presentation at the Wharton School—demonstrated that among 54 medical device firms that went public between June 1995 and July 1997, as of November 1999 the 20 companies covered by a PMA had an average post-initial public offering (IPO) stock price return of +37 percent, compared with a -9 percent average return for the 34 medical device start-ups covered by a 510(k) (Faulkner, 1998a, 1998b; Burns, 2005). This study distinguished PMA approvals and 510(k) clearances, and demonstrated superior post-IPO stock price performance for PMA firms. The dissertation builds upon this foundation by additionally incorporating patent awards to evaluate the financial outcomes of corporate acquisitions among medical device producers.

acquisitions in the medical device industry have enhanced or eroded shareowner wealth and financial accounting performance. Specifically, the thesis responds to King et al's (2004) observation that, "Empirical research has not consistently identified antecedents for predicting post-acquisition performance" (p. 187). This statement echoes Singh and Zollo's (1997) challenge that, "There is a need for a more in-depth investigation of the conditions under which these transactions (corporate acquisitions) create and destroy value" (p. 6). Subsequently, these same authors wrote, "...explanation of the variance around the mean is still very much in need of both theoretical and empirical work" (Zollo and Singh, 2004, p. 1233), so "the determination of factors that influence acquisition success remains an important research question" (Carow, Heron, and Saxton, 2004, p. 563). The dissertation capitalizes on acquisition-related performance heterogeneity (as quantified by coefficient of variation calculations for the financial outcome measures) to assess whether and when acquisitions in the medical device industry have improved or impaired shareholder wealth and financial accounting performance.

Fifth, the research extends a small and emerging body of literature that combines and contrasts short-run (announcement period stock price revaluations) and longer-term (four-year post-acquisition changes in cash flow performance) approaches to evaluating drivers of acquisition financial outcomes. Paulter (2003) explains that "In recent years, researchers have begun to merge the stock market study approach and the accounting/finance approach in the hopes of providing a more robust analysis...The results can provide indications about whether the approaches tend to produce consistent results" (pp. 119-120, 132). A positive, predictive association between stock market revaluations surrounding the announcement date and subsequent realized financial

accounting performance would provide evidence in support of market efficiency.

Sixth, although (a) U.S. manufacturers shipped $69.24 billion in medical device products in 2004 (U.S. Census Bureau, 2005b), (b) medical device product shipments accounted for 0.59 percent of 2004 U.S. gross domestic product (that is, $1 of every $169.47 in overall output of goods and services was medical device manufacturing), and (c) firms in the medical device industry maintained an acquisition pace of one every three weeks during the dissertation study period, this segment of the health industry is strikingly underrepresented in the health services management literature (Burns, 2005). Among the published studies that examine medical device makers, none gauge the impact of corporate acquisitions on stock price and profitability.

Seventh, the discussion section of the thesis summarizes empirical findings, discusses implications for the medical device and general strategic management literatures, offers specific recommendations on managing the cost of expensive and innovative medical devices, raises research issues based on contrasts between the pharmaceutical/biotechnology and medical device industries, acknowledges limitations, identifies research questions for further study, and concludes.

Medical Device Industry: Size, Growth, and Concentration[2]

Industry Size. In 2004, U.S. manufacturers shipped $69.24 billion in medical device products (U.S. Census Bureau, 2005b).[3] Medical device production accounted for

[2] The medical device industry is defined as firms manufacturing products in SIC codes 3841, 3842, 3844, or 3845 (Standard Industrial Classification Manual, 1987). A more detailed industry definition in provided in Chapter 3.

[3] The U.S. Census Bureau publishes two types of Value of Shipments data (U.S. Census Bureau, 2003). The first, *Value of Industry Shipments*, reflects all products shipped by

1.623 percent of total 2004 U.S. manufacturing output (U.S. Census Bureau, 2005a, 2005b). Within the medical device industry, the largest product class is "Orthopedic, Prosthetic, and Surgical Appliances and Supplies" (SIC 3842 / NAICS 335113) with $25.03 billion in 2004 product shipments. "X-Ray and Irradiation Apparatus" (SIC 3844 / NAICS 334517) is the smallest manufacturing segment with 2004 product shipments of $4.38 billion. Product shipments under "Surgical and Medical Instruments and Apparatus" (SIC 3841 / NAICS 339112) and "Electromedical and Electrotherapeutic Apparatus" (SIC 3845 / NAICS 334510) were $22.84 billion and $16.99 billion, respectively, in 2004 (U.S. Census Bureau, 2005b).

Industry Growth. The value of medical device product shipments across the four industry classification codes has nearly quintupled from $14.01 billion in 1983 to $69.24 billion in 2004 (equating to an annualized nominal growth rate of 7.9 percent). "Electromedical and Electrotherapeutic Apparatus" (SIC 3845 / NAICS 334510) was the fastest growing industry segment with a 9.6 percent annual growth rate; "X-Ray and Irradiation Apparatus" (SIC 3844 / NAICS 334517) was the slowest growing segment at 5.1 percent average annual growth (U.S. Census Bureau, 1988, 2005b). Medical device manufacturing represents an increasing portion of U.S. gross domestic product. In 1983, medical device product shipments accounted for 0.396 percent of all goods and services

---

firms grouped by primary industry classification code. This measure (a) includes non-medical device products produced by companies whose primary industry code is medical devices (SIC 3841, 3842, 3844, 3845) and (b) excludes medical device products manufactured by companies whose primary industry code is not medical devices. In contrast, *Value of Product Shipments* reflects the dollar value of medical device products shipped regardless of the company's primary industry classification code. The latter measure (Value of Product Shipments) is reported here.

produced in the U.S. (that is, $1 of every $252.42 in U.S. economic activity was medical device manufacturing). In 2004, the proportion of GDP increased to 0.590 percent (corresponding to $1 of every $169.47 in overall output of goods and services). Table 1 documents the increase in medical device manufacturing as a percentage of U.S. gross domestic product (U.S. Census Bureau, 1988, 1996, 1998, 2003, 2005b; U.S. Bureau of Economic Analysis, 2006). The graph includes a nonlinear fitted trend line. Table 2 (next page) details annual growth in product shipments for the period 1983-2004.

Table 1
Annual Dollar Value of Product Shipments as a Percentage of U.S. Gross Domestic Product
Medical Device Products, 1983-2004

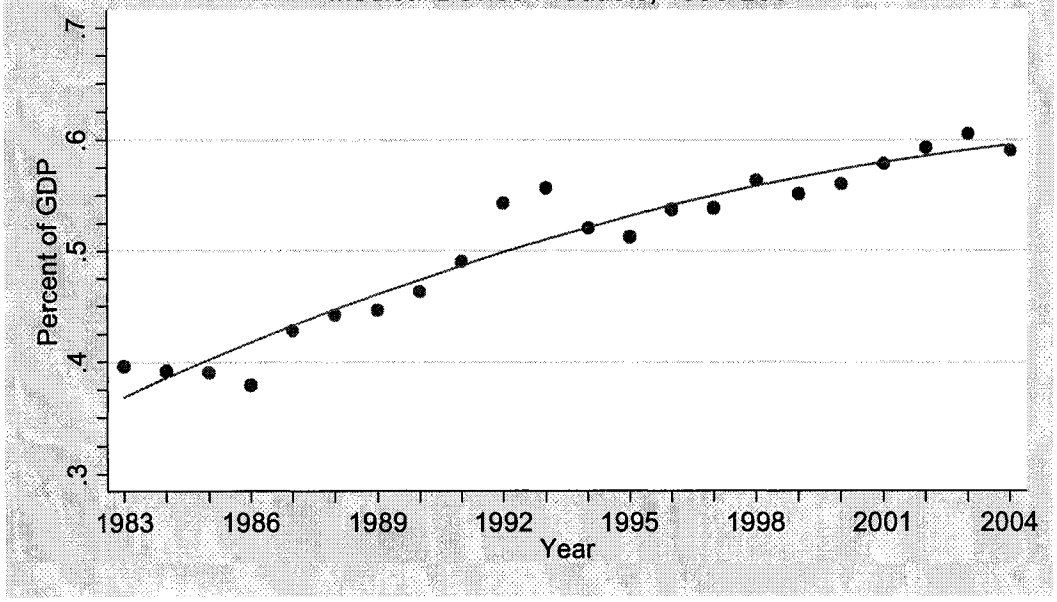

Table 2:

Current Dollar Value of Product Shipments, 1983-2004

(in $millions)

Year	SIC 3841 or NAICS 339112	SIC 3842 or NAICS 339113	SIC 3844 or NAICS 334517	SIC 3845 or NAICS 334510	Medical Device Industry Total
1983	4,592.1	5,402.0	1,544.3	2,472.7	14,011.1
1984	4,599.6	6,015.4	2,013.5	2,768.1	15,396.6
1985	4,951.9	6,911.2	1,797.0	2,796.9	16,457.0
1986	5,252.9	7,194.0	1,682.4	2,803.5	16,932.8
1987	7,231.7	7,981.3	1,556.8	3,513.3	20,283.1
1988	7,958.9	8,895.1	1,648.8	4,031.0	22,533.8
1989	8,654.8	9,474.2	1,690.4	4,657.5	24,476.9
1990	9,857.0	10,354.8	1,854.0	4,807.7	26,873.5
1991	10,473.5	11,514.4	2,201.4	5,193.8	29,383.1
1992	13,275.9	12,437.8	2,360.1	6,306.3	34,380.1
1993	14,759.0	13,284.6	2,510.4	6,514.6	37,068.6
1994	14,264.0	13,144.9	2,493.8	6,894.9	36,797.6
1995	14,935.9	13,317.1	2,695.0	6,988.1	37,936.1
1996	16,191.6	14,304.4	2,960.4	8,501.5	41,957.9
1997	17,368.0	13,521.9	3,393.6	10,424.5	44,708.0
1998	18,590.6	15,824.5	3,581.1	11,266.6	49,262.8
1999	19,847.1	16,318.1	3,623.3	11,303.6	51,092.2
2000	20,878.8	17,963.4	4,077.5	12,071.7	54,991.5
2001	22,547.6	19,147.1	4,237.0	12,574.5	58,506.1
2002	20,450.5	22,088.3	4,512.7	14,962.0	62,013.4
2003	21,430.8	24,719.6	4,136.8	16,106.1	66,393.2
2004	22,840.6	25,027.6	4,379.4	16,994.2	69,241.9
Annualized Nominal Growth Rate, 1983-2004	7.9%	7.6%	5.1%	9.6%	7.9% (a)

Sources:
U.S. Census Bureau (1988) 1986 Annual Survey of Manufactures, M86(AS)-2
U.S. Census Bureau (1996) 1992 Census of Manufactures, MC92-S-1
U.S. Census Bureau (1998) 1996 Annual Survey of Manufactures, M96(AS)-2
U.S. Census Bureau (2003) 2001 Annual Survey of Manufactures, M01(AS)-2
U.S. Census Bureau (2005b) 2004 Annual Survey of Manufactures, M04(AS)-2
Note:
(a) 14,011.1 x (1+g)^21 = 69,241.9 ==> g = .079

Industry Concentration. The Compustat business segment database reports non-zero 2003 revenue figures for 202 U.S.-headquartered medical device producers. The top ten medical device makers captured more than 70 percent of this revenue, and the top twenty generated more than 86 percent of industry sales. Comparable Compustat business segment data are not available for years around the beginning of the study period, but much of the industry consolidation has been achieved via corporate acquisitions. In 2003, the top twenty producers of medical device products were Johnson & Johnson, GE Medical Systems, Tyco International, Medtronic, Baxter International, 3M, Guidant, Boston Scientific, Stryker, Becton Dickinson, Abbott Laboratories, Zimmer, St. Jude Medical, Bristol-Myers Squibb, C.R. Bard, Invacare, Varian Medical Systems, Steris, Edwards Lifesciences, and Respironics.

Coverage and Gaps in the Medical Device Literature

Despite its clinical importance and economic significance, the medical device industry is strikingly underrepresented in the health services management literature (Burns, 2005). Appendix 1 ("Coverage and Gaps in the Medical Device Literature") classifies published literature addressing medical device products and manufacturers into 10 categories. The purpose of this appendix is to demonstrate an unresearched gap in the existing research that is investigated by the dissertation. Among the published studies that examine medical device makers, none gauge the impact of corporate acquisitions on stock price and profitability.

Organization of the Dissertation

The remainder of the dissertation is organized as follows. Chapter 2 reviews the pertinent literature and develops the hypotheses to be tested. Chapter 3 details the unit of analysis, data sources, study dates and sample, measures, and analytic method. Chapter 4 presents descriptive statistics, bivariate analyses, and multiple regression results. Chapter 5 summarizes empirical findings, discusses implications, acknowledges limitations, suggests directions for future research, and concludes. Appendices and references cited complete the dissertation.

CHAPTER 2: THEORY AND HYPOTHESES

Externally Sourcing Product Innovation Capability via Corporate Acquisitions

A fundamental research question investigated by the dissertation is whether buying product innovation capability via corporate acquisitions has been a value-creating approach among medical device manufacturers.[4,5] Innovations that (a) improve diagnostic capabilities or therapeutic techniques; (b) extend life expectancy; (c) enhance quality of life; (d) prevent medical errors; (e) improve ease-of-use and labor productivity among physicians, technicians, nurses, and therapists; (f) facilitate patient services in less expensive outpatient settings; (g) shorten patient recovery times; (h) reduce inpatient lengths of stay; (i) or avoid future inpatient hospitalizations are important drivers of sales and earnings growth among medical device makers (Pollard and Persinger, 1987; Littell, 1994; Centers for Medicare and Medicaid Services, 2003; Burns, 2005; First Research,

---

[4] **Key Definitions**

A *medical device* is defined as an instrument, apparatus, implement, machine, implant or other article which (a) is used in the diagnosis of disease, or in the cure, mitigation, treatment, or prevention of disease, (b) does not achieve any of its primary intended purposes through chemical action within or on the body, and (c) is not dependent upon being metabolized for the achievement of any of its primary intended purposes (U.S. Food and Drug Administration's Center for Devices and Radiological Health, 1998). This definition was paraphrased from http://www.fda.gov/cdrh/devadvice/312.html.

Corporate acquisitions and mergers both describe purchases of the right to control assets in the market for corporate control. A merger is a legal amalgamation of two or more companies to form a single company (Odagiri and Hase, 1989). In a merger, 100 percent of the equity of the target firm is purchased. Acquisition is a more general term and typically refers to the purchase of 51 to 100 percent of the target firm's equity (Odagiri and Hase, 1989). Therefore, mergers are a special case of acquisitions. Use of the term *partial acquisition* emphasizes the purchase of less than 100 percent of the target organization (e.g., a division or subsidiary).

[5] The thesis dually targets the medical device literature (specifically) and the strategic management literature (more generally).

2004; Gold, 2005; Iglehart, 2005; Pauly, 2005; Pearson and Rawlins, 2005).

Product innovation capability and new product introductions can result from internal development or external acquisition (Hitt, Hoskisson, and Ireland, 1990; Hitt, Hoskisson, Johnson, and Moessel, 1996; Ranft and Lord, 2002; Karim and Mitchell, 2004). The following pair of statements from the recent strategic management literature evidence the need for research attention on external sources of firm innovation:

> "Historically, the innovation literature has focused on the role of internal research and development on firm innovation. However, internal R&D expenditures play only a partial role in firm innovation rates...While the decision to commit resources towards internal innovative inputs has received much scrutiny, there remains a need to study firms' decisions to commit resources towards external innovative inputs" (Dushnitsky and Lenox, 2005, p. 947, 948).

> "Contributions inspired by the resource-based theory of the firm (Barney, 1991; Rumelt, 1984; Wernerfelt, 1995) and the theory of dynamic firm capabilities (Nelson, 1991) stress the importance of unique, innovative company capabilities that create sustained performance differentials with other companies. Although we agree that these innovative capabilities are crucial to the company, we would like to add that the efficient use of external resources can also contribute to successful renewal within the company. Following Cohen and Levinthal (1989), we emphasize two important characteristics of the innovation process: the creation of new knowledge through endogenous R&D efforts, and the ability to adopt existing technologies developed by others" (Hagedoorn and Duysters, 2002, p. 168).[6]

[6] Whereas Dushnitsky and Lenox (2005) investigate firm- and industry-level correlates of pursuing "external innovative inputs" (p. 952) and Hagedoorn and Duysters (2002) examine conditions under which firms prefer strategic alliances or corporate acquisitions as the external source of innovative capabilities, neither studies, as the dissertation does, financial outcomes of externally sourcing product innovation capability via corporate acquisitions.

"In industries characterized by rapid innovation, technological complexity, and reliance on highly specialized skills and expertise, the pace and magnitude of technological change, as well as the breadth and depth of knowledge-based resources required to compete, may not allow firms to internally develop all the technologies and capabilities they need to stay competitive" (Ranft and Lord, 2002, p. 420). On the one hand, "Internal development may be perceived by managers to entail high risk because of the (uncertain) probability of innovation success and the length of time required for innovation to provide adequate returns" (Hitt, Hoskisson, and Ireland, 1990, p. 31). On the other hand, acquiring the assets of a target organization with a launched product or an innovation far into the development process will get the buying firm to market faster and with less uncertainty. "Acquisitions may serve as an attractive alternative to investment in R&D because they offer immediate entrance to a new market and/or a larger share of a market currently served" (Hitt, Hoskisson, and Ireland, 1990, p. 31).

Acquiring organizations with high levels of demonstrated product innovation capability paired with target firms that also have high levels of product innovation capability are expected to have the highest levels of "combinative capability to synthesize and apply current and acquired knowledge" (Kogut and Zander, 1992, p. 384) and, in turn, the most post-acquisition financial success. Combinations of acquirers and targets with lower product innovation capabilities are expected to have weaker post-acquisition financial performance.

As stated at the outset of this chapter, product innovation is foundational to growth and competitiveness in the medical device industry. The vital role of innovation is demonstrated and confirmed in the management discussion sections of company 10-K

reports (which are written by management as an annual communication to shareowners, analysts, and other stakeholders):

> "The market for products for minimally invasive surgery is highly competitive. The Company believes it is the leader in this field as the result of its successful innovative efforts and superior products" (U.S. Securities and Exchange Commission, 1995, United States Surgical Corporation Form 10-K Annual Report Filing for the Period Ending December 31, 1994).
>
> "The medical devices market is characterized by rapid product development and technological change. The present or future products of the Company could be rendered obsolete or uneconomic by technological advances by one or more of the Company's present or future competitors. The Company must continue to develop and acquire new products and technologies to remain competitive with other developers of medical devices and therapies" (U.S. Securities and Exchange Commission, 1997, Guidant Corporation Form 10-K Filing for the Period Ending December 31, 1996).
>
> "The Company's success will depend in large part upon its ability to enhance its existing products and to develop new products to meet regulatory and customer requirements and to achieve market acceptance" (U.S. Securities and Exchange Commission, 1998, Abiomed, Inc. Form 10-K Filing for the Period Ending March 31, 1998).
>
> "A key factor in the Company's continuing success in the future will continue to be its ability to develop new products and improve upon existing products and technologies" (U.S. Securities and Exchange Commission, 2005, Zimmer Holdings, Inc. Form 10-K Annual Report Filing for the Period Ending December 31, 2004).

The pace of innovation in the medical device industry is fast and aggressive, creating an ongoing urgency against technological obsolescence (Littell, 1994). Sourcing product innovation via corporate acquisition is a strategic response to mitigate the risk of obsolescence and to sustain sales and earnings growth.

Distinguishing *Innovative* and *Imitative* Regulatory Approvals

Medical device innovation capability among acquiring firms and target organizations is formulated in an original way by distinguishing and measuring a set of three product innovation indicators based on regulatory approval categories. The first is *patent awards*. The U.S. Patent and Trademark Office website summarizes patents and associated rights as follows:[7]

> "The role of the United States Patent and Trademark Office (USPTO), an agency of the U.S. Department of Commerce, is to grant patents for the protection of inventions and to register trademarks. Any person who invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent, subject to the conditions and requirements of the law. A patent for an invention is the grant of a property right to the inventor. The patent confers the right to exclude others from making, using, offering for sale, selling or importing the invention. Generally, the term of a new patent is 20 years from the date on which the application for the patent was filed. In order for an invention to be patentable it must be new as defined in the patent law. The subject matter sought to be patented must be sufficiently different from what has been used or described before. By protecting intellectual endeavors and encouraging technological progress, the USPTO seeks to preserve the United States' technological edge, which is key to our current and future competitiveness."

The second regulatory approval category is the *510(k) clearance* issued by the Office of Device Evaluation within the U.S. Food and Drug Administration's Center for Devices and Radiological Health.[8] To be approved, a 510(k) submission must

---

[7] Paraphrased from http://www.uspto.gov/go/pac/doc/general/index.html.

[8] The clinical testing, manufacture, labeling, distribution, and promotion of medical devices is regulated by the Center for Devices and Radiological Health's (CDRH) Office of Device Evaluation (ODE). CDRH is one of eight centers/offices within the U.S. Food and Drug Administration (FDA) which, in turn, is an agency of the U.S. Department of Health and Human Services (U.S. Food and Drug Administration, 2005). The Office of

demonstrate that the medical device under consideration is substantially equivalent to a legally marketed predicate device (Center for Devices and Radiological Health, 2004):

> "Applicants must compare their 510(k) device to one or more similar devices currently on the U.S. market and make and support their substantial equivalency claims. The legally marketed device(s) to which equivalence is drawn is known as the 'predicate' device(s). Applicants must submit descriptive data and, when necessary, performance data to establish that their device is substantially equivalent to a predicate device. A device is substantially equivalent if, in comparison to a predicate device it (a) has the same intended use as the predicate device and has the same technological characteristics as the predicate device, or (b) has different technological characteristics that do not raise new questions of safety and effectiveness and the sponsor demonstrates that the device is as safe and effective as the legally marketed device. A claim of substantial equivalence does not mean the new and predicate devices must be identical. Substantial equivalence is established with respect to intended use, design, energy used or delivered, materials, performance, safety, effectiveness, labeling, biocompatibility, standards, and other applicable characteristics."[9]

The third product regulatory approval category is *premarket approval* (PMA) from the Office of Device Evaluation. If 510(k) premarket substantial equivalence cannot be established for a device, then a PMA application is required (Center for Devices and Radiological Health, 2002):

Device Evaluation is responsible for "the program areas through which medical devices are evaluated or cleared for clinical trials and marketing" and "evaluating the safety and effectiveness of medical devices before these devices enter the U.S. market place" (ODE 2004 Annual Report, 2005, pp. 15, 64). Medical devices generally enter the marketplace after the Office of Device Evaluation either (a) clears a 510(k) premarket notification submission or (b) approves a premarket approval (PMA) application (Centers for Medicare and Medicaid Services, 2002).

[9] Paraphrased from http://www.fda.gov/cdrh/devadvice/314.html.

> "Premarket approval (PMA) is the FDA process of scientific and regulatory review to evaluate the safety and effectiveness of devices that support or sustain human life, are of substantial importance in preventing impairment of human health, or which present a potential, unreasonable risk of illness or injury. PMA is the most stringent type of device marketing application required by FDA. The applicant must receive FDA approval of its PMA application prior to marketing the device. PMA approval is based on a determination by FDA that the PMA contains sufficient valid scientific evidence to assure that the device is safe and effective for its intended use(s). An approved PMA is, in effect, a private license granting the applicant (or owner) permission to market the device."[10]

Newness and differentiation from existing products distinguish (a) patent awards and PMA approvals from (b) 510(k) clearances.[11] Whereas patents and PMAs "tend to represent new, often breakthrough technologies," medical products "cleared through a 510(k) are, by definition, 'substantially equivalent' to an earlier, legally marketed device" (Littell, 1994, p. 231). Among acquiring firms and target organizations, pre-acquisition patent and PMA yields demonstrate development and introduction of medical device advancements and *product innovation capability*. In contrast, products cleared through the 510(k) process are less innovative, feature at most a slight modification to a predicate device within the bounds of substantial equivalence, and mitigate obsolescence risk to a much lower degree. The dissertation operationalizes this dissimilarity by distinguishing

---

[10] Paraphrased from http://63.240.199.20/cdrh/devadvice/pma/.

[11] In a telephone interview, the author asked Robert R. Gatling (Director of Program Operations Staff, Office of Device Evaluation, Center for Devices and Radiological Health, U.S. Food and Drug Administration) the following question:

> Q. Is it necessary or advantageous for a medical device seeking premarket approval to already have one or more patent awards connected with it?
> A. "Some devices seeking premarket approval have patent awards connected with them, others do not. It's a mixed bag. We at the FDA don't check on patent information and we don't rely on patent information in our PMA application and review process. The FDA and the patent office function independently."

and measuring acquiring and target firms' record of *innovative* product introductions (those with patent protection or PMA application approval from the FDA) and *imitative* product introductions (those with FDA 510(k) clearance establishing substantial equivalence to a predicate device) as antecedent predictors of acquisition-related financial outcomes.

H1a: Acquirer and target product innovation capability will be positively associated with aggregate post-acquisition financial performance.

H1b: Imitative (substantially equivalent) product introductions will not be positively associated with aggregate post-acquisition financial performance.

Additional Hypothesized Sources of Value Creation

The dissertation research seeks to ascertain conditions under which corporate acquisitions in the medical device industry have enhanced or eroded shareholder wealth and financial accounting performance. Three quotations motivate the investigation:

> "Empirical research has not consistently identified antecedents for predicting post-acquisition performance" (King et al, 2004, p. 187);
>
> "There is a need for a more in-depth investigation of the conditions under which these transactions (corporate acquisitions) create and destroy value" (Singh and Zollo , 1997, p. 6). Subsequently, these same authors wrote, "...explanation of the variance around the mean is still very much in need of both theoretical and empirical work" (Zollo and Singh, 2004, p. 1233);
>
> "The determination of factors that influence acquisition success remains an important research question" (Carow, Heron, and Saxton, 2004, p. 563).

Accordingly, the dissertation utilizes acquisition-related performance heterogeneity to analyze and determine correlates of stock price revaluations and changes in operating cash flow. In addition to externally sourcing product innovation capability via corporate acquisitions (H1), hypothesized antecedents of value creation include production efficiency (H2), building product lines along medical specialties (H3), post-acquisition scale (H4), and prior acquisition experience (H5).

Production Efficiency (H2)

Medical device firms are under pressure to continually improve their cost structures to profitably meet customers' pricing and service demands. Manufacturers with the highest levels of production efficiency are those able to convert raw materials into finished goods in cost- and operationally-effective ways (Groover, 2002; ReVelle, 2002). The following five quotes from management discussion sections of 10-K filings highlight the fundamental importance of production efficiency in the medical device industry:

> "In the current environment of managed care, economically motivated buyers and consolidation among U.S. health care providers, the Company has also been increasingly required to compete on the basis of cost" (U.S. Securities and Exchange Commission, 1999, C. R. Bard, Inc. Form 10-K Filing for the Period Ending December 31, 1998).
>
> "The company's success is dependent upon establishing appropriate manufacturing processes, resolving supply issues, obtaining adequate manufacturing resources, and being able to contain manufacturing costs" (U.S. Securities and Exchange Commission, 1999, Fischer Imaging Corporation Form 10-K Filing for the Period Ending December 31, 1998).

> "Our strategy for guiding the Company's continuing growth (includes) reducing costs through production efficiencies" (U.S. Securities and Exchange Commission, 1994, Ballard Medical Products Form 10-K Annual Report Filing for the Period Ending September 30, 1994).
>
> "Fourth quarter net earnings as a percent of sales was higher than the previous three quarters of the year because manufacturing costs and operating expenses increased at a slower rate than sales" (U.S. Securities and Exchange Commission, 1995, Stryker Corporation Form 10-K Annual Report Filing for the Period Ending December 31, 1994).
>
> "The Company is adapting itself to this environment by promoting the cost effectiveness of its products (and) by striving to efficiently produce the highest quality products at the lowest cost" (U.S. Securities and Exchange Commission, 1997, United States Surgical Corporation Form 10-K Annual Report Filing for the Period Ending December 31, 1996).

Arguments presented by Cohen and Levinthal (1990) and Kogut and Zander (1992) form the foundation for the expectation that efficiently producing acquiring firms, all else being equal, will achieve higher levels of combinative acquirer/target post-acquisition performance compared with inefficiently producing acquirers. In a high-speed and dynamic post-acquisition environment, the ability of firms to recognize, assimilate, and apply new information and opportunities to commercial ends (i.e., its absorptive capacity) is largely a function of prior related knowledge (Cohen and Levinthal, 1990). Applying this reasoning to cost management capabilities, efficiently producing acquiring firms are most likely to be creative in solving production efficiency challenges in the post-acquisition phase. Because organizational know-how is not easily imitated or replicated (Nelson and Winter, 1982; Kogut and Zander, 1992), acquirers with cost management and efficient manufacturing proficiencies are better prepared to develop and implement further cost structure innovations over time.

Moreover, acquiring firms may target under-performing and inefficiently operated

producers as turnaround opportunities. Acquirers may purchase poorly managed and financially distressed target assets in order to reap revenue and earnings growth following implementation of operational improvement initiatives and financial control systems. In contrast, the potential for acquisition-related productivity gains and financial improvement between pairs of efficient producers may be limited by a high base rate of performance (Ramaswamy, 1997). Therefore, in corporate acquisitions, the greatest levels of post-acquisition performance improvement (that is, positive stock price revaluations and changes in operating cash flow) are expected to be achieved by combinations of efficiently producing acquiring organizations and inefficiently producing target firms.[12]

> H2: Acquirer production efficiency coupled with target production inefficiency will be positively associated with aggregate post-acquisition financial performance.

Building Product Lines Along Medical Specialties (H3)

The marketing literature defines a product line as a group of products that are closely related because they function in a similar manner or are sold to the same customer groups (Kotler, 1988). Similarly, in the strategic management literature, relatedness refers to the extent to which the products of two or more firms serve similar customers, share distribution systems, utilize similar production technologies, or exploit similar scientific

[12] In order to achieve economies of scale, both production efficiency and sufficient organizational size are required. Hypothesis 2 addresses production efficiency; Hypothesis 4 (combinative post-acquisition scale) addresses organizational size.

research (Rumelt, 1974). Rumelt (1974, 1982), Palepu (1985), Singh and Montgomery (1987), and Ramaswamy (1997) have demonstrated that related acquisitions achieved greater total dollar gains than unrelated acquisitions. By bundling and marketing broad and integrated sets of related products, manufacturers pursue economies of scope in selling and may achieve valuable, rare, and difficult-to-imitate customer relationship capabilities (Barney, 1991; Capron, Dussauge, and Mitchell, 1998; Burns et al, 2002). If these integrated product bundles are difficult and costly for competitors to replicate, then entry barriers may permit sustained competitive advantage (Porter, 1980; Barney, 1991).

Medical device firms build product lines along two dimensions: product line breadth (number of different products within a clinical specialty area) and product line depth (number of types or variations of each product within the clinical specialty area). The dissertation's empirical measures distinguish whether a corporate acquisition increased the buying firm's product line breadth and/or depth. The following five quotes from S-4 and 10-K corporate filings provide first-hand descriptions of the strategic rationale driving product line development among medical device manufacturers:

> "The Merger responds to the changing needs of this evolving customer base by filling gaps in Boston Scientific's existing catheter product line, thereby allowing the combined company to offer one of the broadest product lines in the world for less invasive diagnosis and therapy" (U.S. Securities and Exchange Commission, 1997, Form S-4 filing for the purchase of Target Therapeutics, Inc. by Boston Scientific Corporation).

> "These acquisitions have helped the Company to achieve a strategic mass, which allows it to offer one of the broadest product lines in the world for use in less-invasive procedures. The depth and breadth of the Company's product portfolio has also enabled it to compete more effectively in, and better absorb the pressures of, the current health care environment of cost containment, managed care, large buying groups and hospital

consolidations" (U.S. Securities and Exchange Commission, 2004, Boston Scientific Corporation, Form 10-K Filing for the Period Ending December 31, 2003).

"In particular, management has noted a recent move toward increased consolidation in the medical device industry, which it understands to be driven largely by the need to broaden product lines...and to enable bundling and capitation arrangements with hospitals and managed care organizations, which are increasingly taking actions that favor medical device companies offering large and cost-effective product portfolios" (U.S. Securities and Exchange Commission, 1996, Form S-4 filing for the purchase of Daig Corporation by St. Jude Medical, Inc.).

"The Cardiac Surgery business includes the Heart Valves, Cardiopulmonary, Cannulae and Blood Management businesses. Through a series of strategic acquisitions over the past decade, Medtronic now markets a complete line of blood-handling products that form a life-saving circuit by maintaining blood circulation, oxygen supply and body temperature while the patient is undergoing emergency treatment or open-heart surgery" (U.S. Securities and Exchange Commission, 1996, Medtronic, Inc., Form 10-K Filing for the Period Ending April 30, 1996).

"The Company has set the strategic objectives of focusing on the diagnosis, monitoring and treatment of the respiratory-impaired patient across the worldwide continuum of care and of growing through product line extensions, other internal developments and through acquisitions and strategic combinations in order to broaden its product line and enhance its competitive position" (U.S. Securities and Exchange Commission, 1995, Nellcor Puritan Bennett Incorporated, Form 10-K405 Filing for the Period Ending July 2, 1995).

H3: Building product lines along medical specialties will be positively associated with aggregate post-acquisition financial performance.

Post-Acquisition Scale (H4)

Medical device firms often cite scale economies due to increasing organizational size as a motive for corporate acquisitions. Scale economies exist when average unit cost of production decreases with increasing production (Brealey and Myers, 1988). Post-acquisition integration and consolidation processes pursue returns to scale by (a) restructuring and redeploying target and acquirer resources, (b) disposing redundant assets, and (c) spreading fixed costs over a larger asset base (Capron, 1997; Burns, 2005). Compared with smaller medical device manufacturers, all else being equal, larger medical technology firms may have greater:

- Capacity to fund research and development expenditures, clinical testing of new products, and regulatory approval processes;
- Access to debt and equity capital financing;
- Ability to absorb significant price discounting and increased levels of product servicing;
- Cross-selling opportunities between customer bases; and
- Economies of scope (Nash and Sinkey, 1997; Standard & Poor's, 1998; Centers for Medicare and Medicaid Services, 2003; First Research, 2005; Burns, 2005; Gold, 2005).

Additionally, in exchange for supplying larger firms with new or development-stage products and other organizational resources, acquired smaller manufacturers may expand their access to:

- National distribution channels and purchasing group contracts;

- Established networks of sales representatives having existing relationships with physicians and hospitals; and

- Higher manufacturing capacity and production at or above minimum efficient scale (Carlton and Perloff, 1994; Centers for Medicare and Medicaid Services, 2003; First Research, 2005; Burns, 2005; Gold, 2005).[13]

Rationale stated by medical device firms for seeking increased organizational scale is illustrated in the following three quotes from S-4 and 10-K corporate filings:

> "This acquisition is expected to strengthen the Company's offerings of urological products, reduce costs through economies of scale, and foster growth by leveraging common technologies" (U.S. Securities and Exchange Commission, 2002, Medtronic, Inc. Form 10-K Filing for the Period Ending April 26, 2002).
>
> "The St. Jude Medical Board believes that the changing health care environment, including the increasing emphasis on cost containment, the emergence of large managed-care buying groups and hospital consolidations and the potential for increased federal regulation, requires that a successful medical device company have a certain critical mass to compete effectively in the market and to absorb the pressures of the managed-care structure" (U.S. Securities and Exchange Commission, 1996, Form S-4 filing for the purchase of Daig Corporation by St. Jude Medical, Inc.).
>
> "The acquisitions have also helped the Company to reach a certain strategic mass which should enable it to compete more effectively in, and better absorb the pressures of, the current healthcare environment of cost containment, managed-care, large buying groups and hospital consolidations" (U.S. Securities and Exchange Commission, 1997, Boston Scientific Corporation Form 10-K Filing for the Period Ending December 31, 1996).

H4: Post-acquisition combinative scale will be positively associated with aggregate post-acquisition financial performance.

[13] Minimum efficient scale for a firm is defined as the lowest level of output where average cost is minimized (Carlton and Perloff, 1994; Given, 1996).

Prior Acquisition Experience (H5)

The nature and impact of prior acquisition experience, organizational learning, knowledge, and capabilities development on acquisition performance has received considerable attention in the management literature (e.g., Fowler and Schmidt, 1989; Bruton, Oviatt, and White, 1994; Haleblian and Finkelstein, 1999; Hayward, 2002; King et al, 2004; Zollo and Singh, 2004). Haleblian and Finkelstein (1999) observed that, "The vast majority of research on organization experience adopts a learning-curve perspective that predicts positive returns to experience" (p. 29). Fundamentally, experience and learning lead to the development of acquisition management practices and the ability to manage the acquisition process more effectively. Organizational memory and the "lessons of experience are maintained and accumulated within routines" (Nelson and Winter, 1982; Levitt and March, 1988, p. 326). Organizational routines (a) are "the rules, procedures, technologies, beliefs, and cultures" that guide organizational behavior, (b) are modified and updated "in response to direct organizational experience" and (c) persist despite the turnover of personnel (Levitt and March, 1988, p. 326, 321). Firms with prior acquisition experience (and accompanying codified procedures to guide acquisition-related processes such as due diligence, financial evaluation, information technology conversion, human resources integration, and sales/product integration) are better able to assess and select potential targets and manage the post-acquisition integration phase (Cohen and Levinthal, 1990; Zollo and Singh, 2004).

H5: Prior acquisition experience will be positively associated with aggregate post-acquisition financial performance.

Major Control Variables

Relative Size of Target to Acquirer. Prior research has documented a positive relationship between (a) size of the target organization relative to the acquiring firm and (b) wealth-enhancing stock price revaluations to acquirer shareholders (Asquith, Bruner, and Mullins, 1983; Jarrell and Poulsen, 1989) and to portfolio combinations of acquirer/target shareholders (Seth, Song, and Pettitt, 2002). When an acquirer takes over a larger (compared with a smaller) target, there is greater potential for creating market power, gains from asset sharing, and managerial economies in the post-acquisition organization (Seth, 1990; Seth, Song, and Pettitt, 2002). Also, all else being equal, a larger-sized target may command greater attention and commitment from acquiring managers (Salter and Weinhold, 1979; Bergh 2001).

In contrast, as target size decreases relative to the acquirer, "then even if the target's operations are substantially improved, the net effect" of acquisition-related changes in stock prices or cash flows in the combined firm becomes increasingly diminished (Pilloff, 1996, p. 302). In addition, when targets are relatively small (e.g., an entrepreneurial firm with a dominant leader and relatively few employees), the "human needs of the acquired firm tend to get overlooked or trivialized by the buyer. Alienation breeds its own source of discontent which can prevent a merger from realizing its financial potential" (Very et al, 1997, p. 596). In the post-acquisition environment, entrepreneurs may "feel relatively unimportant, even insignificant in the new power structure" (p. 596). Therefore, acquisition-related stock price gains and cash flow improvements are expected to be more readily observed as the target increases in size relative to the acquirer (Jarrell and Poulsen, 1989).

Collar Provision. In corporate acquisitions, collar provisions limit target shareholders' downside risk in the event of declines in the acquiring firm's stock price between the time of initial acquisition announcement and closing. Typically, a collar contract includes both a lower collar (a floor that limits downside risk) and an upper collar (a ceiling that limits upside potential), and the target firm is "willing to forego upside potential in return for obtaining this downside protection" (Chicago Board Options Exchange, 2002). The following example (based on Officer, 2004), illustrates how a collar provision establishes lower and upper limits on the final purchase price paid to target shareholders:

> Example of a collar provision: Company A (acquiring firm) is buying Company T (target firm). If the 10-day average of A's common stock as of the trading day prior to the effective date is between $41.875 (the lower collar) and $44.875 (the upper collar) per share, then T's shareholders will receive 0.6686567 shares of A for each share of T owned. If A's stock price is below $41.875, then T shareholders will receive $28 of A shares for each T share owned. If A's stock price is above $44.875, then T shareholders will receive $30 of A shares for each T share owned (Officer, 2004, pp. 2719-2721).
>
> For a target shareholder (TS) who owns 10,000 shares of T, if the 10-day average of A's common stock as of the trading day prior to the effective date is:
> - $32 per share, then TS receives 8,750 A shares worth $280,000 (lower collar)
> - $40 per share, then TS receives 7,000 A shares worth $280,000 (lower collar)
> - $42 per share, then TS receives 6,686.567 A shares worth $280,836
> - $43 per share, then TS receives 6,686.567 A shares worth $287,522
> - $44 per share, then TS receives 6,686.567 A shares worth $294,209
> - $48 per share, then TS receives 6,250 A shares worth $300,000 (upper collar)
> - $50 per share, then TS receives 6,000 A shares worth $300,000 (upper collar).

The act of adopting a collar contract to protect target shareholders against downward movements in the acquiring firm's share price may be interpreted by the market as a signal of risk, concern, or uncertainty surrounding the transaction. Alternatively, absence of a collar may signal management confidence in both the merits of the acquisition and expected acquirer stock market performance leading up to the deal's effective date (Jurgens, 2000).

Use of Cash as a Method of Payment. Numerous studies have documented empirical evidence that stock price returns (Travlos, 1987; Brown and Ryngaert, 1991; Franks, Harris, and Titman, 1991; Houston and Ryngaert, 1994; Loughran and Vijh, 1997; Carow, Heron, and Saxton, 2004; Megginson, Morgan, and Nail, 2004) and improvements in cash flow (Ghosh, 2001; Linn and Switzer, 2001; Megginson, Morgan, and Nail, 2004) are more favorable following cash-financed acquisitions compared with stock-financed ones. Berkovitch and Narayanan (1990) emphasize that "investigations of the effect of the medium of exchange have found that stockholders of both acquiring and target firms earn higher returns when the acquisition is financed by cash rather than stock" (p. 154). The financial economics literature offers two explanations for the superior performance of cash-financed acquisitions.

First, in announcing a cash-financed acquisition, an acquiring firm signals private information to the market that (a) its stock price is undervalued and (b) it is confident about its assets, capabilities, and opportunities. In contrast, "Stock offers...send two powerful signals to the market: that the acquirer's shares are overvalued and that its management lacks confidence in the acquisition" (Myers and Majluf, 1984; Rappaport

and Sirower, 1999, p. 154). Travlos (1987) explains:

> "In a world of asymmetric information, the method of payment may signal valuable information to the market. If the bidding firms' managers possess information about the intrinsic value of their firm, independent of the acquisition, which is not fully reflected in the pre-acquisition stock price, they will...prefer a cash offer if they believe that their firm is undervalued, while a common stock exchange offer will be preferred in the opposite case. Accordingly, the market participants interpret a cash offer as good news and a common stock exchange offer as bad news about the bidding firm's true value" (p. 944).

If the management team of an acquiring firm privately believes that its stock price is greater than the company's intrinsic per share value, then it will be reluctant to purchase target assets with cash and instead prefer to transact the acquisition with overvalued shares (the higher the share price, the fewer the number of shares required to meet a given purchase amount). The market, in turn, will react to an announcement of stock financing with suspicion that the acquirer's stock price is overvalued.

Also, in cash-financed acquisitions, acquiring firms signal confidence by committing upfront to absorb all of the acquisition's potential losses. "This contrasts with equity-based offers, where the target firm's shareholders still bear the risks associated with a poorly performing acquisition due to their ownership in the surviving firm" (Carow, Heron, and Saxton, 2004, p. 568). Therefore, acquirers who are "confident that they have identified undervalued targets and/or significant synergies are more likely to use cash than stock" (Carow, Heron, and Saxton, 2004, p. 580). Linn and Switzer's (2001) multi-industry findings support this linkage between "favorable private information about potential synergies" and acquisition-related cash flow improvements

(Linn and Switzer, 2001, p. 1134).

A second explanation for why cash-financed acquisitions outperform stock-financed acquisitions is lower deal complexity. According to Hayward (2003), "Relative to cash-financed acquisitions, stock-financed acquisitions are complex transactions that more extensively utilize...knowledge and thus expertise. Whereas cash-financed acquisitions require valuation of the target's stock, stock-financed acquisitions require valuation of (a) the target's stock, (b) the acquirer's stock, and (c) an exchange rate that persuades target shareholders to exchange their stock for that of the acquirer" (p. 785). Acquisition-related financial performance, then, declines with increasing transaction complexity.

Market Concentration. In the industrial organizational perspective, consolidation in product markets via corporate acquisitions increases market concentration, which, in turn, can lead to a lower level of competition, increased market power, elevated entry barriers, higher price-cost ratios, and greater profitability for the combined entities (Bain, 1951; Scherer, 1970; Porter, 1980; Harrigan, 1981; Carlton and Perloff, 1994; Capron, 1997; McDonald, 1999; Huck, Konrad, and Muller, 2004). Among medical device manufacturers, acquisition-related consolidation may increase post-combination market power and raise entry barriers for new firms by (a) elevating access to and negotiation leverage with high-volume purchasing groups and (b) expanding capacity to fund research, development, regulatory, production, and marketing costs (Mitchell, Shaver, and Yeung, 1994; Frech and Mobley, 2000; Burns et al, 2002; Centers for Medicare and Medicaid Services, 2003; Burns, 2005; First Research, 2005; Gold, 2005). As a result of

these market power and entry barrier enhancements, all else being equal, post-acquisition financial performance is expected to be higher in more concentrated industry settings.

Merger (versus Partial Acquisition). In a *merger*, 100 percent of the target organization is purchased. Acquisition is a more general term, and the phrase *partial acquisition* used in this thesis emphasizes that less than 100 percent of the target organization (e.g., a division or product line) was purchased by the acquirer in the corporate transaction. Overall, buying firms' ability to leverage acquired assets, technology, and strengths is expected to be greater when all (and not just a portion) of the target organization is purchased. As Chaudhuri (2005) explains, given challenges of post-acquisition integration "it may not be in the best interest of the purchasing company to rush the integration process. Rather, the better move may be to *allow the smaller company to continue operations as usual*" for some period of time.

Acquisition Propensity. Snail and Robinson (1998) and Danzon, Epstein, and Nicholson (2004) observe that likelihood of entering into an acquisition agreement and choice of acquisition partner are influenced by ex-ante organizational and industry conditions. The dissertation develops and assesses two variables to control for acquisition propensity. The first is Tobin's q, the ratio of market-to-book value of the firm's assets, in the last full fiscal year before the acquisition announcement. Danzon, Epstein, and Nicholson (2004) report, for example, that "firms with a relatively low Tobin's q are more likely to be acquired...which is consistent with acquisition being a mechanism to transfer assets to more effective managers" (p. 24). The second control for acquisition

propensity is recent trend in overall stock market performance, defined as the change in S&P 500 index level during a six-month period (the last two full calendar quarters) before acquisition announcement. Pre-acquisition trend in S&P 500 index is included as a control variable because corporate acquisition activity has been shown to be positively correlated with stock market valuations (Nelson, 1959; Melicher et al, 1983; Clarke and Ioannidis, 1996; Rhodes-Kropf and Viswanathan, 2004).

Overall Null Hypothesis

The overall null hypothesis for the study is that the hypothesized predictors (independent variables), taken as a group, along with the major control variables, have no predictive ability to explain aggregate post-acquisition financial performance (the dependent variable).

Summary of Hypothesized Relationships

Table 3 (next page) summarizes hypothesized relationships between the independent variables and post-acquisition financial outcomes. This table reappears in Chapter 5 as Table 28 with the addition of columns that summarize empirical results.

Table 3:
Summary of Hypothesized Relationships

	Predicted Effect on Post-Acquisition Financial Outcomes
H1: Product Innovation Capability	
Patent and PMA Yields	+
510(k) Yields	-
H2: Production Efficiency	
Acquirer	+
Target	-
H3: Building Product Lines Along Medical Specialties	+
H4: Post-Acquisition Scale	+
H5: Prior Acquisition Experience	+

CHAPTER 3: METHODS

Unit of Analysis

The primary unit of analysis is the acquirer/target dyad.

Definition of the Industry Under Study

The medical device industry is defined as firms manufacturing equipment and supplies in one or more of the following four 4-digit Standard Industrial Classification (SIC) codes (Standard Industrial Classification Manual, 1987; U.S. Census Bureau, 2004a):[14]

SIC 3841: Surgical and Medical Instruments and Apparatus. Products manufactured in this industry segment include anesthesia equipment, biopsy instruments, blood pressure apparatus, bone drills, cannulae, catheters, retractors, stethoscopes, surgical clamps, surgical stapling devices, suture needles, and trocars.

SIC 3842: Orthopedic, Prosthetic, and Surgical Appliances and Supplies. Cervical collars, crutches, fracture appliances, infant incubators, orthopedic braces, patient restraints, surgical implants, splints, stretchers, sutures, traction apparatus, and wheelchairs are among the items produced in this classification code.

SIC 3844: X-Ray Apparatus and Tubes and Related Irradiation Apparatus. Technologies manufactured in this category include fluoroscopes, nuclear irradiation equipment, and X-ray apparatus and tubes.

[14] SIC code 3843 (Dental Equipment and Supplies) is not included in the study.

SIC 3845: Electromedical and Electrotherapeutic Apparatus. Medical devices manufactured in this segment include computed tomography (CT) scanners, defibrillators, dialyzers, endoscopic equipment, lithotripters, magnetic resonance imaging devices, pacemakers, patient monitoring equipment, and ultrasonic scanning devices.[15]

Rationale for Combining These Four SIC Codes to Define the Industry. The recurrence and overlap of these four SIC codes (3841, 3842, 3844, and 3845) within and across medical device manufacturers in the study sample justify the aggregation. To illustrate, Table 4 (next page) presents primary and secondary SIC classifications (as listed by the Securities Data Corporation (SDC) Worldwide Mergers and Acquisitions) for several of the acquiring firms and target organizations under study. For example, at the time of its May 1984 acquisition, Biomet was producing in SIC codes 3842, 3841, and 3845. St. Jude Medical manufactured products in all four categories. For Medtronic, as of May 1990, SIC codes 3845, 3841, and 3842 are listed. Both CR Bard and Bird Medical Technologies made products coded as 3841, 3842, and 3845. Medical device manufacturing by Cordis fell under SIC codes 3844, 3841, and 3842. Johnson & Johnson, whose primary SIC code is 2834 (pharmaceutical preparations), also competed in 3842 and 3841.

[15] Because considerable product heterogeneity exists within the individual 4-digit SIC codes, product data by medical specialty area are extracted from two additional sources: the Health Devices Sourcebook (published by ECRI) and Medical Device Register (published Medical Economics). These two resources are annual references and provide like medical product information.

Table 4: Primary and Secondary SIC Codes for Selected Medical Device Manufacturers

Firm Name	Acquirer or Target	Acquisition Announcement Date	Primary SIC Code	Secondary SIC Codes
Biomet Inc	Acquirer	May 18, 1984	3842	3841, 3845
American Hospital Supply Corp	Target	June 21, 1985	3841	3842
St. Jude Medical Inc	Acquirer	November 15, 1988	3845	3842, 3844, 3841
LecTec Corp	Acquirer	October 12, 1989	3845	3842
Medtronic Inc	Acquirer	May 16, 1990	3845	3841, 3842
Becton Dickinson & Co	Acquirer	April 4, 1991	3841	3842
Electromedics Inc	Target	November 19, 1993	3841	3845
ADAC Laboratories	Acquirer	February 10, 1994	3845	3844, 3841
CR Bard Inc	Acquirer	May 24, 1995	3841	3842, 3845
Bird Medical Technologies Inc	Target	June 9, 1995	3841	3842, 3845
Cordis Corp	Target	October 19, 1995	3844	3841, 3842
Imagyn Medical Inc	Target	April 21, 1997	3845	3841
Johnson & Johnson	Acquirer	July 21, 1998	2834	3842, 3841
Conmed Corp	Acquirer	July 13, 1999	3845	3841

Source: SDC Database

Conversion to NAICS. In 1997, the U.S. Office of Management and Budget introduced the North American Industry Classification System (NAICS) to replace the 1987 Standard Industrial Classification. Achieving international data comparability among the North American Free Trade Agreement nations (United States, Canada, and Mexico) was a leading motivation for conversion to NAICS. The 1997 NAICS also expanded the number of codified service sectors and emerging industries (U.S. Office of Management and Budget, 1997; Krishnan and Press, 2003).

For the set of four SIC codes that comprise the medical device industry, comparability and time series continuity were preserved among the 1987 SIC, 1997 NAICS, and 2002 revised NAICS (U.S. Census Bureau, 2004a). Table 5 documents the correspondence between 1987 SIC and 2002 NAICS codes for medical device producers.

Table 5: Correspondence Between 1987 SIC and 2002 NAICS Codes

SIC 3841: Surgical and Medical Instruments and Apparatus	<===>	NAICS 339112: Surgical and Medical Instrument Manufacturing
SIC 3842: Orthopedic, Prosthetic, and Surgical Appliances and Supplies	<===>	NAICS 339113: Surgical Appliance and Supplies Manufacturing
SIC 3844: X-Ray Apparatus and Tubes and Related Irradiation Apparatus	<===>	NAICS 334517: Irradiation Apparatus Manufacturing
SIC 3845: Electromedical and Electrotherapeutic Apparatus	<===>	NAICS 334510: Electromedical and Elecrotherapeutic Apparatus

Source: U.S. Census Bureau (2004a)

Study Dates

Acquisitions announced during the 16-year period January 1, 1984, to December 31, 1999, are investigated. For each corporate combination, post-acquisition financial performance data were collected for four fiscal years following the effective date of the deal.[16] Because the study sample includes acquisitions announced during 1999 but completed in 2000, the data under study extend through 2004 (most recent available). The next paragraphs provide rationale for the study's starting date and identify several categories of events and developments during the study period that might impact the financial outcomes of corporate acquisitions in the medical device industry.

[16] An acquisition's announcement date marks its public announcement. The effective date is the date when the transaction is completed and effective.

Rationale for Starting Date. January 1, 1984, was selected as the beginning of the study period for two reasons. First, it commences the first full year following the introduction of Medicare's landmark prospective payment system (PPS) for inpatient hospital services. On March 3, 1983, U.S. Rep. Dan Rostenkowski (D-IL) sponsored H.R.1900 titled "A Bill to Assure the Solvency of the Social Security Trust Funds, to Reform the Medicare Reimbursement of Hospitals, to Extend the Federal Supplemental Compensation Program, and For Other Purposes," which was passed as Public Law No: 98-21 by the 98th Congress on April 20, 1983. Then, in October 1983, Medicare launched a 3-year nationwide phase-in of "a method for the payment of hospitals for operating costs of inpatient hospital services on the basis of DRG (diagnosis-related group) prospective rates" to replace retrospective cost-based reimbursement (U.S. Library of Congress, 1983). Public Law 98-21 marked a new era of reimbursement policies by government and commercial third-party payers that fundamentally altered financial incentives faced by health services providers. Under retrospective cost-based reimbursement, Medicare paid hospitals based on actual costs incurred in providing patient care services; higher levels of reported expenses yielded higher reimbursement levels. Retrospective cost-based reimbursement was highly cost inflationary because it provided little incentive for cost efficiency and hospitals did not bear financial risk for excess costs (Santerre and Neun, 2000). In contrast, under fixed, predetermined per case reimbursement, hospitals make a profit on a given admission if expenses are below the per case rate, and lose money if expenses exceed the per case rate. Rundall et al (2004) observe that "introduction of the prospective payment system by Medicare in 1983 placed hospitals at financial risk for the care provided to Medicare patients and caused managers

in many hospitals to implement policies and procedures to control expenditures" (p. 252).[17] Over the course of the study period, tightening reimbursement policies and heightened cost containment pressures (affecting hospitals and other sites of care) increased the role and importance of group purchasing organizations (GPOs). The GPOs, in turn, consolidated to build scale, market power, and negotiation leverage, and medical device manufacturers consolidated as well to offer product line breadth and depth in contracting with GPOs, provider organizations, and individual physicians (Burns et al, 2002; Burns, 2005). The second reason for the selected starting date is that data

[17] Cost-containment pressures among hospitals and other sites of care impacted medical device manufacturers because these provider organizations adopted, for example, stricter policies for the purchase of capital equipment and non-capital medical supplies, reductions in inventory levels, group purchasing, and product standardization (Burns et al, 2002; Shukla et al, 2003; Burns, 2005; Gold, 2005). Cost containment awareness and activities commenced before 1983, then expanded and intensified throughout the years since Medicare PPS. Concern over annual growth in national health expenditures predated Medicare PPS, and news articles from hospital management trade journals as well as the academic health care literature document that cost containment initiatives (such as nascent participation in group purchasing) among health services providers were under development before Medicare PPS. For example, the following titles from Hospitals evidence growing pre-PPS cost containment attention and activity among health care managers: "AHA Recommends Cost-Containment Committees" by Lille and Danco (1976); "Growth and Development of a Group Purchasing Program" by Pollard (1977); "Cost Containment Pressures Make Suppliers Partners in Productivity" by Appelbaum (1979); "Medical Staff Helps Set Priorities for Equipment Purchases" by Landgarten (1979), and "From Light-Bulbs to CT Scanners: Group Purchasing is Filling the Bill at a Lower Price" by Richards (1982). Hospital cost containment, group purchasing, and supplies management were being addressed in the academic literature as well: "Politics and Economics of Hospital Cost Containment" (1978) by Raphaelson and Hall; "Marrying Regulatory and Competitive Approaches to Health Care Cost Containment" (1978) by Kingsdale; "Effects of Hospital Cost Containment on Development and Use of Medical Technology" (1978) by Warner; Hospital Cost Containment Programs: Policy Analysis (1978) by Hughes et al; "Voluntary Standardization of Medical Devices and Procedures" (1983) by Kaufman; and "The Effectiveness of Group-Purchasing Organizations" (1984) by Cleverly and Nutt. In summary, Medicare PPS was a major inflection point that elevated and accelerated cost containment practices, including stricter policies for the purchase and management of capital equipment and non-capital medical supplies.

availability and completeness across sources were found to be lacking prior to January 1984.

Events and Developments During the Study Period. The study period encompasses (a) several cycles of bear and bull markets,[18] (b) enactments of new federal regulations issued by the U.S. Food and Drug Administration (e.g., Safe Medical Devices Act of 1990, FDA Modernization Act of 1997), (c) periods of prolonged and more expedient FDA review times for new products, (d) court rulings and litigation outcomes that sometimes broadly affected medical device manufacturers and other times related to only a few competitors, (e) revisions in insurance coverage, coding, and reimbursement across inpatient and outpatient settings by the Center for Medicare and Medicaid Services (CMS) and private health insurers, and (f) intensification and persistence of cost containment pressures among hospitals and other health care facilities. In the multivariate analyses (detailed later in this chapter), market cycles and regulatory/judicial events are operationalized several different ways to control for and assess their impact on acquisition-related financial outcomes.

[18] Business cycles include the four consecutive quarter-to-quarter declines in S&P 500 index level from 3Q1983 through 2Q1984, the bull market from 3Q1984 - 3Q1987, the October 1987 stock market crash, the bull market from 1Q1988 - 3Q1989, the bear market beginning late 1989 leading into the July 1990 – March 1991 recessionary period, and the subsequent bull market that continued through 1999) (Lunde and Timmermann, 2004; U.S. Census Bureau, 2004b; Standard & Poor's, 2005). Because numerous authors (e.g., Nelson, 1959; Melicher, Ledolter, and D'Antonio, 1983; Clarke and Ioannidis, 1996; Rhodes-Kropf and Viswanathan, 2004) have documented a positive correlation between stock market valuations and corporate acquisition activity, pre-acquisition recent trend in S&P 500 index is employed in the regression analyses as a control for acquisition propensity.

Sample Selection Procedure

The sample of corporate transactions was identified by applying eight selection criteria to the Securities Data Corporation (SDC) Worldwide Mergers and Acquisitions database:

1. The announcement date lies between January 1, 1984, and December 31, 1999;
2. The primary 4-digit SIC code of either the acquiring or target firm is 3841, 3842, 3844, or 3845;
3. The acquirer organization is headquartered in the United States;
4. The transaction is classified as an acquisition or merger (i.e., buybacks, repurchases, and exchange offers were excluded);
5. The transaction is listed as completed;
6. The acquirer owned between 51 and 100 percent after the transaction;
7. The acquirer acquired between 51 and 100 percent in the transaction; and
8. Both the acquirer and target (or their parent companies) are publicly traded.

This procedure yielded 273 corporate acquisitions for which pre- and post-acquisition data were available. Examples of corporate transactions in the sample include:

- Pfizer's acquisition of Angiomedics Inc., announced December 1, 1986;
- Johnson & Johnson's acquisition of Mitek Surgical Products, announced January 4, 1995; and

- Alaris Medical's acquisition of the Infusion Systems Division of InvaCare Corp., announced May 20, 1998.

Appendix 2 lists the 273 corporate transactions in the sample (averaging one every 21.4 days during the 16-year study period). Nineteen of the 20 largest medical device producers (ranked by 2003 net sales as reported in the Compustat Business Segment database) appear in the sample. The sole exception, Edwards Lifesciences, the 19th largest medical device firm in 2003, became an independent company in 2000 following its spin-off from Baxter International.

Table 6 tallies the sample by year of announcement. Acquisition activity began to intensify after the economic recession ended in March 1991 and further accelerated during the long bull market of the 1990s. The jump in acquisition activity between 1993 and 1995 was contemporaneous with (a) President Clinton's Health Security Act of 1993 (which was widely and heatedly discussed until and even after its death in Congress the following year), (b) ongoing consolidation and integration of hospitals, physician practices, outpatient facilities, long-term care facilities, and home health entities into increasingly large organized delivery systems, and (c) continued managed care enrollment growth and consolidation among managed care entities. The maximum number of acquisition announcements in a year was 36 in 1997, and the minimum was 3 in 1984.[19]

[19] Appendix 3 offers a completeness check of the SDC Mergers and Acquisitions data set using Adam Fein's dissertation (Fein, 1997). Whereas Fein (p. 184) reported eleven acquisitions for Cardinal Health during the period 1978 to 1995, the SDC database identified twelve. Because the SDC database identified at least as many acquisitions as reported by Fein, the author is confident that the SDC database of corporate acquisitions is satisfactorily complete.

Table 6: Acquisitions in the Sample by Year

Year of Announcement	Number of Acquisitions	Percent of Total	Cumulative Percent of Total
1984	3	1.1%	1.1%
1985	8	2.9%	4.0%
1986	10	3.7%	7.7%
1987	6	2.2%	9.9%
1988	9	3.3%	13.2%
1989	9	3.3%	16.5%
1990	9	3.3%	19.8%
1991	15	5.5%	25.3%
1992	12	4.4%	29.7%
1993	14	5.1%	34.8%
1994	23	8.4%	43.2%
1995	35	12.8%	56.0%
1996	28	10.3%	66.3%
1997	36	13.2%	79.5%
1998	33	12.1%	91.6%
1999	23	8.4%	100.0%
Total	273	100.0%	

Data Sources

Ten sources were used to construct the study's data set: (a) Securities Data Corporation (SDC) Worldwide Mergers and Acquisitions database, (b) Center for Research in Security Prices (CRSP) database, (c) Standard & Poor's Compustat financial data files, (d) CPI Detailed Report published by U.S. Department of Labor's Bureau of Labor Statistics, (e) Patent Full-Text and Image Database provided by the U.S. Patent and Trademark Office, (f) U.S. Food and Drug Administration's Center for Devices and Radiological Health approvals database, (g) the Health Devices Sourcebook and Medical Device Register annual series, (h) Factiva online database for news articles, (i) Standard

& Poor's website for past S&P 500 index levels, and (j) U.S. Food and Drug Administration's Office of Device Evaluation annual reports.

Measures

Dependent Variables

Two dependent variables gauging acquisition-related financial performance are operationalized: (a) *cumulative abnormal stock market returns* and (b) *market-adjusted change in pretax operating cash flow return on sales*. The two measures are based on fundamentally different types of data. First, cumulative abnormal stock market returns are measured during a relatively short event window surrounding the acquisition announcement and indicate forward-looking revaluations that reflect the market's revised consensus about a firm's future financial performance following change in corporate ownership. In contrast, change in pretax operating cash flow return on sales is drawn from financial statements and reflects realized post-acquisition economic performance (Anand and Singh, 1997; Healy, Palepu, and Ruback, 1997).

Cumulative Abnormal Stock Market Returns.[20] Standard market-model event study methodology is performed to estimate abnormal stock returns to acquiring firms, target organizations, and portfolio combinations of paired acquirers and targets. Acquisition announcement is the event around which stock price revaluations are investigated. Essentially, a firm's abnormal announcement return is the difference

[20] An articulation of the fundamental importance of shareowner value creation by businesses (including medical device manufacturers) to the health, stability, and growth of the U.S. economy is presented in Appendix 4. The statement was written by Roberto Goizueta, the late Chairman and Chief Executive Officer of The Coca-Cola Company.

between (a) its actual stock return surrounding the acquisition announcement and (b) an estimation of its stock performance over the same time period had the acquisition announcement not occurred. "Hence, the impact of an event is measured by the part of the return that is unanticipated by an economic model of anticipated, normal returns" (Haleblian and Finkelstein, 1999, p. 41).[21]

"Event studies are based on the idea of informationally efficient markets" (Finkelstein and Haleblian, 2002, p. 41). "Because of the scrutiny and immediate feedback offered by the capital markets...(the event study) approach assumes that the market, on balance, can accurately discern the announced transaction's worth" (Harris and Shimizu, 2004, p. 781). "A substantial amount of evidence can be assembled supporting the market efficiency argument...Results from over 100 studies, carefully documented by Elton and Gruber (1987), show that the market responds rapidly to new information...As Jensen (1988) noted, although the evidence is not literally 100 percent in support of the efficient market hypothesis...there is ample evidence for the market efficiency assumption underlying event study methodology" (Haleblian and Finkelstein, 1999, p. 41). "Thus the event's economic impact can be measured using asset prices observed over a relatively short time period" (Campbell, Lo and MacKinlay, 1997, p. 149). A seven-step procedure is performed to compute abnormal announcement returns.

---

[21] Published studies that use the market-model event study methodology presented here include Dodd and Warner, 1983; Brown and Warner, 1985; Davidson and Dutia, 1989; Bowers and Miller, 1990; Choi, 1991; Markides, 1992; Song and Walkling, 1993; Houston and Ryngaert, 1994; Hubbard and Palia, 1995; Anand and Singh, 1997; Campbell, Lo, and MacKinlay, 1997; Carow and Larsen, 1997; Slovin and Sushka, 1998; Haleblian and Finkelstein, 1999; Cybo-Ottone and Murgia, 2000; Capron and Pistre, 2002; Finkelstein and Haleblian, 2002; Harris and Shimizu, 2004; Moeller, Schlingemann, and Stulz, 2004; Shahrur, 2005.

First, daily closing stock prices for the period 300 calendar days before the acquisition announcement to 5 trading days after announcement were extracted from the University of Chicago's Center for Research in Security Prices (CRSP) files for each acquirer and target in the study sample.[22]

Second, daily returns (including dividend payments and adjustments for stock splits) for each stock extracted in Step 1 were calculated according to the equation (Das, Sen, and Sengupta, 1998):

$$R_{j,t} = (P_{j,t} + D_{j,t} - P_{j,t-1}) / P_{j,t-1}$$

where: $R_{j,t}$ = Return to stock j on day t

$P_{j,t}$ = Price of stock j on day t

$D_{j,t}$ = Cash dividend paid by stock j on day t

$P_{j,t-1}$ = Price of stock j on the previous trading day, $t-1$.

Third, baseline parameters for each acquirer and target (to be used in estimating stock price performance had the acquisition announcement not occurred) were produced by ordinary least squares (OLS) regression using daily firm-specific and market-wide stock returns over a 240-day pre-announcement period (from 300 calendar days prior to announcement to 61 calendar days before announcement)[23] according to the market model equation:

---

[22] If a closing price for a stock is not available for a given trading day, then the CRSP database reports bid/ask average for that day.

[23] Selection of the (-300,-61) estimation period follows Song and Walkling (1993), Haleblian and Finkelstein (1999), and Finkelstein and Haleblian (2002).

$$R_{j,t} = \alpha_j + \beta_j R_{m,t} + \varepsilon_{j,t}$$

where: $R_{j,t}$ = Return to stock j on day t (from Step 2)

$R_{m,t}$ = Return on the market portfolio (CRSP equal-weighted index) on day t

α_j, β_j = OLS estimates of the intercept and slope coefficients obtained from regressing $R_{j,t}$ on $R_{m,t}$

$\varepsilon_{j,t}$ = Error term for stock j on day t, $\varepsilon_{j,t} \sim N(0, \sigma^2)$.

"The parameter β_j (beta coefficient) measures the sensitivity of the j^{th} firm's return ($R_{j,t}$) to movements in the market index ($R_{m,t}$)" (Ruback, 1988, p. 140). In this way, the model "controls for marketwide variations through the independent variable $R_{m,t}$" (Singh and Montgomery, 1987, p. 380). The CRSP equal-weighted index, the empirical indicator of $R_{m,t}$ used here, is the daily portfolio performance of equal dollar amounts invested in all stocks listed on the New York, American, and NASDAQ stock exchanges (Center for Research in Security Prices).[24] The residuals, $\varepsilon_{j,t}$, are assumed to be normally distributed with a mean of zero and a constant variance σ^2.[25]

---

[24] Two common alternatives to the equal-weighted index are the Standard & Poor's 500 index and the CRSP value-weighted index, where stocks are weighted by their market capitalization. Because numerous empirical studies report results that are "insensitive to the choice of market portfolio" (e.g., Nayyar, 1993, p. 580; Brous and Kini, 1994; Mathur and Mathur, 1996; Cloninger and Waller, 2000; D'Mello, Tawatnuntachai, and Yaman, 2003), only the equal-weighted index is employed in this dissertation research. Other market model event studies using the CRSP equal-weighted index as the measure of market returns include Brown and Warner, 1985; Singh and Montgomery, 1987; Bradley, Desai, and Kim, 1988; Davidson and Dutia, 1989; Bowers and Miller, 1990; Choi, 1991; Markides, 1992; Kang, 1993; Houston and Ryngaert, 1994; Carow and Larsen, 1997; Slovin and Sushka, 1998; Harris and Shimizu, 2004; Moeller, Schlingemann, and Stulz, 2004.

[25] An alternative to the market model, the capital asset pricing model, was considered but

Fourth, the pre-announcement values for α_j and β_j (from Step 3) were plugged into the following expected returns equation to estimate daily stock returns had the acquisition announcement not occurred. This procedure assumes stability and transferability of α_j and β_j between the pre-announcement estimation period and the event window surrounding acquisition announcement.

$$ER_{j,t} = \alpha_j + \beta_j R_{m,t} = \text{Expected return to stock } j \text{ on day } t.$$

Fifth, daily abnormal returns (prediction errors) were computed as the difference between actual returns (from Step 2) and returns predicted by the market model (from Step 4). These abnormal returns reflect the market's response to the acquisition announcement:

$$AR_{j,t} = R_{j,t} - ER_{j,t}$$

where: $AR_{j,t}$ = Abnormal return to stock j on day t

$R_{j,t}$ = Actual return to stock j on day t

$ER_{j,t} = \alpha_j + \beta_j R_{m,t}$ = Expected return to stock j on day t.

---

not pursued because, as Campbell, Lo, and MacKinlay (1997) explain in The Econometrics of Financial Markets, "The Capital Asset Pricing Model was commonly used in event studies during the 1970s. During the last ten years, however, deviations from the restrictions imposed by the CAPM have been discovered, and this casts doubt on the validity of the restrictions imposed by the CAPM...Since these restrictions can be relaxed at little cost by using the market model, the use of the CAPM in event studies has almost ceased" (p. 156).

Daily abnormal returns are computed for three event periods, each centered around the acquisition's announcement date (trading day zero):

(a) the 3-trading days beginning 1 trading day before announcement and ending 1 day after the announcement (denoted -1,1);

(b) the 5-trading days beginning 2 trading days before announcement and ending 2 days after the announcement (-2,2); and

(c) the 11-trading days beginning 5 trading days before announcement and ending 5 days after the announcement (-5,5).

Including 1, 2, or 5 pre-announcement days in the event period picks up information leakage that may occur before acquisition announcement. Similarly, post-announcement days in the event window capture "market digestion" or "any price adjustments that may occur over the few days subsequent to the acquisition announcement" (Lytle and Joy, 1996, p. 513; Carow, Heron, and Saxton, 2004, p. 572).[26]

Sixth, daily abnormal returns were summed over the event period to determine cumulative abnormal return (CAR). For each stock *j*:

[26] Event studies are most effective when the focal event is unanticipated before its announcement. To control for the possibility of market anticipation of an acquisition prior to trading day -5, a dummy variable was developed to indicate retrieval of at least one news article published before the event window that discusses or anticipates the corporate combination. In addition, possibility of information leakage or market anticipation is the reason why the pre-announcement estimation period (Step 3) ends at trading day -61. Terminating the pre-announcement estimation period two months before the focal event helps to prevent "the parameter estimates from being contaminated with" the acquisition announcement (Bowers and Miller, 1990, p. 38).

$$CAR_j = \sum_{-t}^{t} AR_{j,t}$$

where: $(-t,t) = (-1,1)$, $(-2,2)$, or $(-5,5)$ event periods.

Seventh, the combined total revaluation for each acquirer-target dyad was calculated both as a return and as a dollar figure. *Cumulative abnormal return for acquirer-target portfolio combinations* is expressed by:

$$CAR(-t,t)_P = \frac{[CAR(-t,t)_A \, x \, MVE_{A,t-6}] + [CAR(-t,t)_T \, x \, MVE_{T,t-6}]}{MVE_{A,t-6} + MVE_{T,t-6}}$$

where: $(-t,t) = (-1,1)$, $(-2,2)$, or $(-5,5)$

and MVE (market value of equity) equals the number of shares outstanding multiplied by the closing share price on trading day -6 relative to the acquisition announcement day (Bradley, Desai, and Kim, 1988; Houston and Ryngaert, 1994; Cybo-Ottone and Murgia, 2000; Shahrur, 2005). Trading day -6 was used to calculate MVE for all three event periods. *Dollar abnormal return* (DAR) to acquirers, targets, and acquirer-target portfolio combinations is given by:

$$DAR(-t,t)_A = CAR(-t,t)_A \, x \, MVE_{A,t-6}$$

$$DAR(-t,t)_T = CAR(-t,t)_T \, x \, MVE_{T,t-6}$$

$$DAR(-t,t)_P = DAR(-t,t)_A + DAR(-t,t)_T$$

where: $(-t,t) = (-1,1)$, $(-2,2)$, or $(-5,5)$.

The overall portfolio wealth gain or loss associated with the acquisition is the sum of dollar abnormal returns to the acquiring and target firms (Singh and Montgomery, 1987; Bradley, Desai, and Kim, 1988; Sicherman and Pettway, 1992).

Two-tailed t-tests evaluate whether the mean CARs for acquirers, targets, and dyads are significantly different from zero. The t-statistic is calculated as (Hoel, 1984; Hamburg, 1987):

$$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$$

where: $\bar{x}$ = Sample mean

μ_0 = Zero (because difference from zero is evaluated)

s = Sample standard deviation

n = Sample size

For 272 degrees of freedom (the sample of 273 corporate transactions minus one), t-values greater than 1.969 or less than -1.969 (corresponding to 2.5 percent of the probability area under each of the two tails of the normal probability curve) are judged to be significantly different than zero. As a robustness check, nonparametric Wilcoxon signed-rank tests are performed to confirm the conclusions indicated by t-tests (Wilcoxon, 1945; Hollander and Wolfe, 1973; Hamburg, 1987). In this procedure, the absolute values of CARs in the study sample are pooled and ranked, then the sums of the

ranks are tallied separately for CARs with positive and negative values. The signed rank test then uses the positive and negative signed rank summations to evaluate the null hypothesis that a set of CAR observations has a median value of zero.

To further address concerns over departures from OLS assumptions in the market model, two alternative specifications of the dependent variable are operationalized. First, to control for heteroskedasticity across firms in the study sample (Bradley, Desai, and Kim, 1988; Thakor, 1996; Frame and Lastrapes, 1998; Slovin and Sushka, 1998), standardized cumulative abnormal returns (SCARs) are also used to assess market revaluation surrounding acquisition announcement. Following Bradley, Desai, and Kim (1988), daily standardized abnormal returns (SARs) are computed as:

$$SAR_{j,t} = \frac{AR_{j,t}}{\sigma_j \sqrt{1 + \frac{1}{T_j} + \frac{(R_{m,t} - \overline{R}_m)^2}{\sum_{t=1}^{T_j} (R_{m,t} - \overline{R}_m)^2}}}$$

where: $SAR_{j,t}$ = Standardized abnormal return to stock j on day t

$AR_{j,t}$ = Abnormal return to stock j on day t

σ_j = Standard deviation of the residuals in the estimation period for stock j

T_j = Number of trading days in the estimation period for stock j

$R_{m,t}$ = Return on the market portfolio (CRSP equal-weighted index) on day t

R_m = Mean return to the market portfolio over the estimation period.

Next, standardized abnormal returns (SCARs) are summed over event window days to produce standardized cumulative abnormal returns (SCARs):

$$SCAR_j = \frac{\sum_{t=1}^{K} SAR_{j,t}}{\sqrt{K}}$$

where: $SCAR_j$ = Standardized cumulative abnormal return (SCAR) to stock j

$SAR_{j,t}$ = Standardized abnormal return (SAR) to stock j on day t

K = Number of days in the event window.

The following z-statistic (Bradley, Desai, and Kim, 1988) was used to assess whether standardized cumulative abnormal returns differed significantly from zero in a study sample of N firms:

$$z = \frac{\sum_{j=1}^{N} SCAR_j}{\sqrt{\sum_{j=1}^{N} \left(\frac{T_j - 2}{T_j - 4} \right)}}$$

For the second alternative specification, cumulative abnormal stock market returns are estimated using a generalized autoregressive conditional heteroskedastic market model, GARCH (1,1). GARCH models allow "for nonlinear intertemporal dependence in the residual series" when producing estimation period values for the intercept (α_j) and slope coefficients (β_j) (Corhay and Rad, 1996, p. 530; Frame and Lastrapes, 1998). A GARCH (1,1) model specifies first-order autocorrelation and moving average lag parameters.

Market-Adjusted Change in Pretax Operating Cash Flow Return on Sales. The second measure of post-acquisition financial performance is market-adjusted change in pretax operating cash flow return on sales (ΔPOCFROS) (Healy, Palepu, and Ruback, 1992; Anand and Singh, 1997). Pretax operating cash flow (POCF, Compustat data item #13) is defined as net sales minus cost of goods sold and selling/general/administrative expenses before deducting depreciation and amortization (Healy, Palepu, and Ruback, 1992; Opler, 1992; Hotchkiss, 1995; McLaughlin, Safieddine, and Vasudevan, 1996; Anand and Singh, 1997; Healy, Palepu, and Ruback, 1997). These operating cash flows are then scaled by net sales (Compustat data item #12) to form POCFROS.[27] Change in POCFROS is the difference between post- and pre-acquisition POCFROS. Pre-acquisition POCFROS is measured in the first full fiscal year before the acquisition's effective date.[28] Post-acquisition POCFROS is calculated for two-, three-, and four-year

[27] Following Fee and Thomas (2004), cash flows are indexed by sales rather than, for example, market value of assets ("this measure could be biased upward/downward by systematic post-acquisition stock price declines/increases" p. 439) or book value of assets (to avoid valuations based on historical cost and omission of assets such as intellectual capital or brand name capital that aren't fully reflected on balance sheets). ΔPOCFROS is a firm-level measure.

[28] Compustat's fiscal year coding procedure is potentially confusing. Compustat codes fiscal years ending January 1 through May 31 as ending in the prior calendar year. For example, Medtronic's 10-K report shows $1,390.9 million in net sales for the fiscal year ending April 30, 1994. Although Medtronic generated $1,390.9 million in net sales during the period May 1, 1993 - April 30, 1994, Compustat codes and reports this amount as "April 1993" net sales. Compustat does this because 8 of the 12 months during Medtronic's 1994 fiscal year are in calendar year 1993. The dissertation does not follow Compustat's backdating coding procedure when extracting pre- and post-acquisition financial data. The dissertation reports financial data for the period May 1, 1993 - April 30, 1994 as representing the fiscal year ending April 1994 (not April 1993 as reported and presented by Compustat). The Compustat backdating coding issue does not apply to companies with fiscal years ending between June 1 and December 31.

post-acquisition performance periods.[29] Because this cash flow measure excludes depreciation, goodwill, interest expense, interest income, and income taxes, it is "unaffected by the method of accounting for the acquisition (purchase or pooling accounting) and the method of financing" (Healy, Palepu, and Ruback, 1992, p. 139). Data are extracted from Compustat files of both active and inactive companies. To incorporate the latest and most accurate financial data available, recently restated net sales and pretax operating cash flow figures for companies such as Bristol-Myers Squibb and Tyco International are included in the data set.

The equations for acquirer (Firm A), target (Firm T), and portfolio (Transaction P) ΔPOCFROS (illustrated for a four-year post-acquisition performance period) are:

$$Acquirer: \Delta POCFROS_A = \left[\frac{\sum_{t=t+1}^{t+4} POCF_{A,t}}{\sum_{t=t+1}^{t+4} NS_{A,t}}\right] - \left[\frac{POCF_{A,t-1}}{NS_{A,t-1}}\right]$$

$$Target: \Delta POCFROS_T = \left[\frac{\sum_{t=t+1}^{t+4} POCF_{T,t}}{\sum_{t=t+1}^{t+4} NS_{T,t}}\right] - \left[\frac{POCF_{T,t-1}}{NS_{T,t-1}}\right]$$

$$Portfolio: \Delta POCFROS_P = \left[\frac{\sum_{t=t+1}^{t+4} POCF_{A,t} + \sum_{t=t+1}^{t+4} POCF_{T,t}}{\sum_{t=t+1}^{t+4} NS_{A,t} + \sum_{t=t+1}^{t+4} NS_{T,t}}\right] - \left[\frac{POCF_{A,t-1} + POCF_{T,t-1}}{NS_{A,t-1} + NS_{T,t-1}}\right]$$

In merger cases (that is, when the acquirer purchases the entire target firm), the equation

[29] Year 0, the year of the acquisition, is excluded from ΔPOCFROS calculations to avoid inclusion of one-time acquisition costs or other inconsistencies in acquisition year accounting treatments (Healy, Palepu, and Ruback, 1992; Linn and Switzer, 2001).

for portfolio change in pretax operating cash flow return on sales reduces to:

$$Portfolio:\ \Delta POCFROS_P = \left[\frac{\sum_{t=t+1}^{t+4} POCF_{At}}{\sum_{t=t+1}^{t+4} NS_{At}}\right] - \left[\frac{POCF_{A,t-1} + POCF_{T,t-1}}{NS_{A,t-1} + NS_{T,t-1}}\right]$$

Table 7 further illustrates assessment of cash flow returns following acquisition of a portion or all of the target firm's assets. In non-merger cases, the acquiring firm (Company A) acquires a portion of the assets (T) of the target firm (Company TB). The target firm's remaining lines of business (B) survive. For the acquiring firm, post-acquisition performance of AT is compared with pre-acquisition performance of A. For the target firm, post-acquisition performance of B is compared with pre-acquisition performance of TB. For the portfolio combination, post-acquisition performance of AT + B is compared with A + TB:

Table 7: Assessment of Cash Flow Returns

Non-Merger Case: Acquisition of Less Than 100 Percent of Target Firm

	Acquiring Firm	Target Firm	Portfolio Combination
Pre-Acquisition	A	TB	A + TB
Post-Acquisition	AT	B	AT + B

In merger cases (Table 8), the acquiring firm (Company A) acquires the entire operations of the target firm (Company T). For the acquirer, post-acquisition performance of AT is compared with pre-acquisition performance of A. For the portfolio combination, post-acquisition performance of AT is compared with pre-acquisition performance of A + T.

Table 8: Assessment of Cash Flow Returns

Merger Case: Acquisition of the Entire Target Firm

	Acquiring Firm	Target Firm	Portfolio Combination
Pre-Acquisition	A	T	A + T
Post-Acquisition	AT	--	AT

To isolate and evaluate the impact of corporate acquisitions on realized financial performance, the analysis ideally would compare ΔPOCFROS among (a) medical device manufacturers that engaged in acquisition activity (the treatment group) and (b) a control sample of similar and comparable medical device makers that were not acquirers or targets during the same pre- and post-acquisition period (the control group). Unfortunately, because of widespread acquisition participation by medical device firms during the study period, the matched-firm control approach is not possible. For example, matched control candidates for Stryker Corp. (based on level of sales and primary SIC

code) are Boston Scientific, Becton Dickinson, Guidant, and possibly C.R. Bard. Because all five of these companies made acquisitions with effective dates during the 3-year period 1996-1998, identification of a matched control firm was not possible because of overlapping pre- and post-acquisition periods. Similarly, Invacare, Respironics, and Steris (another set of reasonably similar and comparable medical device firms based on revenue and primary SIC code) all appear in the study sample in 1997. Nineteen of the 20 largest medical device producers (ranked by 2003 net sales as reported in the Compustat Business Segment database) appear in the sample. The sole exception, Edwards Lifesciences, the 19th largest medical device firm in 2003, became an independent company in 2000 following its spin-off from Baxter International.

The dissertation reports both raw and market-adjusted ΔPOCFROS. The market-adjusted measure controls for broad changes in economic conditions and is constructed by subtracting the contemporaneous market-wide ΔPOCFROS from each acquirer, target, and portfolio combination in the study sample. For consistency, this market adjustment is comparable to the market index used in constructing cumulative abnormal stock market returns. Specifically, the market index is total pretax operating cash flow (data item #13) across all companies in the Compustat database in a given period of time divided by total net sales (data item #12) across all companies for that period. Market-adjusted ΔPOCFROS for acquiring firms, target organizations, and portfolio combinations are:

Acquirer: $\Delta POCFROS_{A,\ market\text{-}adjusted} = \Delta POCFROS_{A} - \Delta POCFROS_{MKT}$

Target: $\Delta POCFROS_{T,\ market\text{-}adjusted} = \Delta POCFROS_{T} - \Delta POCFROS_{MKT}$

Portfolio: $\Delta POCFROS_{P,\ market\text{-}adjusted} = \Delta POCFROS_{P} - \Delta POCFROS_{MKT}$

As an alternative specification (and to eliminate extremely large positive or negative cash flow returns), analyses also were performed with values less than -1 bottom-coded at -1.0 and values greater than 1 top-coded at 1.0.

Because overlapping pre- and post-acquisition periods in the study sample preclude a matched-firm control approach, the research investigates (when the dependent variable is change in pretax operating cash flow return on sales) the explanatory power of the hypothesized predictors of accounting performance changes among acquirers and targets. The research cannot isolate the impact of acquisition activity on realized financial performance in the medical device industry by contemporaneously comparing acquirers and non-acquirers.

Strength of Association Between the Two Dependent Measures. An additional empirical question of interest is: What is the strength of association between cumulative abnormal stock market returns (a measure of expected performance) and change in pretax operating cash flow return on sales (a measure of realized performance)? A strong positive correlation between, for example, upward stock price revaluations and subsequent cash flow performance improvement suggests evidence for realization of anticipated financial gains. Healy, Palepu, and Ruback (1992) investigated this relationship using the 50 largest U.S. mergers between 1979 and 1984, and found that "post-merger improvements in operating cash flow returns explained a significant portion of the increase in equity values of the merging firms at the announcement of the merger" (p. 137). Similarly, positive relationships between abnormal stock returns and longer-

term performance assessments have been found for corporate acquisitions (Anand and Singh, 1997) and corporate alliances (Kale, Dyer, and Singh, 2002). The dissertation further explores and quantifies the strength of relationship between announcement revaluations and realized financial accounting results.

Independent Variables

Product Innovation Capability (H1). A set of three ratios operationalizes acquisition partners' medical device innovation capability. Each ratio is distinguished by a different product innovation indicator in the numerator (corresponding one of three regulatory approval categories). The first measure, which gauges patent yields, divides (a) the number of ultimately successful U.S. patent applications filed by a firm during the five years previous to the focal acquisition's effective date by (b) net sales (adjusted using the medical care commodities consumer price index, MCC-CPI) during the last full five fiscal years before the effective date. The second ratio is the count of FDA premarket application (PMA) approvals during the five years prior to the effective date divided by the same denominator (MCC-CPI adjusted net sales). Third is FDA 510(k) clearances over MCC-CPI adjusted net sales. For each firm *i* and 5-year pre-acquisition period *t-5* through *t-1*:

$$\text{Product Innovation}_{(\text{Patents}\,i)} = \frac{\sum_{t=t-5}^{t-1} \text{Number of Patent Awards}_{it}}{\sum_{t=t-5}^{t-1}\left(\frac{\text{Net Sales}_{it}}{\text{Medical Care Commodities CPI}_{t}}\right)}$$

$$\text{Product Innovation}_{(\text{PMAs}\,i)} = \frac{\sum_{t=t-5}^{t-1} \text{Number of PMA Approvals}_{it}}{\sum_{t=t-5}^{t-1}\left(\frac{\text{Net Sales}_{it}}{\text{Medical Care Commodities CPI}_{t}}\right)}$$

$$\text{Product Innovation}_{(510(k)s\,i)} = \frac{\sum_{t=t-5}^{t-1} \text{Number of 510(k) Clearances}_{it}}{\sum_{t=t-5}^{t-1}\left(\frac{\text{Net Sales}_{it}}{\text{Medical Care Commodities CPI}_{t}}\right)}$$

These ratios reflect organizational performance in using sales revenue to fuel innovation development and fund successful regulatory approval processes over a five-year pre-acquisition span. Product innovation capability is calculated for acquiring firms, target organizations, and acquirer-target interactions. To reduce multicollinearity between main effects variables and their interaction terms, the main effects variables were centered (by subtracting the sample mean from each ratio value) before multiplying to produce the interaction terms (Aiken and West, 1991; Haveman, 1995; Robinson and O'Leary-Kelly, 1998; Mehra, Kilduff, and Brass, 2001; and Henle, 2005). Specifically, acquirer-target interaction terms are calculated as:

$$\textit{Interaction Term} = (R_{Ai,c} - \overline{R_{A,c}}) \; x \; (R_{Ti,c} - \overline{R_{T,c}})$$

where: $R_{Ai,c}$ = ratio value for acquirer *Ai* in regulatory approval category *c*

$\overline{R_{A,c}}$ = mean ratio value among acquirers in regulatory approval category *c*

$R_{Ti,c}$ = ratio value for target *Ti* in regulatory approval category *c*

$\overline{R_{T,c}}$ = mean ratio value among targets in regulatory approval category *c*

c = patent awards, PMA approvals, or 510(k) clearances

Data to measure product innovation capability are assembled from five sources. First, the number of patents issued to the assignee corporation resulting from patent applications received by the U.S. Patent and Trademark Office during the five years preceding the focal acquisition's effective date was extracted from the Patent Full Text and Image Database at http://patft.uspto.gov/netahtml/search-adv.htm. Second, counts of PMA approvals and 510(k) clearances were obtained from the U.S. Food and Drug Administration's Center for Devices and Radiological Health website at http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMA/pma.cfm and http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMN/pmn.cfm, respectively. The reported number of PMA approvals includes both original PMAs and PMA supplements (e.g., improvements to the design, components, or specifications of a previously PMA-approved product). The PMA and 510(k) databases search for and list product approvals by decision date (application date is not a search option). Patent, PMA, and 510(k) counts are firm-level tallies.[30] Third, annual net sales is data item #12 from Standard & Poor's Compustat financial research files. Fourth, the SDC Mergers and Acquisitions database is the source of acquisition effective dates. Fifth, the CPI Detailed Report, Table 25 (U.S. Department of Labor, 1991, 2001), is the data source for the medical care commodities CPI. Table 25 publishes annual CPI indexes for 17 medical care expenditure categories

[30] When the overall firm is named as the patent assignee, the invention cannot be identified consistently with specific corporate divisions, subsidiaries, or product lines.

(including "hospital and related services," "physicians' services," "medical care commodities," "eye care," "dental services," and "medical care overall"). Among these 17, the "medical care commodities" is the most closely related to medical devices and supplies.

To substantiate that the three product innovation measures connote different opportunities and benefits conferred to medical device manufacturers (as asserted in the previous chapter), the patent, PMA, and 510(k) ratio values were subjected to two confirmatory procedures. First, Cronbach alpha reliability coefficients were calculated for acquiring firms and target organizations (using both raw and standardized ratio values) to evaluate whether the set of three ratios represent a single underlying construct "product innovation capability." Reliability coefficients below .70 (Nunnally, 1978; MacKenzie, Podsakoff, and Ahearne, 1998; Blau, 1999; Ailawadi, Neslin, and Gedenk, 2001) signal a lack of internal consistency across the three ratio items, the existence of more than one underlying dimension, and the loss of information if the three ratios were replaced with a single, combinative measure. Second, the patent, PMA, and 510(k) ratio values were entered into confirmatory principal factor analyses (Kleinbaum, Kupper and Muller, 1988). Here, interpretation focuses on whether (a) the eigenvalues point to a single common factor, (b) the factor loadings demonstrate consistently strong correlations between the original three ratio values and the factor, and (c) the communality scores indicate a high percentage of variance explained by the underlying factor. Evidence to the contrary of (a), (b), and (c) corroborates not reducing the three innovation ratio values into a single innovation variable.

Finally, an alternative specification of product innovation capability is calculated

and evaluated using research and development (R&D) expenditures (rather than net sales) in the ratio denominator. However, because Compustat data files lack annual R&D information (item #46) for 10 percent of acquirers and nearly 13 percent of targets in the study sample, R&D expenditures serve as a secondary scaling measure.

Production Efficiency (H2). Data envelopment analysis (DEA) is performed to assess pre-acquisition production efficiency. Introduced by Charnes, Cooper, and Rhodes (1978), DEA is a nonparametric linear programming technique that generates comparative input-output efficiency ratings. In the DEA approach, a best-practice frontier is estimated and each firm is assigned an efficiency score relative to the frontier. The maximum score of 100.00 indicates that a firm is on the best-practice frontier. Index scores below 100.00 indicate input-output inefficiency. The greater the deviation from 100.00, the greater the firm's measured relative inefficiency.

DEA has been applied to evaluate operational efficiency in a wide variety of settings.[31] In the present study, because comparable measures of manufacturing inputs (capital and labor) and outputs (production quantities and prices of finished goods) across medical device firms are not available, financial proxies are employed to measure

[31] Examples of industry settings among published data envelopment analyses include: airlines (Gillen and Lall, 1997; Scheraga, 2004), banks (Yeh, 1996; Kantor and Maital, 1999), computer manufacturers (Thore, Kozmetsky, and Phillips, 1994), hotels (Parkan, 1996), oil and gas (Feroz, Kim, and Raab, 2003); sawmills (Salehirad and Sowlati, 2005), pharmaceuticals (Smith, 1990), hospitals (Ozcan and Luke, 1993; Hao and Pegels, 1994; Ozcan and McCue, 1996; Wang et al, 1999; Chern and Wan, 2000; Ferrier and Valdmanis, 2004), physician practices (Rosenman and Friesner, 2004), managed care (Rosenman, Siddharthan, and Ahern, 1997), outpatient substance abuse treatment units (Alexander et al, 1998), and long-term care (Kleinsorge and Karney, 1992; Fizel and Nunnikhoven, 1993; Laine et al, 2005).

production efficiency (Smith, 1990; Thore, Kozmetsky, and Phillips, 1994; Yeh, 1996; Feroz, Kim, and Raab, 2003). The initial, *a priori* vector of cost inputs includes:

1. Average annual cost of goods sold (Compustat item #41), adjusted using the medical care commodities CPI (U.S. Department of Labor, 1991, 2001), during the last three full fiscal years before the acquisition's effective date,

2. Average annual selling, general, and administrative (SGA) expenses (Compustat item #189), adjusted using the medical care commodities CPI, during the last three full fiscal years before the acquisition's effective date, and

3. Average annual research and development expenditures (Compustat item #46), adjusted using the medical care commodities CPI, during the last five full fiscal years before the acquisition's effective date.

The output vector contains:

1. Average annual net sales (Compustat item #12), adjusted using the medical care commodities CPI, during the last three full fiscal years before the effective date,

2. Average annual pretax operating cash flow (Compustat item #13), adjusted using the medical care commodities CPI, during the last three full fiscal years before the effective date,

3. The number of U.S. patent awards in the five years preceding the effective date (U.S. Patent and Trademark Office's Patent Full Text and Image Database at http://patft.uspto.gov/netahtml/search-adv.htm),

4. The number of PMA approvals in the five years before the effective date (U.S. Food and Drug Administration's Center for Devices and Radiological Health website at http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMA/pma.cfm), and

5. The number of 510(k) clearances in the five years before the effective date (U.S. Food and Drug Administration's Center for Devices and Radiological Health website at http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMN/pmn.cfm.

The inputs reflect labor costs, materials costs, marketing and selling costs, and research and development. The efficiency index scores indicate differences in firms' abilities to minimize these costs in the production of a given level of output (where output is operationalized as sales revenue produced, cash flow generated, and product regulatory approvals achieved).[32] Two desirable features of DEA contributed to its selection: (a) it simultaneously evaluates multiple outputs and multiple inputs and (b) it is a nonparametric technique, so it imposes no specific functional form or distributional assumptions on the specification of the best-practice frontier (Rosenman and Friesner, 2004; Scheraga, 2004). Banxia Software's Frontier Analyst package is used to perform the data envelopment analysis among the acquiring and target firms in the study sample. Since DEA does not permit negative or zero numbers, any negative values (e.g., negative pretax operating cash flow) were reset to zero and then all zero values were reset to 0.001.

Because R&D expenditure data are not available for 10 percent of acquirers and nearly 13 percent of targets in the study sample, the initial *a priori* input and output vectors are modified to preserve a full sample size in data analysis. Specifically, net sales is shifted from the DEA output vector to replace R&D expenditures in the revised input vector. As a result, the revised input vector contains cost of goods sold, SGA expenses,

---

[32] In the data envelopment analysis, a longer pre-acquisition period (five years) is specified for R&D expenditures and the regulatory product approval counts because research and product development, application preparation and filing, and responding to regulators' questions often take quite a long time. In this way, a somewhat expanded research and product development period is incorporated in gauging how efficiently firms converted (a) pre-acquisition research and development expenditures, cost of goods sold, and sales/general/ administrative expenses into (b) regulatory product approvals, sales revenue, and cash flow.

and net sales [33]; and the output vector includes pretax operating cash flow, U.S. patent awards, PMA approvals, and 510(k) clearances. In reporting empirical results, the revised DEA is presented first (to retain the sample size), then the initial DEA using the original input and output vectors are reported subsequently.

To evaluate the joint effect of acquirer and target production efficiencies on acquisition-related financial outcomes, interaction terms are created. As was done with the product innovation capability variables, the acquirer and target production efficiency scores were centered before multiplying to produce the interaction terms. Centering reduces multicollinearity between main effects variables and their interaction terms (Aiken and West, 1991; Haveman, 1995; Robinson and O'Leary-Kelly, 1998; Mehra, Kilduff, and Brass, 2001; and Henle, 2005). Specifically, the acquirer-target production efficiency interaction terms are calculated as:

$$Interaction\ Term = (E_{Ai} - \overline{E_A}) \times (E_{Ti} - \overline{E_T})$$

where: E_{Ai} = production efficiency rating for acquirer Ai

$\overline{E_A}$ = mean production efficiency rating among acquirers

E_{Ti} = production efficiency rating for target Ti

$\overline{E_T}$ = mean production efficiency rating among targets.

[33] In the initial *a priori* DEA, net sales were treated as an output of labor, R&D, production, and marketing. In the revised DEA, average annual net sales during the last five full fiscal years before the acquisition's effective date are viewed as an input to enable and fund corporate objectives.

Building Product Lines Along Medical Specialties (H3). The primary indicator for using corporate acquisitions to build product lines along medical specialties is a dummy variable gauging whether acquirer and target products overlapped in at least one major clinical area before the acquisition (1 = yes). The Health Devices Sourcebook and the Medical Device Register series (supplemented by acquisition synopses from the SDC Mergers and Acquisitions database and Factiva online news article searches) are the data sources used to identify acquirer and target products by medical specialty area.[34] The Health Devices Sourcebook (published by ECRI) and Medical Device Register (published Medical Economics) are both annual references and provide like information. Specifically, the Health Devices Sourcebook catalogs product listings by manufacturer (in the "Manufacturers' Product Lines" section) and devices by medical specialty (in the "Product Categories by Specialty" section). Similarly, the "Supplier Profiles" section of the Medical Device Register enumerates medical device companies, their products, and "specialty with which each product is associated" (1997, p. vii). For each acquisition, medical specialty areas (e.g., anesthesia and pulmonary medicine, cardiovascular, otorhinolaryngology, gastroenterology and urology, general hospital products, neurology, obstetrics and gynecology, orthopedics, physical medicine, radiology, general surgery) shared by the acquirer and target organizations were recorded.

An alternative measure of "building product lines within medical specialties" is also developed and evaluated. This second specification documents whether acquisition of the target organization contributed new products to the buyer's clinical specialty

[34] The author thanks Valerie Mahon, Editor at ECRI in Plymouth Meeting, Pennsylvania, for access to the company's complete Health Devices Sourcebook and Medical Device Register series housed in its in-house corporate library.

product line (1 = yes). The alternative measure is distinguished from the primary dummy variable in that the primary dummy variable permits "strictly more of the same products" acquisitions (evidencing increased product line depth) while the alternative measure requires that new products be added to a clinical specialty area via corporate acquisition (thereby extending product line breadth). Three examples of acquisition-related product coding follow:

Example 1: Abbott Laboratories announced and completed its acquisition of Pancretec, Inc. in 1989. Prior to acquisition announcement, Pancretec manufactured three products: two types of infusion pumps and an intravenous administration set. Abbott's product codes indicated that it was already producing these three products before the corporate union, so the acquisition increased its product line depth, but not its product line breadth.

Example 2: With its 1997 acquisition of Marquest Medical Products, Inc., Vital Signs, Inc. added both new and overlapping product codes to its anesthesia and pulmonary medicine product line. Here, the acquiring firm increased both its product line breadth and depth.

Example 3: "Diversifying from its traditional interests in chemicals, glass, and coatings," PPG Industries expanded into a new area of business with its 1986 purchase of Honeywell's Medical Electronics Division (Lubove,

1986). In this case, the acquirer established a new product line because it was not producing in the medical device industry before this acquisition.

Post-Acquisition Scale (H4). Post-acquisition combinative scale is operationalized as the natural log of the sum of acquirer and target net sales in the last full fiscal year before the acquisition's effective date, adjusted using the medical care commodities consumer price index, MCC-CPI (U.S. Department of Labor, 1991, 2001; Haunschild and Beckman, 1998; Honjo, 2004): [35]

$$\text{Scale} = \ln\left[\frac{\text{Acquirer Net Sales}_{t-1} + \text{Target Net Sales}_{t-1}}{\text{MCC - CPI}_{t-1}}\right]$$

Post-acquisition scale is natural log transformed in order to normalize its distribution. Visual inspection of histograms confirmed that ln(scale) is much more normally distributed compared with both the raw scale measure and other potential transformations.

The source for acquirer net sales is Compustat data item #12. If the entire target company was purchased by the acquirer, then Compustat data item #12 is also the source for target net sales. However, in cases where less than 100 percent of the target's assets

[35] Guided by prior research (e.g., Keats and Hitt, 1988; Pisano, 1990; Haunschild and Beckman, 1998; Larsson and Finkelstein, 1999; Gerety, Hoi, and Robin, 2001; Wright, Kroll, and Elenkov, 2002; Honjo, 2004), net sales is used as the organizational size measure. Other studies have used either book value of total assets or market value of total assets to measure size (e.g., Scanlan, Trifts, and Pettway, 1989; Seth, 1990; Chatterjee et al, 1992; Cannella and Shen, 2001; Moeller, Schlingemann, and Stulz, 2004), but in the present sample, acquisitions of less than 100 percent of the target organization (e.g., division or product line) preclude use of book value of assets (because these data are available only at the firm level) or market value of assets (because equity prices refer to the entire corporation, and acquisition price often is not publicly disclosed).

was acquired, then, following Larsson and Finkelstein (1999), annual revenue for the acquired operations was either (a) obtained from a Factiva online search of news articles, the "Supplier Profiles" section of the Medical Device Register, or the "Manufacturers' Product Lines" section of the Health Devices Sourcebook, or, in some cases, (b) estimated from available quarterly sales data, divisional sales data that predates the year before acquisition announcement, post-acquisition divisional sales data, changes in year-to-year revenue for either the acquirer or surviving target organization around the time of the acquisition, target-to-acquirer employee ratios, acquisition purchase price, or other information. A statistically significant positive relationship between combinative scale and post-acquisition financial performance would provide evidence of scale economies.

Two alternative specifications for post-acquisition combinative scale are evaluated. The first is the sum of acquirer and target net sales in the year before acquisition announcement, adjusted using the medical care commodities CPI (in $billions, not taking the natural log). The second examines the possibility that small and large organizational sizes impart diseconomies of scales. Small medical device firms, for example, may lack (a) the capacity to fund R&D expenditures, clinical testing of new products, and regulatory approval processes and (b) access to national marketing, sales, distribution, and group purchasing networks. Burns, Nicholson, and Evans (2005) conclude that "M&As do not lead to pronounced economies of scale or scope, although they may help small firms to achieve some economies" (p. 248). Graves and Langowitz (1993) report decreasing returns to scale in R&D among pharmaceutical firms. At large scales, a firm's total cost curve may become convex, indicating upward sloping marginal and average cost curves, production beyond optimal scale, and decreasing returns to

scale) (Nicholson, 1987; Pindyck and Rubinfeld, 1992; Carlton and Perloff, 1994). To assess curvilinearity in the relationship between post-acquisition scale and financial outcomes, squared scale terms were constructed. The primary measure of post-acquisition combinative scale is the natural log of the sum of acquirer and target net sales. However, because $\ln(x^2) = 2\ln(x)$, the natural log of squared sales would be perfectly correlated the natural log of sales. Consequently, raw sales were centered (by subtracting the sample mean from each value) and then squared to form squared sales measure.

Prior Acquisition Experience (H5). The indicator for acquirers' prior acquisition experience is derived from the theory of natural decay, which states that a rate of disintegration is proportional at any instant to quantity present (Sanchez, Allen, and Kyner, 1983). Applying the theory of natural decay to acquisition experience, acquisition-related organizational memory and management ability decline with time since prior acquisition experience and learning. If $y(t)$ is the quantity present at time t and the rate of change of y with respect to t is proportional to quantity present $y(t)$ at time t, then the separable first-order differential equation governing the process is (Sanchez, Allen, and Kyner, 1983; Stewart, 1991):

$$\frac{\delta y}{\delta t} = ky$$

The solution to this equation is (Stewart, 1991):

$$\frac{\delta y}{\delta t} = ky$$

$$\frac{\delta y}{y} = k\delta t \quad \text{where } y \neq 0$$

$$\int \frac{\delta y}{y} = \int k\delta t$$

$$\ln | y | = kt + C$$

$$|y| = e^{(kt + C)} = e^{C} e^{kt}$$

$y = Ce^{kt}$ where C is the initial quantity present

$y_{(t)} = y_{(0)}e^{kt}$

To illustrate how the equation $y_{(t)} = y_{(0)}e^{kt}$ is applied in the context of corporate acquisition experience, the following example calculates the discount factor for an acquisition made 7½ years ago assuming (a) a 4-year half-life for acquisition experience[36] and (b) acquisition experience begins to depreciate 6 months after a given acquisition's effective date:

Given: $y_{(t=0)} = 1$ and $y_{(t=4)} = 0.5$

$y_{(t=4)} = y_{(t=0)}e^{kt}$

$y_{(t=4)} = e^{4k} = 0.5$

$4k = \ln(.5)$

$k = [\ln(.5)]/4$

[36] For comparison, Henderson and Cockburn (1994) used a 20 percent depreciation rate for organizational knowledge. This equates to a half-life between 3 and 4 years (3.106 years to be exact because $.80^{\wedge 3.106} = .50$).

The discount factor at time t = 7 is:

$$y(7) = e^{7[\ln(.5)/4]} = \underline{0.2973}.$$

Acquisition experience values are calculated two ways: based on (a) the total number of prior acquisitions and (b) prior acquisition transaction values (however, transaction values are not available for all deals listed in the SDC database). Measured experience, therefore, increases with the number, size, and recency of acquisition activity. In the above example, the present value of the acquisition made 7½ years ago (assuming a 4-year half-life for acquisition experience and depreciation onset 6 months after the effective date) is 0.2973. If this firm made no other acquisitions during the 7½ year period, then its measured acquisition experience would have depreciated by about 70 percent. In addition, if the original transaction value was $31.8 million, then the transaction's discounted experience value is $9.45 million (31.8 million x 0.2973). To finalize the acquisition experience measure, the discounted counts and values are indexed by organizational size (using net sales in the last full fiscal year before the acquisition's effective date, adjusted using the medical care commodities consumer price index [MCC-CPI, U.S. Department of Labor, 1991, 2001]). Acquisitions of both publicly traded and privately owned firms are included in the experience measure. For sensitivity analysis, experience values are calculated for half-lives of 2, 3, 4, 5, and 6 years. Data on the number and value of prior acquisitions are from the SDC database of mergers and acquisitions. Acquisitions completed within 6 months of a focal acquisition's effective date are not included in the experience calculations (because acquisition-related knowledge and experience are still being developed). Acquisition experience of the target

organization is not incorporated into the calculation because, for example, whether the target's firm-level acquisition experience is transferred to the acquirer in a partial acquisition (e.g., division, subsidiary, or product line) is uncertain.

Table 9 (next page) offers a complete illustrative calculation of the acquisition experience measures. Prior to its purchase of Target Therapeutics in 1997 (deal number 187 of 273 in the study sample), Boston Scientific completed 9 acquisitions. The discounted value of these 9 acquisitions at the time of the Target Therapeutics acquisition was 7.294 acquisitions. Transaction value was available for 7 of these corporate combinations, the discounted value of which was $2,020.82 million. The final acquisition experience measures (assuming a 4-year half-life) after indexing by organizational size (inflation-adjusted net sales) are:

- .01058 acquisitions per million in net sales (or 1.058 acquisitions per $100 million in net sales), and
- $2.93 worth of acquisition activity per million in net sales.

Table 9 concludes by presenting acquisition experience measures using alternative half-life values of 2, 3, 5, and 6 years.

Table 9: Acquisition Experience Calculation

Acquirer:	Boston Scientific
Target:	Target Therapeutics
Effective Date of Acquisition:	8-Apr-97
Half-Life Assumption (years):	4

Effective Date of Acquisition	Acquisition Number	Value of Deal ($ mil)	Years Since Focal Effective Date *	Discount Factor on Prior Acquisitions	Discounted Number of Prior Acquisitions	Discounted $ Value of Prior Acquisitions
06/08/93	1	not listed	3.333	0.5613	0.561	-
02/24/95	2	1074.20	1.619	0.7554	0.755	$ 811.40
03/09/95	3	93.80	1.584	0.7600	0.760	$ 71.29
03/23/95	4	not listed	1.545	0.7651	0.765	-
11/17/95	5	423.90	0.891	0.8570	0.857	$ 363.26
01/02/96	6	490.90	0.765	0.8759	0.876	$ 429.96
01/23/96	7	159.70	0.707	0.8846	0.885	$ 141.27
03/14/96	8	153.00	0.568	0.9063	0.906	$ 138.66
05/03/96	9	70.00	0.431	0.9281	0.928	$ 64.96
Undiscounted Values:	9.000	$ 2,465.50		**Discounted Values:**	7.294	$ 2,020.82

Final Calculations: Indexing by CPI-Adjusted Net Sales:

Acquisition Experience (based on a count of 9 reported transactions):

The discounted number of prior acquisitions is indexed by acquirer's CPI-adjusted net sales ($MM) in the last full fiscal year before announcement:

7.294 / [1462.040/2.120] = .01058

Acquisition Experience (based on 7 reported transaction values):

The discounted value of prior acquisitions is indexed by acquirer's CPI-adjusted net sales ($MM) in the last full fiscal year before announcement:

2020.82 / [1462.040/2.120] = 2.93025

Sensitivity Analysis:

Half-Life	Acq'n Experience based on Count	Acq'n Experience based on Value
2-year	0.00872	$ 2.41561
3-year	0.00990	$ 2.74580
4-year	0.01058	$ 2.93025
5-year	0.01101	$ 3.04775
6-year	0.01132	$ 3.12909

* Acquisition experience begins to depreciate 6 months after the acquisition's effective date

Applying the theory of natural decay is an attempt to improve upon previous research that measured prior acquisition experience as an undiscounted count of acquisitions. Specifically, Fowler and Schmidt (1989) gauged acquisition experience as the number of acquisitions "made by an acquiring firm in the 4-year period preceding the year" of the focal deal (p. 344). Similarly, Bruton, Oviatt, and White (1994) and Porrini (2004) "measured acquisition experience by the number of acquisitions made by an acquiring firm during the four years prior to the purchase of a focal acquired firm" (Bruton et al, p. 981). The present study (a) incorporates a longer acquisition experience timeframe (e.g., in Johnson & Johnson's purchase of DePuy in 1997, prior acquisitions in the experience calculations date back to 1978) and (b) discounts experience to account for possible decay, forgetting, or obsolescence of organizational knowledge gained from past organizational experiences (Ingram and Baum, 1997; Baum and Ingram, 1998). One author, Hayward (2002), does discount prior acquisition experience using "1 divided by the years elapsed from the prior experience" (p. 28), but this method leads to a more rapid decline of measured organizational experience in the years following the focal acquisition event.

As an alternative specification to measuring acquirers' *total* acquisition experience, acquirers' *industry* acquisition experience is also calculated by restricting acquisition involvement to targets with primary Standard Industrial Classification (SIC) codes of 3841, 3842, 3844, or 3845.

Major Control Variables

Relative Size of Target to Acquirer. Like Bruton, Oviatt, and White (1994), Hayward and Hambrick (1997), Larsson and Finkelstein (1999), and Seth, Song, and Pettit (2002), relative size is defined as the ratio of target-to-acquirer net sales in the fiscal year before the acquisition partners complete their corporate combination:

$$\text{Relative Size} = \frac{\text{Target Net Sales}_{t-1}}{\text{Acquirer Net Sales}_{t-1}}$$

The source for acquirer net sales is Compustat data item #12. If the entire target company was purchased by the acquirer, then Compustat data item #12 is also the source for target net sales. However, as was done with the post-acquisition scale variable (H4), in cases where less than 100 percent of the target's assets was acquired, then annual revenue for the acquired operations was either (a) obtained from a Factiva online search of news articles, the "Supplier Profiles" section of the Medical Device Register, or the "Manufacturers' Product Lines" section of the Health Devices Sourcebook, or, in some cases, (b) estimated from available quarterly sales data, divisional sales data that predates the year before acquisition announcement, post-acquisition divisional sales data, changes in year-to-year revenue for either the acquirer or surviving target organization around the time of the acquisition, target-to-acquirer employee ratios, acquisition purchase price, or other information (Larsson and Finkelstein, 1999).

Collar Provision. A dummy variable indicates the presence of a collar provision (1 = yes). The SDC Mergers and Acquisitions database, the source of this measure, records only the presence or absence of a collar; details of collar contacts are not specified.

Use of Cash as a Method of Payment. Two measures are created to indicate use of cash as a method of acquisition payment. The first is a dummy variable denoting whether cash was among the listed methods of acquisition payment (1 = yes). The second, also a dummy variable, specifies that cash was the only form of payment (1 = yes). The SDC Mergers and Acquisitions database, the source of these data, records only the presence or absence of cash as a method of payment; neither percentage of payment made in cash nor dollar amount of cash are specified. Other studies (e.g., Suk and Sung, 1997; Emery and Switzer, 1999; Ghosh, 2001; Linn and Switzer, 2001) obtained method of payment information and other deal terms from Wall Street Journal articles. In the present sample of medical device firms, however, consistently reported acquisition payment information is available in major news publications for only a modest percentage of corporate combinations. The likelihood of deal terms appearing in the Wall Street Journal or other published news sources increases with acquirer and target size.

Market Concentration. Following Burns, Chilingerian, and Wholey (1994), Vistnes (1995), Keeler, Melnick, and Zwanziger (1999), Young, Desal, and Hellinger (2000), and Robinson (2004), market concentration is measured by the Herfindahl-Hirschmann index (HHI) of market concentration. The HHI "is calculated by squaring

the market share of each firm competing in the market and then summing the resulting numbers...The HHI takes into account the relative size and distribution of the firms in a market and approaches zero when a market consists of a large number of firms of relatively equal size. The HHI increases both as the number of firms in the market decreases and as the disparity in size between those firms increases" (U.S. Department of Justice, 1997). In this way, the HHI measure of market concentration reflects the net effect of (a) market entry and growth among new firms and (b) consolidation via corporate acquisitions. Specifically, HHI is operationalized as:

$$HHI_{t-1} = \sum_{i=1}^{N} s^2_{(i,\,t-1)}$$

where (a) $s^2_{(i,\,t-1)}$ is the squared market share for firm i in the medical device industry in the year before the acquisition t-1, (b) each firm's market share s is its aggregate net sales across business segments with primary SIC codes 3841, 3842, 3844, or 3845 from the Compustat Business Segments database of active and inactive companies divided by total industry net sales across all firms with business segments bearing these primary SIC codes, and (c) there are N firms in the industry. As discussed earlier in this chapter, the recurrence and overlap of these four SIC codes (3841, 3842, 3844, and 3845) within and across medical device manufacturers justify combining them to define the industry under study. The Compustat Segments database contains primary and secondary SIC codes and net sales figures for up to 10 business segments per company per year. To illustrate, Boston Scientific and St. Jude Medical had market shares of 0.90 and 0.72 percent for

fiscal year ending December 31, 1994.

Whereas the antitrust authorities (Federal Trade Commission and Department of Justice) calculate HHI using percentage of the market (so that the HHI value of perfect monopoly is 10,000), market share proportion is used in the present study (so the maximum value for the HHI is 1.000). Also, although 4- and 8-firm concentration ratios (percentage of industry sales accounted for by the largest four or eight producers) are sometimes used to measure market structure, HHI is preferred because all firms in the market are included in the index calculation. If pre-acquisition HHI indicates an already consolidated market, additional consolidation will further reduce the level of competition and may create even greater market power, entry barriers, price-cost ratios, and profitability (Bain, 1951; Scherer, 1970; Porter, 1980; Harrigan, 1981; Carlton and Perloff, 1994; Capron, 1997; McDonald, 1999; Huck, Konrad, and Muller, 2004).

Two alternative specifications for market concentration are also examined. The first is *lagged change in HHI* (rather than the lagged HHI level). Specifically, recent change in HHI is $HHI_{t-1} - HHI_{t-2}$ (source: Compustat Business Segments database). In this way, regression analysis evaluates, for example, the impact of change in HHI from 1991 to 1992 on corporate unions announced during 1993. A positive value for change in HHI indicates a more highly concentrated market in HHI_{t-1} compared with HHI_{t-2}. Second, the predictive ability of *calendar year of acquisition announcement* is employed as a broader and subsuming specification for changes in industry conditions and market concentration over the course of the study period (source: SDC database).

Merger or Partial Acquisition is operationalized as a dummy variable indicating whether the corporate transaction was a merger (1 = acquisition of 100 percent of the target firm) or a partial acquisition (0 = purchase of less than 100 percent of the target organization (source: SDC Mergers and Acquisitions database).

Acquisition Propensity. Tobin's q is computed as the sum of market value of equity (Compustat data item #199 times item #25) plus liquidating value of preferred stock (item #10) plus long-term debt (item #9) plus net short term debt (item #5 minus item #4), all divided by total book value of assets (item #6) (Broussard, Buchenroth, and Pilotte 2004). This measure of lagged Tobin's q is calculated for both acquirer firms and target organizations in the study sample. A centered interaction term is also constructed and evaluated. As an alternative specification, following Danzon, Epstein, and Nicholson (2004), the Tobin's q measure is also top-coded at 20.

The second control for acquisition propensity is recent trend in overall stock market performance, defined as the change in S&P 500 index level during a six-month period (the last two full calendar quarters) before acquisition announcement (source: Standard & Poor's website at http://www2.standardandpoors.com). An alternative specification, change in S&P 500 index level during a twelve-month period (the last four full calendar quarters) before acquisition announcement, is also assessed.

Additional Control Variables

Acquirer's percent of sales in the medical device industry is defined as the buying firm's net sales in business segments with primary SIC codes 3841, 3842, 3844, or 3845 as a percentage of total corporate net sales in the last full fiscal year before the acquisition's effective date (source: Compustat Business Segment database). For example, 100 percent of Boston Scientific's net sales were in medical device business segments the year before announcing its 1995 acquisition of Heart Technology, Inc. In contrast, medical devices accounted for 37 percent of Johnson & Johnson's net sales in year before its 1997 acquisition of Innotech. In this way, the percent of sales measure controls for acquirer's pre-acquisition focus on producing medical devices.

Prior news. This dummy variable indicates the retrieval of at least one news article published prior to the event window that discusses or anticipates acquisition of the target by the acquiring firm (1 = yes) (source: Factiva online database for news articles).

Debt service coverage ratio is defined as net sales divided by total debt in the year before acquisition. The higher the ratio, the stronger the ability to service debt obligations (source: Compustat). Since 5 percent of acquirers in the study sample had no debt (giving rise to an infinite ratio), the debt service coverage ratio for acquirers with zero debt is reported as one standard deviation above the maximum ratio among acquirers with debt obligations. A similar calculation is made for target organizations. News articles and 10-K reports confirm debt-free status. For example, Nellcor (who acquired Puritan-Bennett in 1995) "has no debt and almost $119 million in cash and marketable securities on hand"

(Modern Healthcare, 1994). Similarly, Daig Corporation (acquired by St. Jude Medical in 1996), reported zero long-term obligations in its 1994 and 1995 10-K reports (U.S. Securities and Exchange Commission, 1995, Daig Corporation Form 10-K Annual Report Filing for the Period Ending September 30, 1995).

Time Effects. Three additional measures are constructed to control for and assess the possible impact of time-specific trends and events on acquisition-related financial outcomes. First, a series of yearly dummy variables (indicating calendar year of acquisition announcement) broadly accounts for changes in regulatory policies, judicial rulings, corporate acquisition waves, market structure, and other industry conditions over time (source: SDC database).[37] In the multivariate regression analyses, the calendar year with the most acquisitions, 1997, is the omitted contrast. Second, a pair of dichotomous indicators control for the potential influence of two major federal regulatory enactments that occurred during the study period: The Safe Medical Devices Act of 1990 (Public Law 101-629 signed into law by President Bush on November 28, 1990) and The FDA Modernization Act of 1997 (Public Law 105-115 signed into law by President Clinton on November 21, 1997) (Federal Register, 1999). These measures equal zero if a corporate acquisition was announced before the regulation's presidential signing date, and one if announced after becoming law. Third, average total review times (in days) of PMA applications and 510(k) filings during the calendar year before acquisition announcement control for (dis)incentives associated with periods of prolonged and more expedient FDA

[37] The calendar year of acquisition announcement measure serves as both (a) an alternative specification for market concentration (because year-to-year changes in HHI are correlated with time) and (b) a control variable on its own.

review process durations for medical device products (source: FDA Office of Device Evaluation annual reports for fiscal years 1985, 1989-1991, 1993-2002).

Method of accounting is a dummy variable indicating whether the pooling of interests (= 1) or the purchase method (= 0) of accounting was used in the corporate transaction (source: SDC database).

Hostile acquisition is a dummy variable that takes on the value of one if the acquisition was listed as "hostile" in the SDC database, and zero otherwise.

Presence of litigation is a dummy variable indicating the presence of litigation surrounding the acquisition (1 = yes) (source: SDC database).

Analytic Method

The data analysis follows a six step procedure. First, descriptive statistics (means, standard deviations, coefficients of variation, medians) and bivariate correlations among study variables are reported. The coefficient of variation, a scale-invariant measure of dispersion expressed as standard deviation divided by mean (Allison, 1978; Hamburg, 1987; Chatman and Flynn, 2001), capitalizes on acquisition-related performance heterogeneity to assess whether and when acquisitions in the medical device industry have improved or eroded shareholder wealth and financial accounting performance.

Tables of descriptive statistics are presented for dependent variables, independent variables, control variables, and alternative specifications of these measures. The

correlation tables report Pearson correlations, bivariate significance levels, mean absolute correlations, and maximum absolute correlation values. All analyses are performed using Stata 8.

In the second step, for each dependent variable (cumulative abnormal stock market returns and market-adjusted change in pretax operating cash flow return on sales), a full ("initial") and a reduced ("base") regression model is estimated. Robust regression with a correction for non-independent observations is the regression technique performed. Robust regression (a) produces robust standard errors which compensate for departures from normality and homoscedasticity (constant variance) in the residual error terms and (b) is less sensitive than least squares methods to outlier observations (Rousseeuw and Leroy, 1987; Berk, 1990). The correction for non-independent observations (Stata's *robust cluster* command) is specified because numerous acquirers appear more than once in the study sample (e.g., three acquisitions by Stryker Corporation and two by CR Bard, Inc). The full models contain an initial set of 24 regressors (all 20 independent variables reported in the table of descriptive statistics for independent variables (Table 12) plus four acquisition propensity controls). The base models are constructed by (a) removing regressors that are highly correlated with other predictors in the full model and (b) dropping from the full model right-hand side variables that do not contribute significantly (individually and jointly based on partial F-tests) to the prediction of acquisition-related financial outcomes. In this way, the ratio of observations to degrees of freedom is increased in the base models compared with the initial, full models. All regression tables present F-statistics to judge the overall significance of the model, R-squared values (which measure the proportion of the

variation in acquisition-related financial outcomes explained by the set of predictors in the regression model), a power sufficiency evaluation,[38] regression coefficients, and their standard errors and significance levels.[39]

In the third step of the data analysis procedure, a series of six regression diagnostics and robustness checks is performed on the announcement and cash flow returns base models (Tables 16A and 17A). First, the overall F-statistic of each model is examined to confirm that the predictor variables collectively explain a significant amount of the variation in the dependent variable (a condition that should be met before interpreting individual regression coefficients).

Second, partial F-tests confirm that independent and control variables removed from the full model to create the reduced base model do not contribute significantly—both as a group and individually—to predicting the dependent variable.

Third, each base model's F-statistic is compared to its critical F-value needed to demonstrate sufficient statistical power to detect hypothesized relationships.

Fourth, partial F-tests are again conducted, this time to confirm that the hypothesized independent variables and major control variables contribute significantly

---

[38] Statistical power refers to the ability to detect significant effects in a dataset when these effects do in fact exist. For a regression analysis with 273 observations and 17 predictors (e.g., the announcement returns base model), the critical F-value for sufficient power at the customary .80 level (that is, a .20 probability of committing a Type II error) is 1.20. Murphy and Myors (1998) present F-tables for determining critical F-values, along with a procedure for linear interpolation when the F-tables do not include a row for a particular number of predictor variables or a column for a particular number of degrees of freedom. Statistical power of a regression estimation is deemed to be sufficient if the observed F-value exceeds the critical F-value.

[39] The regression results tables report two-tailed significance tests for regression coefficients. This follows the convention of presenting the more conservative, two-tailed significance test. To illustrate, a t-statistic of 1.651 with 255 degrees of freedom has a directional, one-tailed p-value of .05 and a two-tailed p-value of .10.

as a group to predicting acquisition-related financial outcomes "after accounting (or controlling) for the contribution of" the acquisition propensity measures (Kleinbaum, Kupper, and Muller, 1988, p. 127).

Fifth, the variance inflation factor (VIF) is used to assess multicollinearity in the base models. "A rule of thumb for evaluating VIFs is to be concerned with any value larger than 10.0" (Kleinbaum, Kupper, and Muller, 1988, p. 210; Greene, 2000).

Sixth, the reliability of the base models is assessed with a split sample procedure whereby (a) the full sample of corporate acquisitions is randomly divided into two groups, (b) the base model regression equation is estimated for Group 1, (c) the estimated regression coefficients from Group 1 are used to predict acquisition-related financial outcomes for Group 2, and (d) the cross-validation correlation is calculated as the Pearson correlation between the predicted and actual financial outcomes among Group 2 acquisitions (Kleinbaum, Kupper, and Muller, 1988). This split sample procedure is repeated a total of 10 times (as programmed in a Stata do-file) to produce a series of five cross-validation correlation values for announcement returns and five for cash flow returns.

In addition, the consistency, pattern, and strength of the base model regression results are assessed with five alternative estimation approaches: (a) robust regression without the correction for non-independent observations (thereby restoring a substantial number of degrees of freedom in the estimation procedure), (b) median regression, a least absolute deviations technique that is less sensitive to outlier observations than least squares procedures (Greene, 2000), (c) robust regression re-run without outlier cases, where outliers are defined as observations whose studentized deleted residual is greater

than a Bonforonni-adjusted critical t-value,[40] (d) models that use research and development expenditures in the denominators of the product innovation capability ratios (H1) and in the production efficiency input vector (H2), and (e) models that evaluate the impact of additional control variables in the announcement return and cash flow return base models. Overall, confidence in the results and conclusions of research is heightened when they withstand sensitivity analysis and alternative specifications (Grannemann, Brown, and Pauly, 1986; Judge et al, 1988).

The fourth step of the data analysis procedure confirms that product innovation capability, production efficiency, acquisition experience, and Tobin's q are not merely all measuring the same thing about acquiring firms and target organizations, but rather each of these measures contributes unique information to the analysis. Stata's *alpha* command is used to construct a scale, termed "asset quality," from unstandardized and standardized product innovation capability, production efficiency, acquisition experience, and Tobin's q measures. Scale reliability coefficients (Cronbach's alpha) assess the internal consistency of acquirer and target asset quality scales, and the scales (with an interaction term) are entered into regression models to ascertain their predictive ability.

Fifth, corporate acquisitions in the medical device industry are further analyzed in a series of subsample analyses. Specifically, separate regression models are estimated and compared for (a) smaller versus larger corporate combinations, (b) limiting the analysis to each acquirer's largest acquisition only, (c) high-technology, general supplies, and

[40] For example, in a regression estimation containing the full sample of 273 corporate acquisitions, an observation is judged to be an outlier if its studentized residual exceeds 3.793 in absolute value (because pr(|t|>3.793) = .05/273 based on a two-tailed test at the .05 significance level). Studentized deleted residuals detect outlier cases by appraising how each observation *i* deviates from a fitted regression model that excludes observation *i* (Kleinbaum, Kupper, and Muller, 1988).

diversifying acquisitions, (d) surviving target organizations, and (e) sensitivity to firms with restated financial reports.

Sixth, as a final robustness check, regression models are re-run using alternative specifications for dependent, independent, control variables.

CHAPTER 4: RESULTS

Descriptive Statistics: Dependent Variables

Cumulative Abnormal Stock Market Returns. The mean cumulative abnormal stock market return for the study sample of 273 portfolio combinations of acquirer/target pairs using the 3-day event window surrounding the announcement date, $CAR_{P(-1,1)}$, was .0102 (or 1.02 percent) (Table 10).[41] This return is significantly different than zero at the .05 significance level based on a standard t-test evaluating whether $CAR_{P(-1,1)} = 0$. Specifically, the t-test yielded a t-statistic of 2.77 and a two-tailed p-value of .006. The median $CAR_{P(-1,1)}$ was lower (.0031, or 0.31 percent) than the mean $CAR_{P(-1,1)}$, but still significantly different than zero at the .05 significance level based on the nonparametric Wilcoxon signed rank test (which produced a z-score of 2.03 and p-value of .042, corroborating rejection of the null hypothesis that the mean $CAR_{P(-1,1)}$ is zero). Mean portfolio CARs for the 5- and 11-day event windows (0.90 and 1.43 percent) surrounded the 3-day value (1.02 percent), and were also significantly different from zero at the .05 significance level.[42]

$CAR_{P(-1,1)}$ was positive (indicating acquisition-related shareholder wealth creation) in 54 percent of corporate transactions and negative (indicating wealth

---

[41] Prior corporate acquisition studies generally have not combined acquirer and target CARs into a joint portfolio return measure. Instead, CARs for acquiring firms and target organizations typically have been analyzed and reported separately. Compared with those studies that do report combined acquirer/target transaction returns (e.g., 0.46 percent by Houston and Ryngaert, 1994; 2.25 percent by Shahrur, 2005; 4.03 percent by Cybo-Ottone and Murgia, 2000), returns to acquirer/target pairs in the medical device industry are relatively modest.

[42] In the multivariate regression analyses, the announcement return measure with the shortest event window, $CAR_{P(-1,1)}$ serves as the primary measure of cumulative abnormal stock market returns.

Table 10: Descriptive Statistics
Dependent Variables

Cumulative Abnormal Stock Market Returns		n	Mean	Std Dev	Coeff of Variation	Median	Percent Positive
$CAR_{P(-1,1)}$	Portfolio CAR, 3-day event window (-1,1)	273	0.0102	0.0606	5.97	0.0031	54%
$CAR_{P(-2,2)}$	Portfolio CAR, 5-day event window (-2,2)	273	0.0090	0.0624	6.91	0.0050	54%
$CAR_{P(-5,5)}$	Portfolio CAR, 11-day event window (-5,5)	273	0.0143	0.0770	5.40	0.0139	58%
$CAR_{A(-1,1)}$	Acquirer CAR, 3-day event window (-1,1)	273	0.0090	0.0773	8.63	0.0015	52%
$CAR_{A(-2,2)}$	Acquirer CAR, 5-day event window (-2,2)	273	0.0082	0.0818	9.95	0.0041	52%
$CAR_{A(-5,5)}$	Acquirer CAR, 11-day event window (-5,5)	273	0.0084	0.1058	12.53	0.0098	55%
$CAR_{T(-1,1)}$	Target CAR, 3-day event window (-1,1)	273	0.0865	0.2020	2.33	0.0164	65%
$CAR_{T(-2,2)}$	Target CAR, 5-day event window (-2,2)	273	0.0906	0.2133	2.36	0.0223	64%
$CAR_{T(-5,5)}$	Target CAR, 11-day event window (-5,5)	273	0.1168	0.2209	1.89	0.0477	70%
Market-Adjusted Change in Pretax Operating Cash Flow Return on Sales							
$\Delta POCFROS_{P2}$	Portfolio, 2-yr post-acquisition evaluation period	229	0.0583	0.3351	5.75	0.0113	65%
$\Delta POCFROS_{P3}$	Portfolio, 3-yr post-acquisition evaluation period	208	0.0579	0.3363	5.80	0.0163	63%
$\Delta POCFROS_{P4}$	Portfolio, 4-yr post-acquisition evaluation period	195	0.0623	0.3493	5.60	0.0189	64%
$\Delta POCFROS_{A2}$	Acquirer, 2-yr post-acquisition evaluation period	229	0.1421	1.0133	7.13	0.0057	57%
$\Delta POCFROS_{A3}$	Acquirer, 3-yr post-acquisition evaluation period	208	0.1666	1.1126	6.68	0.0040	54%
$\Delta POCFROS_{A4}$	Acquirer, 4-yr post-acquisition evaluation period	195	0.1804	1.1845	6.57	0.0065	58%
$\Delta POCFROS_{T2}$	Target, 2-yr post-acquisition evaluation period	149	(0.0783)	0.7553	9.64	0.0048	56%
$\Delta POCFROS_{T3}$	Target, 3-yr post-acquisition evaluation period	143	(0.0575)	0.6240	10.86	0.0080	56%
$\Delta POCFROS_{T4}$	Target, 4-yr post-acquisition evaluation period	136	(0.0514)	0.5882	11.45	0.0094	57%

destruction) in 46 percent of cases. The coefficient of variation (standard deviation divided by mean) for $CAR_{P(-1,1)}$ was 5.97, indicating considerable dispersion in acquisition-related stock price revaluations. The multivariate regression and subsample analyses aim to capitalize on this heterogeneity in announcement abnormal returns to identify conditions associated with increases and decreases in shareowner wealth.

The corporate combinations with the two largest positive $CAR_{P(-1,1)}$ announcement returns were Spectranetics' purchase of Advanced Interventional Systems (announced October 1993) and Eclipse Surgical Technologies' purchase of CardioGenesis (announced October 1998). The two largest negative announcement returns were Steris Corporation's purchase of AMSCO International (announced December 1995) and Interpore International's purchase of Cross Medical Products (announced February 1998).

Shareowners of acquiring organizations received mean CARs of 0.896, 0.822, and 0.845 percent for the 3-, 5-, and 11-day event windows, respectively. None of these three acquirer CARs is significantly different than zero at the two-tailed .05 level (although $CAR_{A(-1,1)}$ approaches this threshold). The acquirer announcement returns reported in the present study are highly comparable to values previously documented by Jarrell and Poulsen, 1989 (.92 percent); Bradley, Desai, and Kim, 1988 (.97 percent); and Moeller, Schlingemann, and Stulz, 2004 (1.10 percent). Other studies have reported negative but nonsignificant acquirer announcement returns (e.g., Jensen and Ruback, 1983; Singh and Montgomery, 1987; Anand and Singh, 1997; Capron and Pistre, 2002).

Announcement returns to target shareholders were an order of magnitude greater than acquirer shareholder returns, averaging 8.65, 9.06, and 11.68 percent for the 3-, 5-,

and 11-day event windows ($p<.0001$ for each). These target returns are in the lower range of values reported in prior corporate acquisitions research: Jensen and Ruback, 1983 (7.72 percent); Anand and Singh, 1997 (13.78 percent); Houston and Ryngaert, 1994 (14.77 percent); Shahrur, 2005 (15.89 percent); Ruback, 1988 (22.21 percent); Song and Walkling, 1993 (23.4 percent). Interestingly, coefficients of variation were considerably smaller for target CARs compared with acquirer CARs, indicating a more consistent level of announcement returns to target shareowners.

Compared with mean values, median cumulative abnormal returns to acquirer and target shareowners were smaller in value (indicating some large positive values pulling up the mean). As with mean values, median target CARs consistently exceeded median acquirer returns:

$CAR_{A(-1,1)} = 0.15$ percent; $CAR_{A(-2,2)} = 0.41$ percent; $CAR_{A(-5,5)} = 0.98$ percent

$CAR_{T(-1,1)} = 1.64$ percent; $CAR_{T(-2,2)} = 2.23$ percent; $CAR_{T(-5,5)} = 4.77$ percent.

Using the Wilcoxon signed rank test, median values for $CAR_{T(-1,1)}$, $CAR_{T(-2,2)}$ and $CAR_{T(-5,5)}$ were all significantly different than zero at the .001 level; $CAR_{A(-1,1)}$, $CAR_{A(-2,2)}$ and $CAR_{A(-5,5)}$ were not significantly different from zero at the .05 level.

The median dollar abnormal return among acquirer/target portfolio combinations for the 3-day event window surrounding acquisition announcement, $DAR_{P(-1,1)}$, was $968,788—just under $1 million. $DAR_{P(-1,1)}$ was positive (indicating net acquirer/target shareholder wealth gains) in 54 percent of cases, and exceeded $1 billion in shareowner wealth creation in 12 of the 273 acquisitions under study. Median portfolio dollar

abnormal returns for the 5- and 11-day event windows ($DAR_{P(-2,2)}$ and $DAR_{P(-5,5)}$) were somewhat larger than the 3-day window: $2.93 million and $5.85 million.

From the perspective of an individual investor, a pre-acquisition stake of $100,000 in the median acquirer (that is, the acquirer with the middle-ranked $CAR_{A(-1,1)}$) produced a wealth increase of $155 for the 3-day event window; a $100,000 investment in the target organization with the median $CAR_{T(-1,1)}$ generated a $1,638 wealth gain. In contrast, $100,000 pre-acquisition investments in the acquirer and target whose $CAR_{(-1,1)}$ is at the 75th percentile of the study sample produced wealth gains of $3,177 and $12,649.

Market-Adjusted Change in Pretax Operating Cash Flow Return on Sales. The mean market-adjusted ΔPOCFROS for portfolio combinations was .0583 (or 5.83 percent) for 2-year post-acquisition evaluation periods, 5.79 percent for 3-year periods, and 6.23 percent for 4-year periods (Table 10).[43] The market-adjusted measure controls for broad changes in economic conditions by subtracting the contemporaneous market-wide ΔPOCFROS from each acquisition ΔPOCFROS. The market-wide ΔPOCFROS is calculated using all companies in the Compustat database (e.g., a total of 7,430 corporations comprise the 1991 pretax operating cash flow and net sales data), and

[43] To isolate and evaluate the impact of corporate acquisitions on realized financial performance, the analysis ideally would compare ΔPOCFROS among (a) medical device manufacturers that engaged in acquisition activity (the treatment group) and (b) a control sample of similar and comparable medical device makers that were neither acquirers nor targets during the same pre- and post-acquisition period (the control group). Unfortunately, as explained in Chapter 3, because of widespread acquisition participation by medical device firms during the study period, the matched-firm control approach is not possible and the research cannot isolate the impact of acquisition activity on realized financial performance by contemporaneously comparing acquirers and non-acquirers. Instead, the research investigates (when the dependent variable is ΔPOCFROS) the explanatory power of the hypothesized predictors of accounting performance changes among firms that engaged in corporate acquisition activity.

averaged 0.42, 0.51, and 0.61 percent for 2-, 3-, and 4-year post-acquisition evaluation periods. Clearly, the medical device producers in the study sample achieved above-market cash flow returns during the 21-year period beginning in 1984 (the first acquisition effective dates in the study sample) and extending through 2004 (the fourth and final post-acquisition evaluation year for corporate transactions with effective dates in 2000). For the 2-, 3-, and 4-year evaluation periods, portfolio ΔPOCFROS was greater than zero in 65, 63, and 64 percent of acquisitions. Market-adjusted portfolio change in pretax operating cash flow return on sales for all three post-acquisition evaluation periods was significantly different than zero at the .05 level based on both t-tests and the Wilcoxon signed rank test. Mean ΔPOCFROS values exceed median values, signaling the presence of some large positive ΔPOCFROS cases. Coefficients of variation for portfolio cash flow returns and announcement returns were similar (e.g., 5.60 for $\Delta POCFROS_{P4}$ and 5.97 for $CAR_{P(-1,1)}$).

Two years of post-acquisition financial data was available for 84 percent of deals in the study sample (n = 229), three years was available for 76 percent (n = 208), and four years was available for 71 percent (n = 195). The decline in financial data availability during the post-acquisition evaluation period is due to corporate events following the focal acquirer-target combination (e.g., subsequent merger or acquisition activity, bankruptcy, liquidation, or leveraged buyout) as identified by Compustat's "Reason for Deletion Code" (data item AFTNT35).

In the multivariate regression analyses, the cash flow return measure with the longest post-acquisition evaluation period, $\Delta POCFROS_{P4}$, serves as the primary measure of market-adjusted portfolio change in pretax operating cash flow return on sales. The

corporate unions with the two largest positive $\Delta POCFROS_{P4}$ cash flow returns were Taunton Technologies' purchase of VISX Inc. (announced April 1990) and Eclipse Surgical Technologies' purchase of CardioGenesis (announced October 1998). The two largest negative cash flow returns were Horizon Medical Products' purchase of CryoLife's Ideas for Medicine subsidiary (announced September 1998) and Advanced NMR Systems' purchase of Medical Diagnostics (announced May 1995). Eclipse Surgical Technologies' purchase of CardioGenesis had both the second largest positive announcement return and the second largest cash flow return in the study sample.

Mean and median acquirer ΔPOCFROS for the 2-, 3-, and 4-year post-acquisition evaluation periods were 14.21 and 0.57 percent, 16.66 and 0.40 percent, and 18.04 and 0.65 percent. The dissimilarity in these mean and median values support the performance of multivariate analyses with and without outlier observations and top coded values.

In the study sample, 103 corporate transactions were classified as mergers (acquisition of 100 percent of the target firm), leaving 170 surviving target organizations. Of these 170 surviving targets, two years of post-acquisition financial data was available for 88 percent of transactions (n = 149), three years was available for 84 percent (n = 143), and four years was available for 80 percent (n = 136). For all three post-acquisition periods studied, surviving target organizations experienced a negative mean ΔPOCFROS (but median values were positive, indicating mean sensitivity to large negative values).

Strength of Association Between the Two Dependent Variables.

Positive and significant correlation coefficients were found between the measures of cumulative abnormal stock market returns (a measure of expected performance) and market-adjusted change in pretax operating cash flow return on sales (a measure of realized performance) (Table 11). For example, the correlation coefficient between (a) cumulative abnormal stock market return for portfolio combinations of acquirer/target pairs using the 3-day event window, $CAR_{P(-1,1)}$, and (b) market-adjusted change in pretax operating cash flow return on sales using the 4-year post-acquisition period, $\Delta POCFROS_{P4}$, was .36 (p-value = .0000). This correlation is similar to the .32 relationship reported by Kale, Dyer, and Singh (2002) between (a) abnormal stock market returns to alliance partners surrounding corporate alliance announcements and (b) manager assessment ratings of long-term alliance performance. Other studies (Healy, Palepu, and Ruback, 1992, 1997; Anand and Singh, 1997) discuss a positive relationship between abnormal stock returns and cash flow returns, but do not report correlation coefficients.

Table 11: Correlation Between the Two Dependent Variables	
Corr ($CAR_{P(-1,1)}$, $\Delta POCFROS_{P2}$)=.38	(p-value=.0000)
Corr ($CAR_{P(-1,1)}$, $\Delta POCFROS_{P3}$)=.33	(p-value=.0000)
Corr ($CAR_{P(-1,1)}$, $\Delta POCFROS_{P4}$)=.36	(p-value=.0000)
Corr ($CAR_{P(-2,2)}$, $\Delta POCFROS_{P2}$)=.29	(p-value=.0000)
Corr ($CAR_{P(-2,2)}$, $\Delta POCFROS_{P3}$)=.23	(p-value=.0010)
Corr ($CAR_{P(-2,2)}$, $\Delta POCFROS_{P4}$)=.25	(p-value=.0005)
Corr ($CAR_{P(-5,5)}$, $\Delta POCFROS_{P2}$)=.15	(p-value=.0207)
Corr ($CAR_{P(-5,5)}$, $\Delta POCFROS_{P3}$)=.08	(p-value=.2297)
Corr ($CAR_{P(-5,5)}$, $\Delta POCFROS_{P4}$)=.09	(p-value=.1910)

These results provide evidence on the predictive association between stock market valuations around the announcement date and subsequent realized financial accounting performance, and corroborates the market efficiency hypothesis (Anand and Singh, 1997). The strength of association, however, fades with longer CAR event windows.

Descriptive Statistics: Independent and Major Control Variables

Table 12 displays descriptive statistics for the primary independent variables and major control variables.

Table 12: Descriptive Statistics
Independent and Major Control Variables
(n=273)

Independent Variables				**Coeff of**	
Product Innovation Capability (H1)		**Mean**	**Std Dev**	**Variation**	**Median**
Patent Awards					
H1apatns	Ratio of patents to net sales ($M), acquirer ◊	0.2629	1.0614	4.04	0.0440
H1tpatns	Ratio of patents to net sales ($M), target ◊	1.0772	6.0583	5.62	0.0379
H1intpatns	Interaction, H1apatns x H1tpatns, centered ◊	0.0379	3.0501	80.58	0.2021
Premarket Approvals					
H1apmans	Ratio of PMAs to net sales ($M), acquirer ◊	0.01819	0.06727	3.70	0.00000
H1tpmans	Ratio of PMAs to net sales ($M), target ◊	0.01015	0.05901	5.81	0.00000
H1intpmans	Interaction, H1apmans x H1tpmans, centered ◊	0.00048	0.00636	13.29	0.00018
510(k) Clearances					
H1a510kns	Ratio of 510(k)s to net sales ($M), acquirer ◊	0.1114	0.3903	3.50	0.0082
H1t510kns	Ratio of 510(k)s to net sales ($M), target ◊	0.2664	1.4374	5.40	0.0093
H1int510kns	Interaction, H1a510kns x H1t510kns, centered ◊	-0.0201	0.1737	8.62	0.0214
Production Efficiency (H2)					
H2aperns	Acquirer's production efficiency rating (0-100) ◊	36.25	21.18	0.58	31.96
H2tperns	Target's production efficiency rating (0-100) ◊	32.93	24.38	0.74	27.22
H2intperns	Interaction, H2aperns x H2tperns, centered ◊	89.03	561.42	6.31	37.71
Building Product Lines Along Medical Specialties (H3)					
H3plms	Whether acquirer and target products overlapped in at least one medical specialty area before the acquisition (1=yes) ◊	0.7692	0.4221	0.55	1.00
Post-Acquisition Scale (H4)					
H4lnscns	ln (combined acquirer + target net sales in $B) ◊	19.199	2.337	0.12	19.040
Prior Acquisition Experience (H5)					
H5aexp	Discounted number of prior acquisitions by acquirer, 4-yr half-life, scaled by net sales ($M) ◊	0.0664	0.2088	3.14	0.0070
Major Control Variables					
Relative Size of Target to Acquirer					
relsize	Ratio of target to acquirer net sales ◊	0.3878	0.8327	2.15	0.0673
Collar Provision					
collar	Presence of a collar provision (1=yes)	0.0623	0.2421	3.89	0.00
Use of Cash as a Method of Payment					
cash	Whether cash was a form of payment (1=yes)	0.4542	0.4988	1.10	0.00
Market Concentration					
hhi	HHI, medical device industry ◊	0.0672	0.0170	0.25	0.0694
Merger or Partial Acquisition					
m1a0	Merger=1; partial acquisition=0	0.3773	0.4856	1.29	0.0000
Acquisition Propensity					
aq	Tobin's q, acquirer ◊	2.1763	2.9076	1.34	1.4497
tq	Tobin's q, target ◊	1.9773	5.2783	2.67	1.2243
interq	Interaction, aq x tq, centered ◊	1.2463	10.0684	8.08	0.4980
sp6m	Recent market trend (lagged 6-month change in S&P 500 index level) ◊	0.0948	0.0935	0.99	0.1013

◊ Indicates lagged independent variable (measured in time periods prior to the focal acquisition event)

Product Innovation Capability (H1). During the five years before the effective dates of the acquisitions under study:

- Acquirers generated on average 2.6 patent awards, 0.18 premarket approvals (PMAs), and 1.1 510(k) clearances per $10 million in medical care commodities (MCC) CPI-adjusted net sales, and

- Target organizations received 10.8 patents, 0.10 PMAs, and 2.7 510(k)s per $10 million MCC-CPI adjusted net sales.

The higher pre-acquisition rates of patent awards and 510(k) clearances among target organizations demonstrate external sourcing by acquiring firms of both (a) advanced products, patented technologies, and innovation development capability and (b) imitative products that are substantially equivalent to earlier, legally marketed items (Littell, 1994). PMA approvals are much more infrequent than patent awards or 510(k) clearances. Two reasons explain why PMA is the most sparse regulatory product approval category. First, new medical devices requiring the FDA's PMA review process are truly novel innovations for which substantial equivalence to a predicate device cannot be demonstrated. Relatively few products seeking FDA clearance-to-market are unique and without substantial equivalence to an already "legally marketed device" (Center for Devices and Radiological Health, 2004). Second, patent awards are more numerous than PMA approvals because device firms can obtain patents for manufacturing processes and methods as well as product features and associated instruments, supplies, and packaging.

Multiple patent awards can be associated with a single PMA approval, and patent protections are also sought for 510(k)-type incremental product modifications.

The summary statistics also reveal that target organizations have a lower rate of PMA approvals per $10 million in net sales compared with acquiring firms, suggesting that medical device producers who successfully complete the lengthy, rigorous, and expensive PMA regulatory processes necessary to demonstrate new device safety and effectiveness are subsequently somewhat less apt to be sold to an acquirer firm.

To confirm that the patent, PMA, and 510(k) ratio values indicate different opportunities and benefits conferred to medical device manufacturers, the three product innovation measures were subjected to two confirmatory procedures. First, Cronbach alpha reliability coefficients were calculated for acquiring firms and target organizations to evaluate whether the set of three ratios represents a single underlying construct "product innovation capability." For the three-item scale containing acquirer's ratios of patent awards, premarket approvals, and 510(k) clearances to net sales, the alpha reliability coefficients were .25 (using raw ratio values) and .46 (using standardized ratio values). Analogous values for target's ratios were .15 (using raw ratio values) and .22 (using standardized ratio values). All of these scale reliability coefficients are below the rule-of-thumb .70 benchmark value (Nunnally, 1978; MacKenzie, Podsakoff, and Ahearne, 1998; Blau, 1999; Ailawadi, Neslin, and Gedenk, 2001), suggesting the existence of more than one underlying dimension and the loss of information if the three ratios were consolidated into a single, combinative measure. Second, acquirer and target patent, PMA, and 510(k) ratio values were entered into confirmatory principal factor analyses (Kleinbaum, Kupper and Muller, 1988), again to assess whether the ratio types

represent a single underlying construct "product innovation capability." For the triad of acquirer ratios, the resultant factor had an eigenvalue less than one (indicating evidence against a clear underlying common factor), not all factor loadings were greater than .30 (demonstrating low correlations between the original ratio measures and the factor), and small communality values (reflecting a large proportion of the variance not explained by the underlying factor). The target ratios yielded identical factor analysis interpretations and conclusions. Consequently, both the Cronbach alpha reliability coefficients and the factor analyses indicate that the three ratios are not well-explained by a single common factor, and the individual ratios for patent awards, premarket approvals, and 510(k) clearances are retained in subsequent analyses and hypothesis testing.[44]

Production Efficiency (H2). Mean efficiency ratings for acquirers and targets were 36.3 and 32.9, respectively. Five acquirers and 10 targets obtained maximum efficiency scores of 100.0. Because research and development expenditure data are not available for 28 acquirers (10.3 percent) and 35 targets (12.8 percent) in the study sample, R&D expenditures were excluded from the production efficiency measure reported in Table 12 (that is, average annual R&D expenditures during the last five full fiscal years before the acquisition's effective date were removed from the initial, *a priori* input vector of the data envelopment analysis and were replaced with MCC-CPI adjusted net sales, a resource that enables and funds operations, research, and development). As a result, the vector of cost inputs specified in the data envelopment analysis contained (a)

[44] Cronbach alpha reliability coefficients and factor analyses were also assessed for two-item scales containing the patent award and PMA approval ratios only. The conclusion to retain individual ratio items for acquirers and targets was unchanged.

average annual MCC-CPI adjusted *cost of goods sold* during the last three full fiscal years before the acquisition's effective date, (b) average annual MCC-CPI adjusted *selling, general, and administrative (SGA) expenses* during the last three full fiscal years before the acquisition's effective date, and (c) average annual MCC-CPI adjusted *net sales* during the five year period preceding the effective date. The output vector contained: (a) average annual MCC-CPI adjusted *pretax operating cash flow* during the last three full fiscal years before the effective date, (b) the number of U.S. *patent awards* in the five years preceding the effective date, (c) the number of *PMA approvals* in the five years before the effective, and (d) the number of *510(k) clearances* in the five years before the effective date.[45]

Building Product Lines along Medical Specialties (H3). Acquirer and target products overlapped in at least one major clinical area before the acquisition in 210 (77 percent) of the corporate combinations under study.[46,47] Medical specialty product areas

[45] As an alternative specification, the data envelopment analysis was also run using the initial input and output vectors whereby (a) average annual MCC-CPI adjusted R&D expenditures during the last five full fiscal years preceding the focal acquisition's effective date was restored to the input vector, and (b) net sales was moved to the output vector.

[46] The remaining 63 cases (23 percent) were diversifying acquisitions.

[47] The primary indicator for using corporate acquisitions to build product lines along medical specialties is a dummy variable gauging whether acquirer and target products overlapped in at least one major clinical area before the acquisition (1 = yes). Use of the terms "related diversification" and "unrelated diversification" were considered in this context but not adopted for two reasons. First, the buying firm is not necessarily pursuing unrelated diversification if acquirer and target products did not overlap in a major clinical area before the acquisition. For example, in a case where a manufacturer of orthopedic products acquirers a target organization with product codes that map to physical medicine, neurology, or anesthesia (but not orthopedics), the author lacks the clinical expertise to judge the (un)relatedness (from a patient treatment perspective) of the medical product combination. Conversely, the buying firm is not necessarily pursuing

shared by the acquirer and target organizations included anesthesia and pulmonary medicine (32 cases), cardiovascular (79 cases), gastroenterology and urology (45 cases), general hospital products (84 cases), neurology (24 cases), obstetrics and gynecology (17 cases), orthopedics (24 cases), otorhinolaryngology (11 cases), physical medicine (17 cases), radiology (20 cases), and general surgery (69 cases).

Post-Acquisition Scale (H4). The average value for post-acquisition combinative scale, operationalized as the sum of acquirer and target net sales in the year before acquisition announcement, adjusted using the medical care commodities consumer price index (MCC-CPI), was $2.31 billion. The median value was $186 million, indicating the presence of large acquirer-target pairs hoisting the mean above from the median. In the multivariate regression analyses, the natural log of combined acquirer and target MCC-CPI adjusted net sales is used as the primary independent variable (mean = 19.20).[48]

Prior Acquisition Experience (H5). The mean discounted number of prior acquisitions by acquirers, using a 4-year half-life assumption for acquisition experience, is 0.66 acquisitions per $10 million in MCC-CPI adjusted net sales. For sensitivity analysis, experience values are also calculated for half-lives of 2, 3, 4, 5, and 6 years using both the number and transaction value of corporate acquisitions (Table 25).

---

related diversification if acquirer and target products did overlap in a major clinical area before the acquisition. Again, the author does not have the clinical knowledge to determine, for example, the degree to which acquirer and target cardiovascular products are or are not related in the treatment of cardiovascular diseases or conditions.

[48] The correlation coefficient between building product lines along medical specialties and post-acquisition scale was .169, indicating an empirical distinction between pursuing economies of scope in selling (the former measure) and organizational scale (the latter measure).

Relative Size of Target to Acquirer. The mean ratio of target-to-acquirer net sales in the fiscal year before acquisition announcement was 0.388. In other words, on average acquirers had $2.58 in net sales for every $1.00 in target net sales.

Collar Provision. A collar provision was present in 17 corporate transactions (6.2 percent of cases). Collar provision was coded "not present" in seven cases where (a) this field was blank in the SDC Mergers and Acquisitions database and (b) Factiva news article searching found no evidence of one.

Use of Cash as a Method of Payment. Cash was used as a method of acquisition payment in 124 corporate acquisitions (45 percent).

Market Concentration. The Herfindahl-Hirschmann index in the year before acquisition announcement (where each firm's market share is its aggregate net sales across Compustat business segments with primary SIC codes 3841, 3842, 3844, or 3845 divided by total industry net sales across all firms with business segments bearing these primary SIC codes) averaged .067.

Merger or Partial Acquisition. In the study sample, 103 corporate transactions, or 38 percent, were mergers (that is, acquisition of 100 percent of the target firm) and 170, or 62 percent, were partial acquisitions (purchase of less than 100 percent of the target organization).

Acquisition Propensity. Both mean and median Tobin's q were lower for target organizations compared with acquiring firms, indicating that distressed or underperforming organizations are more inclined to be dealt. Acquirer market-to-book value in the year before acquisition announcement averaged 2.18, while targets averaged 1.98. Median Tobin's q values were 1.45 and 1.22. The second control for acquisition propensity, recent trend in overall stock market performance (defined as the change in S&P 500 index level during the last two full calendar quarters before acquisition announcement), averaged 9.48 percent. This level of return is high by historical standards, but the S&P 500 index more than tripled between the 4th quarter of 1994 and 4th quarter of 1999.

Descriptive Statistics: Additional Control Variables

Table 13 provides descriptive statistics for additional control variables.

Percent of Sales in the Medical Device Industry. On average, 58.6 percent of acquirers' total corporate revenues in the year before acquisition announcement were in business segments with primary SIC codes 3841, 3842, 3844, or 3845. In other words, about 59 cents of every $1 in revenue among acquirers was generated within a primary industry code of either 3841, 3842, 3844, or 3845; 41 cents was generated from outside these SIC codes.

Table 13: Descriptive Statistics
Additional Control Variables
(n=273)

		Mean	Std Dev	Coeff of Variation	Median
Percent of Sales in the Medical Device Industry					
pctmdi	Acquirers' sales in the medical device industry as a percentage of total corporate sales ◊	58.60	46.75	0.80	100.00
Prior News					
prnews	Retrieved at least one news article that anticipates the acquisition (1=yes) ◊	0.1026	0.3039	2.96	0.0000
Debt Service Coverage Ratio					
adebt	Net sales divided by total debt, acquirer ◊	117.67	375.08	3.19	6.1045
tdebt	Net sales divided by total debt, target ◊	498.07	1359.05	2.73	6.0778
Time Effects					
Calendar Year of Acquisition Announcement					
yr1984	Acquisition announced in 1984 (1=yes)	0.0110	0.1044	9.50	0.00
yr1985	Acquisition announced in 1985 (1=yes)	0.0293	0.1690	5.77	0.00
yr1986	Acquisition announced in 1986 (1=yes)	0.0366	0.1882	5.14	0.00
yr1987	Acquisition announced in 1987 (1=yes)	0.0220	0.1469	6.68	0.00
yr1988	Acquisition announced in 1988 (1=yes)	0.0330	0.1789	5.43	0.00
yr1989	Acquisition announced in 1989 (1=yes)	0.0330	0.1789	5.43	0.00
yr1990	Acquisition announced in 1990 (1=yes)	0.0330	0.1789	5.43	0.00
yr1991	Acquisition announced in 1991 (1=yes)	0.0549	0.2283	4.15	0.00
yr1992	Acquisition announced in 1992 (1=yes)	0.0440	0.2054	4.67	0.00
yr1993	Acquisition announced in 1993 (1=yes)	0.0513	0.2210	4.31	0.00
yr1994	Acquisition announced in 1994 (1=yes)	0.0842	0.2783	3.30	0.00
yr1995	Acquisition announced in 1995 (1=yes)	0.1282	0.3349	2.61	0.00
yr1996	Acquisition announced in 1996 (1=yes)	0.1026	0.3039	2.96	0.00
yr1997	Acquisition announced in 1997 (1=yes)	0.1319	0.3390	2.57	0.00
yr1998	Acquisition announced in 1998 (1=yes)	0.1209	0.3266	2.70	0.00
yr1999	Acquisition announced in 1999 (1=yes)	0.0842	0.2783	3.30	0.00
Federal Regulatory Enactments					
smda	Announcement followed SMDA of 1990 (1=yes)	0.8059	0.3963	0.49	1.00
fdama	Announcement followed FDAMA of 1997 (1=yes)	0.2271	0.4197	1.85	0.00
Average Review Times (in days) for FDA Approval					
pmarevtime	PMA applications in year before announcement ◊	322.94	95.82	0.30	343.00
revtime510k	510(k) filings in year before announcement ◊	137.88	47.36	0.34	130.00
Method of Accounting					
acctg	Pooling of interests (=1) or purchase method (=0)	0.1471	0.3548	2.41	0.0000
Hostile Acquisition (1=yes)					
attitude	Hostile (=1) or friendly (=0)	0.0184	0.1346	7.32	0.0000
Presence of Litigation (1=yes)		0.0293	0.1690	5.77	0.0000

◊ Indicates lagged independent variable (measured in time periods prior to the focal acquisition event)

Prior News. In 28 cases (10.3 percent of the study sample), at least one news article published prior to the event window was retrieved that discusses or anticipates acquisition of the target by the acquiring firm.

Debt service coverage ratio. On average, acquirers generated $118 and targets produced $489 in net sales per $1 dollar of total debt in the year before acquisition. These mean values, however, are sensitive to firms with low levels of reported debt. Median net sales-to-debt ratios are $6.10 and $6.08 for acquirers and targets, respectively.

Time Effects. Three control measures were constructed to account for the possible impact of time-specific trends and events on acquisition-related financial outcomes. The first was a series of year dummy variables (indicating calendar year of acquisition announcement) to broadly capture economy-wide and industry-specific conditions over time. The number of acquisitions by year was presented in Table 6. The second control for time effects was a pair of dichotomous measures indicating whether acquisition announcement followed The Safe Medical Devices Act of 1990 (yes for 81 percent of the acquisitions under study) or The FDA Modernization Act of 1997 (yes for 23 percent of the sample). Third, average total FDA review times of PMA applications and 510(k) filings during the calendar year before acquisition announcement (a control for (dis)incentives associated with periods of prolonged and more expedient review process durations for medical products) were 323 and 138 days, respectively.

Method of accounting. Pooling of interests was indicated as the accounting method in 40 cases (14.7 percent) and the purchase method in 233 cases (85.3 percent).

Hostile acquisitions and presence of litigation. The Securities Data Corporation (SDC) database listed only 5 of the 273 corporate acquisitions as "hostile" transactions, and the presence of litigation surrounding the deal in 8 cases.

Pearson Correlations

Four correlation matrices are presented (Tables 14A, 14B, 15A, and 15B). First, Table 14A documents correlation coefficients, bivariate significance levels, mean absolute correlations, and maximum absolute correlation values among (a) the announcement returns dependent variable (cumulative abnormal stock market return for portfolio combinations of acquirer/target pairs using the 3-day event window, $CAR_{P(-1,1)}$), (b) all 20 independent variables reported in Table 12, and (c) the four acquisition propensity control measures. The sample size is 273 corporate acquisitions, coefficients of .12 and above (in absolute value) are significant at the .05-level,[49] and the highest absolute correlations are between main effects and interaction terms. The mean absolute correlation in this matrix is .109.

[49] Threshold significance levels were determined by solving the following t-statistic equation for r given t and n. Specifically, when $t_{critical,.05} = 1.96$ and n = 273, then $r_{critical,.05} = .1182$.

$$t = \frac{r}{\sqrt{(1-r^2)/(n-2)}}$$

The correlation matrix in Table 14B is a reduced version of Table 14A and corresponds to the base regression model (Table 16A). The base model matrix contains 17 predictor variables, a mean absolute correlation of .116, and a maximum absolute correlation of .577 (between acquirer's Tobin's q and the patent award ratio interaction term). Of the 153 correlation coefficients in the base model matrix, five are at least .40 in absolute value. In response, to confirm that acquirer and target variables are not merely all measuring the same thing, Stata's *alpha* command is used to construct acquirer and target scales, termed "asset quality," from unstandardized and standardized product innovation capability, production efficiency, acquirer acquisition experience, and Tobin's q measures. A multiplicative interaction term is also formed. Reliability coefficients (Cronbach's alpha) assess the internal consistency of acquirer and target asset quality scales, and the scales (with the interaction term) are entered into regression models to ascertain their predictive ability. The results of the consolidated "asset quality" regression analysis (which are presented and discussed later in this chapter in Table 18), show the asset quality variables are non-significant when announcement return is the dependent variable. This analysis concludes that the acquirer and target measures contribute unique information to the study.

The variables in Table 15A are identical to Table 14A, except the dependent variable is market-adjusted change in pretax operating cash flow return on sales using a 4-year post-acquisition period, $\Delta POCFROS_{P4}$. In this matrix, the sample size is 195, coefficients of .14 and above (in absolute value) are significant at the .05-level, and the mean absolute correlation is .135. In the reduced version (Table 15B), there are 15 predictor variables, the mean absolute correlation is somewhat higher (.157) and the

maximum absolute correlation is .634 (again between acquirer's Tobin's q and the patent award ratio interaction term). The correlation between the dependent variable and acquirer's pre-acquisition patent yield (.54) indicates that about 29 percent of the variance in overall cash flow returns is explained by this indicator of acquirer's product innovation capability. Also, the correlation matrix in Table 15B has nine correlation coefficients of at least .40 in absolute value. To again confirm that acquirer and target variables are not merely all measuring the same thing, the consolidated "asset quality" regression analysis yielded a small and non-significant overall F-statistic when predicting cash flow returns, corroborating that the acquirer and target measures contribute unique information to the study.

Table 14A: Pearson Correlations
Dependent Variable: $CAR_{P(-1,1)}$
Full Model

Mean absolute correlation: 0.109
Maximum absolute correlation: 0.920 (tq, interq)

			1	2	3	4	5	6	7	8	9	10	11	12
1	$CAR_{P(-1,1)}$	Portfolio CAR, 3-day event window (-1,1)												
2	H1apatns	Ratio of patents to net sales ($M), acquirer	0.13											
3	H1tpatns	Ratio of patents to net sales ($M), target	0.08	0.01										
4	H1intpatns	Interaction, H1apatns x H1tpatns, centered	0.00	0.06	-0.34									
5	H1apmans	Ratio of PMAs to net sales ($M), acquirer	0.16	0.46	0.06	-0.21								
6	H1tpmans	Ratio of PMAs to net sales ($M), target	0.14	0.00	0.00	-0.01	0.12							
7	H1intpmans	Interaction, H1apmans x H1tpmans, centered	0.38	0.00	0.01	0.00	0.13	0.50						
8	H1a510kns	Ratio of 510(k)s to net sales ($M), acquirer	0.00	0.23	-0.04	-0.06	-0.03	-0.02	-0.01					
9	H1t510kns	Ratio of 510(k)s to net sales ($M), target	0.13	0.01	0.24	0.05	0.02	-0.02	-0.01	-0.04				
10	H1int510kns	Interaction, H1a510kns x H1t510kns, centered	-0.12	-0.13	-0.18	-0.01	0.01	0.03	0.02	-0.50	-0.83			
11	H2aperns	Acquirer's production efficiency rating (0-100)	0.04	0.23	0.01	-0.02	0.45	0.13	0.02	0.31	0.03	-0.17		
12	H2tperns	Target's production efficiency rating (0-100)	0.00	-0.01	0.38	-0.13	0.08	0.32	0.11	-0.03	0.32	-0.25	0.17	
13	H2intperns	Interaction, H2aperns x H2tperns, centered	0.03	-0.14	-0.03	0.01	-0.02	0.24	0.13	-0.13	0.01	0.08	-0.03	0.18
14	H3plms	Whether acquirer and target products overlapped in at least one medical specialty area before the acquisition (1=yes)	-0.06	-0.05	-0.06	-0.09	0.04	0.09	0.04	-0.01	-0.03	0.05	0.15	0.21
15	H4lnscns	ln (combined acquirer + target net sales in $B)	-0.12	-0.33	0.02	-0.07	-0.14	0.04	-0.06	-0.33	-0.01	0.17	-0.04	0.14
16	H5aexp	Discounted number of prior acquisitions by acquirer, scaled by net sales ($M)	-0.04	0.27	0.01	0.44	0.06	-0.05	-0.03	-0.04	0.03	-0.02	-0.03	-0.09
17	relsize	Ratio of target to acquirer net sales	-0.01	0.20	-0.07	0.02	0.16	0.01	0.06	0.18	-0.05	-0.05	0.05	-0.10
18	collar	Presence of a collar provision (1=yes)	-0.09	-0.03	0.11	-0.07	0.07	0.25	0.05	-0.03	0.06	-0.03	0.13	0.22
19	cash	Whether cash was a form of payment (1=yes)	0.07	0.01	0.04	-0.10	-0.08	-0.10	-0.07	0.03	-0.12	0.07	-0.06	-0.11
20	hhi	HHI, medical device industry	-0.07	-0.06	-0.12	0.20	-0.12	0.00	0.07	0.04	-0.05	0.02	-0.10	-0.12
21	m1a0	Merger=1; partial acquisition=0	0.11	0.02	0.21	0.01	0.11	0.15	0.09	-0.11	0.19	-0.07	0.14	0.27
22	aq	Tobin's q, acquirer	-0.08	0.29	0.12	0.58	0.11	0.07	-0.02	0.09	0.09	-0.12	0.42	0.19
23	tq	Tobin's q, target	-0.07	0.00	0.13	-0.04	0.06	0.03	-0.02	-0.02	0.43	-0.27	0.14	0.21
24	interq	Interaction, aq x tq, centered	-0.04	-0.05	0.08	-0.08	0.04	0.05	-0.01	-0.03	0.40	-0.24	0.11	0.10
25	sp6m	Lagged 6-month change in S&P 500 index level	-0.02	-0.08	-0.02	-0.05	0.01	0.03	-0.04	-0.09	0.06	-0.02	0.03	0.00

n=273. Coefficients of .12 and above are significant at p<.05.

Table 14A: Pearson Correlations
Dependent Variable: $CAR_{P(-1,1)}$
Full Model (continued)

Mean absolute correlation: 0.109
Maximum absolute correlation: 0.920 (tq, interq)

			13	14	15	16	17	18	19	20	21	22	23	24	25
1	$CAR_{P(-1,1)}$	Portfolio CAR, 3-day event window (-1,1)													
2	H1apatns	Ratio of patents to net sales ($M), acquirer													
3	H1tpatns	Ratio of patents to net sales ($M), target													
4	H1intpatns	Interaction, H1apatns x H1tpatns, centered													
5	H1apmans	Ratio of PMAs to net sales ($M), acquirer													
6	H1tpmans	Ratio of PMAs to net sales ($M), target													
7	H1intpmans	Interaction, H1apmans x H1tpmans, centered													
8	H1a510kns	Ratio of 510(k)s to net sales ($M), acquirer													
9	H1t510kns	Ratio of 510(k)s to net sales ($M), target													
10	H1int510kns	Interaction, H1a510kns x H1t510kns, centered													
11	H2aperns	Acquirer's production efficiency rating (0-100)													
12	H2tperns	Target's production efficiency rating (0-100)													
13	H2intperns	Interaction, H2aperns x H2tperns, centered													
14	H3plms	Whether acquirer and target products overlapped in at least one medical specialty area before the acquisition (1=yes)	0.08												
15	H4lnscns	ln (combined acquirer + target net sales in $B)	0.13	0.17											
16	H5aexp	Discounted number of prior acquisitions by acquirer, scaled by net sales ($M)	-0.04	-0.11	-0.36										
17	relsize	Ratio of target to acquirer net sales	-0.14	0.03	-0.30	0.03									
18	collar	Presence of a collar provision (1=yes)	0.20	0.07	0.12	-0.07	-0.02								
19	cash	Whether cash was a form of payment (1=yes)	-0.08	0.01	-0.11	0.07	0.18	-0.20							
20	hhi	HHI, medical device industry	-0.09	-0.04	-0.18	0.15	0.07	-0.09	-0.10						
21	m1a0	Merger=1; partial acquisition=0	0.09	0.03	0.26	-0.10	0.02	0.33	-0.18	-0.17					
22	aq	Tobin's q, acquirer	0.09	-0.02	-0.07	0.35	0.10	0.18	-0.08	-0.03	0.18				
23	tq	Tobin's q, target	0.13	0.08	0.06	-0.03	-0.06	0.02	-0.04	-0.10	0.10	0.08			
24	interq	Interaction, aq x tq, centered	0.21	0.07	0.10	-0.07	-0.06	0.05	-0.07	-0.10	0.10	0.00	0.92		
25	sp6m	Lagged 6-month change in S&P 500 index level	0.01	0.02	0.09	-0.08	0.05	-0.06	0.06	-0.25	-0.07	-0.06	0.02	0.00	

n=273. Coefficients of .12 and above are significant at p<.05.

Table 14B: Pearson Correlations
Dependent Variable: $CAR_{P(-1,1)}$
Base Model

Mean absolute correlation: 0.116
Maximum absolute correlation: 0.577 (aq, H1intpatns)

			1	2	3	4	5	6	7	8	9	10	11	12
1	$CAR_{P(-1,1)}$	Portfolio CAR, 3-day event window (-1,1)												
2	H1apatns	Ratio of patents to net sales ($M), acquirer	0.13											
3	H1tpatns	Ratio of patents to net sales ($M), target	0.08	0.01										
4	H1intpatns	Interaction, H1apatns x H1tpatns, centered	0.00	0.06	-0.34									
5	H1apmans	Ratio of PMAs to net sales ($M), acquirer	0.16	0.46	0.06	-0.21								
6	H1tpmans	Ratio of PMAs to net sales ($M), target	0.14	0.00	0.00	-0.01	0.12							
7	H1intpmans	Interaction, H1apmans x H1tpmans, centered	0.38	0.00	0.01	0.00	0.13	0.50						
8	H1a510kns	Ratio of 510(k)s to net sales ($M), acquirer												
9	H1t510kns	Ratio of 510(k)s to net sales ($M), target	0.13	0.01	0.24	0.05	0.02	-0.02	-0.01					
10	H1int510kns	Interaction, H1a510kns x H1t510kns, centered												
11	H2aperns	Acquirer's production efficiency rating (0-100)												
12	H2tperns	Target's production efficiency rating (0-100)	0.00	-0.01	0.38	-0.13	0.08	0.32	0.11		0.32			
13	H2intperns	Interaction, H2aperns x H2tperns, centered												
14	H3plms	Whether acquirer and target products overlapped in at least one medical specialty area before the acquisition (1=yes)	-0.06	-0.05	-0.06	-0.09	0.04	0.09	0.04		-0.03			0.21
15	H4lnscns	ln (combined acquirer + target net sales in $B)	-0.12	-0.33	0.02	-0.07	-0.14	0.04	-0.06		-0.01			0.14
16	H5aexp	Discounted number of prior acquisitions by acquirer, scaled by net sales ($M)	-0.04	0.27	0.01	0.44	0.06	-0.05	-0.03		0.03			-0.09
17	relsize	Ratio of target to acquirer net sales												
18	collar	Presence of a collar provision (1=yes)	-0.09	-0.03	0.11	-0.07	0.07	0.25	0.05		0.06			0.22
19	cash	Whether cash was a form of payment (1=yes)	0.07	0.01	0.04	-0.10	-0.08	-0.10	-0.07		-0.12			-0.11
20	hhi	HHI, medical device industry	-0.07	-0.06	-0.12	0.20	-0.12	0.00	0.07		-0.05			-0.12
21	m1a0	Merger=1; partial acquisition=0	0.11	0.02	0.21	0.01	0.11	0.15	0.09		0.19			0.27
22	aq	Tobin's q, acquirer	-0.08	0.29	0.12	0.58	0.11	0.07	-0.02		0.09			0.19
23	tq	Tobin's q, target	-0.07	0.00	0.13	-0.04	0.06	0.03	-0.02		0.43			0.21
24	interq	Interaction, aq x tq, centered												
25	sp6m	Lagged 6-month change in S&P 500 index level												

n=273. Coefficients of .12 and above are significant at p<.05.

Table 14B: Pearson Correlations
Dependent Variable: $CAR_{P(-1,1)}$
Base Model (continued)

Mean absolute correlation: 0.116
Maximum absolute correlation: 0.577 (aq, H1intpatns)

			13	14	15	16	17	18	19	20	21	22	23	24	25
1	$CAR_{P(-1,1)}$	Portfolio CAR, 3-day event window (-1,1)													
2	H1apatns	Ratio of patents to net sales ($M), acquirer													
3	H1tpatns	Ratio of patents to net sales ($M), target													
4	H1intpatns	Interaction, H1apatns x H1tpatns, centered													
5	H1apmans	Ratio of PMAs to net sales ($M), acquirer													
6	H1tpmans	Ratio of PMAs to net sales ($M), target													
7	H1intpmans	Interaction, H1apmans x H1tpmans, centered													
8	H1a510kns	Ratio of 510(k)s to net sales ($M), acquirer													
9	H1t510kns	Ratio of 510(k)s to net sales ($M), target													
10	H1int510kns	Interaction, H1a510kns x H1t510kns, centered													
11	H2aperns	Acquirer's production efficiency rating (0-100)													
12	H2tperns	Target's production efficiency rating (0-100)													
13	H2intperns	Interaction, H2aperns x H2tperns, centered													
14	H3plms	Whether acquirer and target products overlapped in at least one medical specialty area before the acquisition (1=yes)													
15	H4lnscns	ln (combined acquirer + target net sales in $B)		0.17											
16	H5aexp	Discounted number of prior acquisitions by acquirer, scaled by net sales ($M)		-0.11	-0.36										
17	relsize	Ratio of target to acquirer net sales		0.03	-0.30	0.03									
18	collar	Presence of a collar provision (1=yes)		0.07	0.12	-0.07									
19	cash	Whether cash was a form of payment (1=yes)		0.01	-0.11	0.07		-0.20							
20	hhi	HHI, medical device industry		-0.04	-0.18	0.15		-0.09	-0.10						
21	m1a0	Merger=1; partial acquisition=0		0.03	0.26	-0.10		0.33	-0.18	-0.17					
22	aq	Tobin's q, acquirer		-0.02	-0.07	0.35		0.18	-0.08	-0.03	0.18				
23	tq	Tobin's q, target		0.08	0.06	-0.03		0.02	-0.04	-0.10	0.10	0.08			
24	interq	Interaction, aq x tq, centered		0.07	0.10	-0.07		0.05	-0.07	-0.10	0.10	0.00	0.92		
25	sp6m	Lagged 6-month change in S&P 500 index level		0.02	0.09	-0.08		-0.06	0.06	-0.25	-0.07	-0.06	0.02		

n=273. Coefficients of .12 and above are significant at p<.05.

Table 15A: Pearson Correlations
Dependent Variable: $\Delta POCFROS_{P4}$
Full Model

Mean absolute correlation: 0.135
Maximum absolute correlation: 0.944 (tq, interq)

			1	2	3	4	5	6	7	8	9	10	11	12
1	$\Delta POCFROS_{P4}$	Portfolio, 4-yr post-acquisition evaluation period												
2	H1apatns	Ratio of patents to net sales ($M), acquirer	0.54											
3	H1tpatns	Ratio of patents to net sales ($M), target	0.09	0.01										
4	H1intpatns	Interaction, H1apatns x H1tpatns, centered	0.63	0.05	-0.21									
5	H1apmans	Ratio of PMAs to net sales ($M), acquirer	0.23	0.47	0.12	-0.23								
6	H1tpmans	Ratio of PMAs to net sales ($M), target	0.06	0.00	0.01	-0.01	0.12							
7	H1intpmans	Interaction, H1apmans x H1tpmans, centered	0.15	0.00	0.01	0.00	0.13	0.50						
8	H1a510kns	Ratio of 510(k)s to net sales ($M), acquirer	0.07	0.22	-0.05	-0.07	-0.05	-0.03	-0.01					
9	H1t510kns	Ratio of 510(k)s to net sales ($M), target	-0.01	-0.04	0.40	-0.11	0.04	-0.03	-0.01	-0.04				
10	H1int510kns	Interaction, H1a510kns x H1t510kns, centered	-0.01	-0.14	-0.25	0.14	0.01	0.05	0.02	-0.71	-0.65			
11	H2aperns	Acquirer's production efficiency rating (0-100)	0.19	0.24	0.15	-0.05	0.46	0.12	0.01	0.33	0.09	-0.29		
12	H2tperns	Target's production efficiency rating (0-100)	-0.06	-0.03	0.39	-0.12	0.08	0.35	0.12	-0.04	0.31	-0.17	0.21	
13	H2intperns	Interaction, H2aperns x H2tperns, centered	-0.14	-0.16	0.31	-0.07	-0.02	0.25	0.14	-0.16	0.14	0.04	-0.04	0.38
14	H3plms	Whether acquirer and target products overlapped in at least one medical specialty area before the acquisition (1=yes)	-0.04	-0.07	0.07	-0.14	0.05	0.10	0.04	-0.03	0.09	-0.02	0.18	0.32
15	H4lnscns	ln (combined acquirer + target net sales in $B)	-0.22	-0.38	0.10	-0.08	-0.18	0.03	-0.07	-0.37	0.12	0.16	-0.16	0.18
16	H5aexp	Discounted number of prior acquisitions by acquirer, scaled by net sales ($M)	0.37	0.28	0.01	0.48	0.07	-0.05	-0.03	-0.05	-0.05	0.07	-0.03	-0.11
17	relsize	Ratio of target to acquirer net sales	0.16	0.22	-0.08	0.02	0.19	0.00	0.06	0.20	-0.08	-0.09	0.11	-0.09
18	collar	Presence of a collar provision (1=yes)	-0.06	-0.04	0.20	-0.07	0.07	0.26	0.05	-0.05	0.11	-0.06	0.14	0.27
19	cash	Whether cash was a form of payment (1=yes)	-0.08	0.04	0.01	-0.09	-0.05	-0.11	-0.07	0.05	-0.11	0.03	-0.04	-0.09
20	hhi	HHI, medical device industry	0.05	-0.07	-0.16	0.22	-0.16	-0.01	0.07	0.02	-0.12	0.07	-0.13	-0.21
21	m1a0	Merger=1; partial acquisition=0	0.14	0.00	0.23	0.03	0.13	0.15	0.10	-0.15	0.20	-0.01	0.20	0.30
22	aq	Tobin's q, acquirer	0.54	0.28	0.22	0.63	0.09	0.07	-0.02	0.08	0.05	-0.10	0.39	0.19
23	tq	Tobin's q, target	-0.02	-0.01	0.19	-0.04	0.06	0.03	-0.03	-0.03	0.70	-0.40	0.15	0.20
24	interq	Interaction, aq x tq, centered	-0.06	-0.05	0.17	-0.09	0.04	0.04	-0.02	-0.04	0.68	-0.37	0.12	0.15
25	sp6m	Lagged 6-month change in S&P 500 index level	-0.15	-0.09	0.12	-0.12	0.02	0.06	-0.04	-0.09	0.04	0.00	0.02	0.05

n=195. Coefficients of .14 and above significant at p<.05.

Table 15A: Pearson Correlations
Dependent Variable: $\Delta POCFROS_{P4}$
Full Model (continued)

Mean absolute correlation: 0.135
Maximum absolute correlation: 0.944 (tq, interq)

			13	14	15	16	17	18	19	20	21	22	23	24	25
1	$\Delta POCFROS_{P4}$	Portfolio, 4-yr post-acquisition evaluation period													
2	H1apatns	Ratio of patents to net sales ($M), acquirer													
3	H1tpatns	Ratio of patents to net sales ($M), target													
4	H1intpatns	Interaction, H1apatns x H1tpatns, centered													
5	H1apmans	Ratio of PMAs to net sales ($M), acquirer													
6	H1tpmans	Ratio of PMAs to net sales ($M), target													
7	H1intpmans	Interaction, H1apmans x H1tpmans, centered													
8	H1a510kns	Ratio of 510(k)s to net sales ($M), acquirer													
9	H1t510kns	Ratio of 510(k)s to net sales ($M), target													
10	H1int510kns	Interaction, H1a510kns x H1t510kns, centered													
11	H2aperns	*Acquirer's production efficiency rating (0-100)*													
12	H2tperns	Target's production efficiency rating (0-100)													
13	H2intperns	Interaction, H2aperns x H2tperns, centered													
14	H3plms	Whether acquirer and target products overlapped in at least one medical specialty area before the acquisition (1=yes)	0.02												
15	H4lnscns	ln (combined acquirer + target net sales in $B)	0.14	0.12											
16	H5aexp	Discounted number of prior acquisitions by acquirer, scaled by net sales ($M)	-0.04	-0.14	-0.37										
17	relsize	Ratio of target to acquirer net sales	-0.21	0.05	-0.34	0.04									
18	collar	Presence of a collar provision (1=yes)	0.23	0.05	0.13	-0.08	-0.03								
19	cash	Whether cash was a form of payment (1=yes)	-0.13	0.02	-0.11	0.09	0.21	-0.20							
20	hhi	*HHI, medical device industry*	-0.12	-0.09	-0.25	0.18	0.08	-0.10	-0.05						
21	m1a0	Merger=1; partial acquisition=0	0.13	0.04	0.31	-0.12	-0.01	0.34	-0.15	-0.22					
22	aq	Tobin's q, acquirer	0.11	-0.02	-0.11	0.40	0.11	0.19	-0.04	-0.04	0.21				
23	tq	Tobin's q, target	0.16	0.10	0.06	-0.03	-0.07	0.02	-0.04	-0.14	0.11	0.08			
24	interq	Interaction, aq x tq, centered	0.21	0.05	0.09	-0.07	-0.08	0.05	-0.09	-0.13	0.11	0.01	0.94		
25	sp6m	Lagged 6-month change in S&P 500 index level	-0.01	0.05	0.15	-0.13	0.10	-0.05	0.06	-0.18	-0.03	-0.09	0.04	0.02	

n=195. Coefficients of .14 and above significant at p<.05.

Table 15B: Pearson Correlations
Dependent Variable: $\Delta POCFROS_{P4}$
Base Model

Mean absolute correlation: 0.157
Maximum absolute correlation: 0.634 (aq, H1intpatns)

			1	2	3	4	5	6	7	8	9	10	11	12
1	$\Delta POCFROS_{P4}$	Portfolio, 4-yr post-acquisition evaluation period												
2	H1apatns	Ratio of patents to net sales ($M), acquirer	0.54											
3	H1tpatns	Ratio of patents to net sales ($M), target	0.09	0.01										
4	H1intpatns	Interaction, H1apatns x H1tpatns, centered	0.63	0.05	-0.21									
5	H1apmans	Ratio of PMAs to net sales ($M), acquirer	0.23	0.47	0.12	-0.23								
6	H1tpmans	Ratio of PMAs to net sales ($M), target	0.06	0.00	0.01	-0.01	0.12							
7	H1intpmans	Interaction, H1apmans x H1tpmans, centered	0.15	0.00	0.01	0.00	0.13	0.50						
8	H1a510kns	Ratio of 510(k)s to net sales ($M), acquirer												
9	H1t510kns	Ratio of 510(k)s to net sales ($M), target												
10	H1int510kns	Interaction, H1a510kns x H1t510kns, centered												
11	H2aperns	Acquirer's production efficiency rating (0-100)	0.19	0.24	0.15	-0.05	0.46	0.12	0.01					
12	H2tperns	Target's production efficiency rating (0-100)	-0.06	-0.03	0.39	-0.12	0.08	0.35	0.12				0.21	
13	H2intperns	Interaction, H2aperns x H2tperns, centered	-0.14	-0.16	0.31	-0.07	-0.02	0.25	0.14				-0.04	0.38
14	H3plms	Whether acquirer and target products overlapped in at least one medical specialty area before the acquisition (1=yes)	-0.04	-0.07	0.07	-0.14	0.05	0.10	0.04				0.18	0.32
15	H4lnscns	ln (combined acquirer + target net sales in $B)	-0.22	-0.38	0.10	-0.08	-0.18	0.03	-0.07				-0.16	0.18
16	H5aexp	Discounted number of prior acquisitions by acquirer, scaled by net sales ($M)	0.37	0.28	0.01	0.48	0.07	-0.05	-0.03				-0.03	-0.11
17	relsize	Ratio of target to acquirer net sales												
18	collar	Presence of a collar provision (1=yes)												
19	cash	Whether cash was a form of payment (1=yes)												
20	hhi	HHI, medical device industry												
21	m1a0	Merger=1; partial acquisition=0	0.14	0.00	0.23	0.03	0.13	0.15	0.10				0.20	0.30
22	aq	Tobin's q, acquirer	0.54	0.28	0.22	0.63	0.09	0.07	-0.02				0.39	0.19
23	tq	Tobin's q, target	-0.02	-0.01	0.19	-0.04	0.06	0.03	-0.03				0.15	0.20
24	interq	Interaction, aq x tq, centered												
25	sp6m	Lagged 6-month change in S&P 500 index level												

n=195. Coefficients of .14 and above significant at p<.05.

Table 15B: Pearson Correlations
Dependent Variable: $\Delta POCFROS_{P4}$
Base Model (continued)

Mean absolute correlation: 0.157
Maximum absolute correlation: 0.634 (aq, H1intpatns)

			13	14	15	16	17	18	19	20	21	22	23	24	25
1	$\Delta POCFROS_{P4}$	Portfolio, 4-yr post-acquisition evaluation period													
2	H1apatns	Ratio of patents to net sales ($M), acquirer													
3	H1tpatns	Ratio of patents to net sales ($M), target													
4	H1intpatns	Interaction, H1apatns x H1tpatns, centered													
5	H1apmans	Ratio of PMAs to net sales ($M), acquirer													
6	H1tpmans	Ratio of PMAs to net sales ($M), target													
7	H1intpmans	Interaction, H1apmans x H1tpmans, centered													
8	H1a510kns	Ratio of 510(k)s to net sales ($M), acquirer													
9	H1t510kns	Ratio of 510(k)s to net sales ($M), target													
10	H1int510kns	Interaction, H1a510kns x H1t510kns, centered													
11	H2aperns	Acquirer's production efficiency rating (0-100)													
12	H2tperns	Target's production efficiency rating (0-100)													
13	H2intperns	Interaction, H2aperns x H2tperns, centered													
14	H3plms	Whether acquirer and target products overlapped in at least one medical specialty area before the acquisition (1=yes)	0.02												
15	H4lnscns	ln (combined acquirer + target net sales in $B)	0.14	0.12											
16	H5aexp	Discounted number of prior acquisitions by acquirer, scaled by net sales ($M)	-0.04	-0.14	-0.37										
17	relsize	Ratio of target to acquirer net sales													
18	collar	Presence of a collar provision (1=yes)													
19	cash	Whether cash was a form of payment (1=yes)													
20	*hhi*	*HHI, medical device industry*													
21	m1a0	Merger=1; partial acquisition=0	0.13	0.04	0.31	-0.12									
22	aq	Tobin's q, acquirer	0.11	-0.02	-0.11	0.40					0.21				
23	tq	Tobin's q, target	0.16	0.10	0.06	-0.03					0.11	0.08			
24	interq	Interaction, aq x tq, centered													
25	sp6m	Lagged 6-month change in S&P 500 index level													

n=195. Coefficients of .14 and above significant at p<.05.

Regression Analyses: Cumulative Abnormal Stock Market Returns

Base Model Diagnostics. The base model for the first dependent variable, cumulative abnormal stock market return for acquirer/target portfolio combinations using the 3-day event window surrounding acquisition announcement, $CAR_{P(-1,1)}$, is presented in Table 16A. The regression technique performed in the base model is robust regression with a correction for non-independent observations (Stata's *robust cluster* command). Before interpreting the base model results, a series of six diagnostic checks was conducted. First, the overall F-statistic of the base model (6.08 with a p-value of .0000) indicates the set of 17 predictor variables, taken as a whole, has significant ability to predict the variation in the dependent variable (that is, the null hypothesis that the predictor variables collectively do not explain a significant amount of the variation in $CAR_{P(-1,1)}$ is rejected) (Kleinbaum, Kupper, and Muller, 1988).

Second, partial F-tests confirm that the seven variables removed from the full model to create the reduced base model do not contribute significantly to predicting $CAR_{P(-1,1)}$ either as a group (the partial F-statistic is 1.05 with a p-value = .400) or individually (all seven individual partial F-values were non-significant).[50]

Third, the F-statistic of the announcement returns base model (6.08) exceeds the

[50] The seven variables removed from the full model to create the base model are (a) acquirer's ratio of 510(k)s to net sales, (b) acquirer/target interaction term for 510(k)s to net sales ratio, (c) acquirer's production efficiency rating, (d) acquirer/target interaction term for production efficiency rating, (e) ratio of target-to-acquirer net sales (relative size), (f) acquirer/target interaction term for Tobin's q, and (g) lagged 6-month change in S&P 500 index level (recent stock market trend). When, for example, the recent stock market trend variable is added back to the base model, the F-statistic decreases to 5.55, R-squared increases slightly to .2881, the partial F-statistic on the added variable is 0.30 (p-value = .582), and the pattern of significant regression coefficients is completely unchanged. Similar results are obtained for adding back the other excluded variables. The 24-variable full model has an F-statistic of 5.28 and a p-value of .0000 (regression output not shown).

critical F-value (1.24 at the customary .80 level) needed to demonstrate sufficient statistical power to detect hypothesized relationships.

Fourth, an additional partial F-test verified that the set of 15 hypothesized independent variables and major control variables in the base model contributes significantly to the prediction of $CAR_{P(-1,1)}$ after accounting (or controlling) for the acquisition propensity measures (the partial F-statistic was 5.82 with a p-value = .0000).

Fifth, mean and maximum variance inflation factor (VIF) values (1.58 and 3.11, respectively) indicate that multicollinearity is not a problem in the base model. "A rule of thumb for evaluating VIFs is to be concerned with any value larger than 10.0" (Kleinbaum, Kupper, and Muller, 1988, p. 210; Greene, 2000). In comparison, the mean and maximum VIF values in the 24-variable full model were 7.31 and 57.81. The R-squared of the base model regression estimation, .2873, shows that 28.7 percent of the variation in $CAR_{P(-1,1)}$ is explained.

Sixth, the reliability of the announcement returns base model was assessed with a split sample procedure whereby (a) the sample of 273 corporate acquisitions was randomly divided into two groups, (b) the regression equation was estimated for Group 1, (c) the estimated regression coefficients from Group 1 were used to predict acquisition-related financial outcomes for Group 2, and (d) the cross-validation correlations were calculated between the predicted and actual Group 2 $CAR_{P(-1,1)}$ values (Kleinbaum, Kupper, and Muller, 1988). A Stata do-file program produced a series of five cross-validation correlation values, which averaged .263 (p-value = .0024), evidencing a statistically significant relationship between predicted and actual returns, and a reliable announcement returns base model.

Table 16: Results of Regression Analyses
Cumulative Abnormal Stock Market Returns

Dependent Variable: $CAR_{P(-1,1)}$

		Model 16A ++ (Base Model) Robust Regression (with non-independence correction)			Model 16B ++ Robust Regression			Model 16C ++ Median Regression		
Indep Variables:		Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
H1	apatns	0.006704	0.007330	0.362	0.006704	0.007260	0.357	-0.002045	0.002218	0.357
H1	tpatns	0.001553	0.000754	0.041 **	0.001553	0.000685	0.024 **	0.000899	0.000395	0.024 **
H1	intpatns	0.005354	0.002835	0.061 *	0.005354	0.002708	0.049 **	0.002047	0.001440	0.156
H1	apmans	0.112259	0.071233	0.117	0.112259	0.071820	0.119	0.106017	0.048366	0.029 **
H1	tpmans	0.009886	0.079855	0.902	0.009886	0.058710	0.866	0.049788	0.037169	0.182
H1	intpmans	3.375508	0.774625	0.000 ***	3.375508	0.779847	0.000 ***	4.082377	0.234232	0.000 ***
H1	t510kns	0.007107	0.003999	0.078 *	0.007107	0.004624	0.126	0.007668	0.002556	0.003 ***
H2	tperns	-0.000127	0.000169	0.456	-0.000127	0.000184	0.493	-0.000166	0.000158	0.294
H3	plms	-0.003276	0.008040	0.684	-0.003276	0.008172	0.689	-0.006425	0.007814	0.412
H4	lnscns	-0.002653	0.001691	0.119	-0.002653	0.001808	0.143	-0.001303	0.001588	0.412
H5	aexp	-0.040107	0.023176	0.086 *	-0.040107	0.018033	0.027 **	-0.019966	0.017332	0.250
Ctl	collar	-0.022589	0.017833	0.207	-0.022589	0.017842	0.207	-0.024374	0.014236	0.088 *
Ctl	cash	0.012517	0.006905	0.072 *	0.012517	0.006606	0.059 *	0.012192	0.006694	0.070 *
Ctl	hhi	-0.361879	0.187717	0.056 *	-0.361879	0.195592	0.065 *	-0.078279	0.197072	0.692
Ctl	m1a0	0.013905	0.008877	0.119	0.013905	0.008380	0.098 *	0.019190	0.007461	0.011 **
Ctl	aq	-0.005084	0.002687	0.061 *	-0.005084	0.002458	0.040 **	-0.002335	0.001694	0.169
Ctl	tq	-0.001548	0.000492	0.002 ***	-0.001548	0.000641	0.016 **	-0.001871	0.000347	0.000 ***
	constant	0.090060	0.041928	0.033 **	0.090060	0.044391	0.044 **	0.040784	0.035533	0.252
	Observations	n =	273		Observations	n =	273	Observations	n =	273
	Overall significance of regression				Overall significance of regression			Overall significance of regression		
		F(17, 143, .05) =	6.08			F(17, 255, .05) =	4.29		F(17, 255, .05) =	52.59
		Prob > F	0.0000 ***			Prob > F	0.0000 ***		Prob > F	0.0000 ***
		R-squared =	0.2873			R-squared =	0.2873		Pseudo R-squared =	0.0899
	Power sufficiency				Power sufficiency			Power sufficiency		
		Fcrit(17, 143, .80) =	1.24 s			Fcrit(17, 255, .80) =	1.20 s		Fcrit(17, 255, .80) =	1.20 s
		Power sufficient at .80 level				Power sufficient at .80 level			Power sufficient at .80 level	

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Table 16: Results of Regression Analyses
Cumulative Abnormal Stock Market Returns
(outlier observations excluded)

Dependent Variable: $CAR_{P(-1,1)}$

		Model 16D ++			Model 16E ++			Model 16F ++		
		Robust Regression (with non-independence correction)			Robust Regression			Median Regression		
Indep Variables:		Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
H1	apatns	0.027019	0.010580	0.012 **	0.027019	0.009688	0.006 ***	0.030733	0.006911	0.000 ***
H1	tpatns	0.006536	0.001917	0.001 ***	0.006536	0.001788	0.000 ***	0.007154	0.001489	0.000 ***
H1	intpatns	0.027207	0.009325	0.004 ***	0.027207	0.008455	0.001 ***	0.032839	0.006192	0.000 ***
H1	apmans	0.105836	0.056560	0.063 *	0.105836	0.057488	0.067 *	0.106870	0.051066	0.037 **
H1	tpmans	-0.003687	0.063436	0.954	-0.003687	0.055950	0.948	0.018993	0.040113	0.636
H1	intpmans	3.460313	0.802367	0.000 ***	3.460313	0.803621	0.000 ***	4.113970	0.248144	0.000 ***
H1	t510kns	-0.001901	0.004754	0.690	-0.001901	0.004683	0.685	-0.004282	0.003520	0.225
H2	tperns	-0.000219	0.000151	0.149	-0.000219	0.000153	0.153	-0.000120	0.000173	0.488
H3	plms	-0.002602	0.007205	0.718	-0.002602	0.007356	0.724	-0.007576	0.008233	0.358
H4	lnscns	-0.001371	0.001617	0.398	-0.001371	0.001694	0.419	-0.000498	0.001704	0.770
H5	aexp	-0.022592	0.010853	0.039 **	-0.022592	0.012201	0.065 *	-0.017715	0.020025	0.377
Ctl	collar	-0.019961	0.014773	0.179	-0.019961	0.016211	0.219	-0.015813	0.015309	0.303
Ctl	cash	0.012878	0.006173	0.039 **	0.012878	0.005956	0.032 **	0.009819	0.007122	0.169
Ctl	hhi	-0.212251	0.174172	0.225	-0.212251	0.180707	0.241	-0.029983	0.207853	0.885
Ctl	m1a0	0.013412	0.007725	0.085 *	0.013412	0.007191	0.063 *	0.020176	0.007953	0.012 **
Ctl	aq	-0.002203	0.001801	0.223	-0.002203	0.001813	0.225	-0.001889	0.001885	0.317
Ctl	tq	-0.000903	0.000489	0.067 *	-0.000903	0.000525	0.086 *	-0.000770	0.000398	0.054 *
	constant	0.044715	0.041154	0.279	0.044715	0.042226	0.291	0.011553	0.038995	0.767
	Observations	n = 269			n = 269			n = 269		
	Overall significance of regression									
		F(17, 141, .05) = 23.23			F(17, 251, .05) = 8.30			F(17, 251, .05) = 70.43		
		Prob > F 0.0000 ***			Prob > F 0.0000 ***			Prob > F 0.0000 ***		
		R-squared = 0.3470			R-squared = 0.3470			Pseudo R-squared = 0.1129		
	Power sufficiency									
		Fcrit(17, 141, .80) = 1.24 s			Fcrit(17, 251, .80) = 1.20 s			Fcrit(17, 251, .80) = 1.20 s		
		Power sufficient at .80 level			Power sufficient at .80 level			Power sufficient at .80 level		

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Table 16: Results of Regression Analyses
Cumulative Abnormal Stock Market Returns
(using R&D data in H1 and H2 measures)

Dependent Variable: $CAR_{P(-1,1)}$

		Model 16G ++	-----Robust Regression-----	(with non-independence correction)			Model 16H ++	-----Robust Regression-----			Model 16I ++	-----Robust Regression-----	(with non-independence correction and outlier observations excluded)		
Indep Variables:		Coef.	Std. Err.	P>|t|		Coef.	Std. Err.	P>|t|		Coef.	Std. Err.	P>|t|	
H1	apatrd	0.000074	0.000021	0.001	***	0.000074	0.000021	0.001	***	0.000080	0.000017	0.000	***
H1	tpatrd	0.000036	0.000788	0.964		0.000036	0.000918	0.969		-0.000174	0.000804	0.829	
H1	apmard	0.002889	0.010626	0.786		0.002889	0.011091	0.795		0.003467	0.009027	0.702	
H1	tpmard	0.018500	0.021547	0.392		0.018500	0.019153	0.335		-0.000225	0.009951	0.982	
H1	t510krd	-0.001619	0.000628	0.011	**	-0.001619	0.000746	0.031	**	-0.001895	0.000666	0.005	***
H2	tperrd	-0.000430	0.000370	0.248		-0.000430	0.000361	0.235		0.000027	0.000240	0.910	
H3	plms	-0.002949	0.011473	0.798		-0.002949	0.011037	0.790		-0.002904	0.007651	0.705	
H4	lnscns	-0.004215	0.002632	0.112		-0.004215	0.002706	0.121		-0.000942	0.001681	0.576	
H5	aexp	-0.007815	0.065926	0.906		-0.007815	0.075683	0.918		-0.030889	0.032552	0.345	
Ctl	collar	-0.025898	0.014799	0.083	*	-0.025898	0.016112	0.109		-0.017795	0.011200	0.115	
Ctl	cash	0.002132	0.008120	0.793		0.002132	0.008535	0.803		0.010837	0.006547	0.101	
Ctl	hhi	-0.173299	0.229884	0.453		-0.173299	0.238354	0.468		-0.174570	0.183834	0.344	
Ctl	m1a0	0.025031	0.012045	0.040	**	0.025031	0.011974	0.038	**	0.014864	0.008607	0.087	*
Ctl	aq	-0.002477	0.002912	0.397		-0.002477	0.002837	0.384		-0.001853	0.002119	0.384	
Ctl	tq	-0.000806	0.000326	0.015	**	-0.000806	0.000368	0.030	**	-0.000506	0.000335	0.133	
	constant	0.133018	0.073254	0.072	*	0.133018	0.073658	0.072	*	0.036164	0.047997	0.453	
		Observations n = 223				Observations n = 223				Observations n = 219			
		Overall significance of regression				Overall significance of regression				Overall significance of regression			
		F(15, 113, .05) = 7.30				F(15, 207, .05) = 6.35				F(15, 111, .05) = 7.72			
		Prob > F 0.0000			***	Prob > F 0.0000			***	Prob > F 0.0000			***
		R-squared = 0.1016				R-squared = 0.1016				R-squared = 0.0881			
		Power sufficiency				Power sufficiency				Power sufficiency			
		Fcrit(15, 113, .80) = 1.35 s				Fcrit(15, 207, .80) = 1.29 s				Fcrit(15, 111, .80) = 1.36 s			
		Power sufficient at .80 level				Power sufficient at .80 level				Power sufficient at .80 level			

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Interpretation of Regression Results: Predictors of Announcement Returns. The announcement returns base model (Table 16A) demonstrates (a) favorable market reaction to acquisitions of target organizations with demonstrated product innovation capability (as indicated by the target's pre-acquisition patent yields), (b) the impact of product innovation capability on stock price revaluations (as measured by the interaction term for PMA approval ratios) is jointly determined through the interplay of acquiring firms and target organizations,[51] and (c) the purchase of distressed targets (expressed as target's Tobin's q) enhances shareowner wealth.

Tables 16B – 16I present alternative model specifications and sensitivity analyses.[52] Overall, the set of nine announcement return regression models that comprise

---

[51] To further assess product innovation capability interaction, quadrant dummy variables were created to indicate corporate combinations of (a) above median acquirers and above median targets, (b) at-or-below median acquirers and above median targets, (c) above median acquirers and at-or-below median targets, or (d) at-or-below median acquirers and at-or-below median targets (the omitted contrast). In a regression model that replaced the centered interaction terms with the quadrant dummy variables for pre-acquisition patent and PMA yields, two quadrants were found to have significantly positive regression coefficients (p-values < .05): (1) combinations of acquiring firms and target organizations that *both have above median PMA yields*, and (2) combinations of above median PMA acquirers and at-or-below median PMA targets. The quadrant dummy variables for patent yields were nonsignificant both as a group and individually. Nevertheless, for both patent and PMA ratios, acquisition of above median targets was invariably associated with a positively signed regression coefficient.

[52] Table 16B is identical to the base model except that the correction for non-independent observations is removed. As a result, the degrees of freedom change from 143 in Table 16A (144 unique acquirers in the study sample minus one) to 255 in Table 16B (273 corporate acquisitions minus 17 predictor variables minus one). The robust regression coefficients are the same in Tables 16A and 16B, but the correction for non-independent observations adjusts the standard errors (and therefore also the t-statistics and p-values). Table 16C repeats the base model using median regression. Next, outlier observations are removed from Tables 16A – 16C to create Tables 16D – 16F. For a sample size of 273, an observation is judged to be an outlier if its studentized deleted residual exceeds 3.793 in absolute value (because pr(|t|>3.793) = .00018315 = .05/273 based on a two-tailed test at the .05 significance level). Studentized deleted residuals detect outlier cases by appraising how each observation *i* deviates from a fitted regression model that excludes

Table 16 point to four findings. First, equity markets value the purchase, via corporate acquisition, of target organizations that have a demonstrated ability to innovate and improve medical products. Announcement returns are positive as well when acquiring firms also possess a track record of product innovation capability. The significant regression coefficients on the interaction terms for PMA and patent ratios demonstrate that the relationship between acquisition-related abnormal announcement returns and *acquirer* product innovation is conditional on the *target* organization's product innovation (and, equivalently, that the relationship between announcement returns and *target* product innovation is conditional on the *acquiring firm's* product innovation). In other words, acquirer and target product innovation capability jointly determine stock price revaluation. These effects are intensified when outlier observations are excluded (Tables 16D – 16F).

Second, shareholder wealth was destroyed following announcement of acquisition targets with high 510(k) clearance counts relative to R&D expenditures (Tables 16G – 16I). For a given R&D expense level, the market reacts unfavorably to target organizations that have abundant numbers of 510(k) approvals for products deemed "substantially equivalent" to an already available "predicate device" (Center for Devices and Radiological Health, 2004). The market devalues corporate acquisitions when the target organization has a track record introducing too many non-innovative, imitative "me-too" products.

---

observation *i* (Kleinbaum, Kupper, and Muller, 1988). Finally, three models are estimated (Tables 16G – 16I) that use research and development expenditures in the denominators of the product innovation capability ratios (H1) and in the production efficiency input vector (H2). The sample size for these models falls because the Compustat data files contain annual R&D information for both the acquiring firm and the target organization in 223 cases.

Third, the market reacted positively to news that financially distressed organizations (as reflected in low Tobin's q values) are to be acquired. The pre-acquisition difficulties experienced by the target organization represent an optimistic turnaround opportunity for the new corporate ownership.

Fourth, stock price increases were also related, albeit more marginally, to (a) acquiring the entire target firm (compared with purchasing only a portion of the target's assets such as a division or product line), (b) use of cash as a method of payment, and (c) not being a high-frequency, serial acquirer.

Assessment of Additional Control Variables. A set of nine regression estimations is performed to check the impact of including additional controls variables in the announcement returns base model. Each of these estimations contains the base model's 17 predictor variables plus one of the following: (a) acquirer's percent of sales in the medical device industry during the last full fiscal year before the acquisition's effective date, (b) a dummy variable indicating the retrieval of at least one news article published prior to the event window that discusses or anticipates acquisition of the target by the acquiring firm, (c) acquirer and target debt service coverage ratio in the year before acquisition, (d) a series of dummy variables indicating calendar year of acquisition announcement (1997 is the omitted contrast), (e) a pair of dichotomous indicators documenting whether an acquisition was announced before or after The Safe Medical Devices Act of 1990 and The FDA Modernization Act of 1997, (f) average total review times (in days) for PMA applications and 510(k) filings during the calendar year before acquisition announcement to control for (dis)incentives associated with periods of

prolonged or more expedient FDA review process durations, (g) a dichotomous indicator of accounting method (pooling of interest or purchase method), (h) a dummy variable that takes on the value of one if the acquisition was listed as "hostile" in the SDC database, and (i) a dummy variable indicating the presence of litigation surrounding the acquisition. In all nine regressions, the added controls did not contribute significantly to the base model. For example, the partial F-statistic and p-value for adding acquirer and target debt service coverage ratios to the base model were 0.28 and .753 (in fact, the p-values associated with the partial F-statistics were greater than .25 in all nine regression estimations and exceeded .50 in six of the 9). Regression results tables for the additional control variable estimations are not reported.[53]

---

[53] A regression estimation containing the base model's 17 predictor variables plus 12 control variables [(a) – (i) as described above with the exception of raw calendar year rather than yearly dummy variables] was also estimated. The set of 12 control variables, as a group, did not contribute significantly to the prediction of announcement returns (partial F-statistic = 0.59, p-value = .8440). None of the 12 control variables had a p-value less than .25, and the fundamental pattern of results and conclusions among the independent variables was unchanged (regression results table not reported).

In addition, the correlation matrix composed of (a) cumulative abnormal stock market return for acquirer/target portfolio combinations using the 3-day event window surrounding acquisition announcement, $CAR_{P(-1,1)}$, (b) the 17 predictor variables from the base model, and (c) the set of 12 control variables (using raw calendar year rather than the series of yearly dummy variables) had a mean absolute correlation coefficient of .103. This average is lower than the .116 mean absolute correlation reported in the base model matrix (Table 14B). The most highly correlated variables were measures of time and market concentration. The largest absolute correlation coefficients in the matrix were between (a) calendar year and whether the acquisition was announced after The Safe Medical Devices Act of 1990, .826; (b) calendar year and HHI, .726; and (c) whether the acquisition was announced after The Safe Medical Devices Act of 1990 and average total review time for 510(k) filings during the calendar year before acquisition announcement, .660. These three were the only (among the 435 matrix elements) with an absolute correlation coefficient of .60 or greater.

Regression Analyses: Change in Pretax Operating Cash Flow Return on Sales

Base Model Diagnostics. The base model for the second dependent variable, market-adjusted change in pretax operating cash flow return on sales for acquirer/target combinations using the 4-year post-acquisition evaluation period, $\Delta POCFROS_{P4}$, is presented in Table 17A. As with the announcement returns base model, robust regression with a correction for non-independent observations is the regression technique performed. The series of six diagnostic checks was repeated for the 195-observation $\Delta POCFROS_{P4}$ base model.

First, the overall F-statistic (11.55 with a p-value of .0000) rejects the null hypothesis that the set of 15 predictor variables, taken as a collective whole, do not explain a significant amount of the variation in cash flow returns.

Second, partial F-tests confirm that the nine variables removed from the full model to create the reduced base model do not contribute significantly to predicting $\Delta POCFROS_{P4}$ either as a group (the partial F-statistic was 1.23 with a p-value = .284) or individually (all nine individual partial F-values were non-significant).[54]

Third, the base model's F-statistic (11.55) exceeds the critical F-value (1.38) needed to demonstrate sufficient statistical power at the .80 level.

---

[54] The nine variables removed from the full model to create the base model are (a) acquirer's ratio of 510(k)s to net sales, (b) target's ratio of 510(k)s to net sales, (c) acquirer/target interaction term for 510(k)s to net sales ratio, (d) ratio of target-to-acquirer net sales (relative size), (e) presence of a collar provision, (f) cash as a method of payment, (g) market concentration (HHI), (h) acquirer/target interaction term for Tobin's q, and (i) lagged 6-month change in S&P 500 index level (recent stock market trend). When, for example, the relative size measure is added back to the base model, the F-statistic decreases to 10.83, R-squared increases slightly to .7866, the partial F-statistic on the added variable is 0.23 (p-value = .636), and the pattern of significant regression coefficients is virtually unchanged (significance level changes on one coefficient only). Similar results are obtained for adding back the other excluded variables. The 24-variable full model has an F-statistic of 9.26 and a p-value of .0000 (regression output not shown).

Fourth, an additional partial F-test verified that the set of 13 hypothesized independent variables and major control variables in the base model contributes significantly to the prediction of $\Delta POCFROS_{P4}$ after controlling for the acquisition propensity measures (the partial F-statistic was 11.34 with a p-value = .0000).

Fifth, mean and maximum variance inflation factor (VIF) values (1.79 and 3.53, respectively) indicate that multicollinearity is not problematic. By comparison, the mean and maximum VIF values in the 24-variable full model were 6.04 and 38.27. The R-squared of the cash flow returns base model, .7863, demonstrates that nearly 79 percent of the variation in $\Delta POCFROS_{P4}$ is explained. The correlation matrix among $\Delta POCFROS_{P4}$ and the 15 predictor variables (Table 15B) has a mean absolute correlation of .157 and a maximum absolute correlation of .634 (between acquirer's Tobin's q and the patent award ratio interaction term).

Sixth, the reliability of the base model was assessed with the split sample procedure described above. The sequence of five cross-validation correlation values averaged .590, corresponding to a highly significant .0000 p-value. As with the announcement returns base model, the cash flow returns base model was deemed reliable for predicting market-adjusted change in pretax operating cash flow return on sales using the set of 15 predictor variables.

Table 17: Results of Regression Analyses
Market-Adjusted Change in Pretax Operating Cash Flow Return on Sales

Dependent Variable: $\Delta POCFROS_{P4}$

		Model 17A ++ (Base Model) Robust Regression (with non-independence correction)			Model 17B ++ Robust Regression			Model 17C ++ Robust Regression (with non-independence correction and outlier observations excluded)		
Indep Variables:		Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
H1	apatns	0.138474	0.054140	0.012 **	0.138474	0.053846	0.011 **	0.177160	0.106986	0.101
H1	tpatns	0.027514	0.006618	0.000 ***	0.027514	0.006537	0.000 ***	0.034135	0.030920	0.272
H1	intpatns	0.092452	0.021211	0.000 ***	0.092452	0.020666	0.000 ***	0.123342	0.120553	0.309
H1	apmans	0.566429	0.520890	0.280	0.566429	0.512213	0.270	0.571865	0.289126	0.051 *
H1	tpmans	0.158273	0.173431	0.364	0.158273	0.142995	0.270	0.114060	0.131756	0.389
H1	intpmans	5.245025	2.055094	0.012 **	5.245025	2.070996	0.012 **	6.204445	1.709496	0.000 ***
H2	aperns	0.001316	0.001757	0.456	0.001316	0.001713	0.443	-0.000545	0.000437	0.215
H2	tperns	-0.001225	0.000551	0.028 **	-0.001225	0.000547	0.026 **	-0.000876	0.000387	0.026 **
H2	intperns	-0.000045	0.000026	0.088 *	-0.000045	0.000028	0.107	-0.000049	0.000020	0.014 **
H3	plms	0.066389	0.032446	0.043 **	0.066389	0.032883	0.045 **	0.044308	0.017879	0.015 **
H4	lnscns	-0.002900	0.004978	0.561	-0.002900	0.004757	0.543	0.002865	0.003222	0.376
H5	aexp	-0.165449	0.151032	0.276	-0.165449	0.108975	0.131	-0.071976	0.051743	0.167
Ctl	m1a0	0.042726	0.035720	0.235	0.042726	0.035210	0.227	0.004531	0.011862	0.703
Ctl	aq	-0.025509	0.023410	0.279	-0.025509	0.023090	0.271	0.001426	0.005298	0.788
Ctl	tq	-0.002122	0.000882	0.018 **	-0.002122	0.000903	0.020 **	-0.002067	0.002242	0.359
	constant	0.029529	0.084004	0.726	0.029529	0.077835	0.705	-0.070021	0.072584	0.337
		Observations n = 195			Observations n = 195			Observations n = 192		
		Overall significance of regression			Overall significance of regression			Overall significance of regression		
		F(15, 98, .05) = 11.55			F(15, 179, .05) = 11.36			F(15, 95, .05) = 3.84		
		Prob > F 0.0000 ***			Prob > F 0.0000 ***			Prob > F 0.0000 ***		
		R-squared = 0.7863			R-squared = 0.7863			R-squared = 0.6238		
		Power sufficiency			Power sufficiency			Power sufficiency		
		Fcrit(15, 98, .80) = 1.38 s			Fcrit(15, 179, .80) = 1.30 s			Fcrit(15, 95, .80) = 1.39 s		
		Power sufficient at .80 level			Power sufficient at .80 level			Power sufficient at .80 level		

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Table 17: Results of Regression Analyses
Market-Adjusted Change in Pretax Operating Cash Flow Return on Sales
(using R&D data in H1 and H2 measures)

Dependent Variable: $\Delta POCFROS_{P4}$

		Model 17D			Model 17E ++			Model 17F ++		
		Robust Regression (with non-independence correction)			Median Regression			Median Regression (outlier observations excluded)		
Indep Variables:		Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
H1	apatrd	0.000023	0.000169	0.892	0.000114	0.000030	0.000 ***	0.000114	0.000022	0.000 ***
H1	tpatrd	-0.000761	0.003328	0.820	-0.000738	0.001257	0.558	-0.001040	0.000962	0.281
H1	apmard	-0.021362	0.029428	0.470	0.003319	0.008339	0.691	0.003592	0.006327	0.571
H1	tpmard	0.091474	0.042542	0.035 **	0.036491	0.014806	0.015 **	0.039382	0.010921	0.000 ***
H1	intpmard	-0.060324	0.029659	0.045 **	-0.029324	0.011423	0.011 **	-0.031941	0.008427	0.000 ***
H1	t510krd	-0.006812	0.006684	0.311	0.000461	0.001660	0.782	0.000406	0.001299	0.755
H2	aperrd	-0.001816	0.002116	0.394	-0.000034	0.000385	0.930	-0.000027	0.000288	0.927
H2	tperrd	-0.006317	0.003707	0.092 *	-0.000602	0.000307	0.052 *	-0.000527	0.000233	0.025 **
H2	intperrd	0.000295	0.000162	0.073 *	-0.000014	0.000019	0.442	-0.000016	0.000014	0.248
H3	plms	0.106476	0.055919	0.061 *	0.033221	0.013021	0.012 **	0.032711	0.010009	0.001 ***
H4	lnscns	-0.028184	0.017956	0.121	0.000187	0.002036	0.927	0.000238	0.001579	0.881
H5	aexp	-0.288114	0.229782	0.214	0.049539	0.048942	0.313	0.048567	0.037225	0.194
Ctl	m1a0	0.123666	0.075212	0.104	0.000307	0.010146	0.976	0.000809	0.007779	0.917
Ctl	aq	-0.005552	0.009949	0.578	-0.002340	0.002197	0.289	-0.002456	0.001684	0.147
Ctl	tq	-0.001930	0.001360	0.160	-0.000100	0.000218	0.645	-0.000067	0.000168	0.691
	constant	1.042524	0.503822	0.042 **	0.030504	0.046601	0.514	0.025081	0.036328	0.491
	Observations	n =	163		n =	163		n =	162	
	Overall significance of regression									
		F(15, 78, .05) =	1.49		F(15, 147, .05) =	3.91		F(15, 146, .05) =	6.69	
		Prob > F	0.1295 ns		Prob > F	0.0000 ***		Prob > F	0.0000 ***	
		R-squared =	0.2769		Pseudo R-squared =	0.0535		Pseudo R-squared =	0.0696	
	Power sufficiency									
		Fcrit(15, 78, .80) =	1.42 s		Fcrit(15, 147, .80) =	1.31 s		Fcrit(15, 146, .80) =	1.31 s	
		Power sufficient at .80 level			Power sufficient at .80 level			Power sufficient at .80 level		

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Interpretation of Regression Results: Predictors of Cash Flow Returns. Four results in the cash flow returns base model (Table 17A) parallel the announcement returns findings. First, acquisition of target organizations with demonstrated product innovation capability (as indicated by the target's pre-acquisition patent yields) is positively associated with higher 4-year market-adjusted changes in pretax operating cash flow return on sales. Second, cash flow returns are positive for acquiring firms that also possess a track record of product innovation capability. Third, the impact of product innovation capability on cash flow returns (as measured by the interaction terms for patent award and PMA approval ratios) is jointly determined through acquirer/target reciprocity.[55] Fourth, the purchase of distressed targets (gauged by target's Tobin's q and production efficiency rating) is related to gains in cash flow return. In addition, unlike short-run stock price revaluations, positive changes in longer-term cash flow performance were associated with using corporate acquisitions to build product lines along medical specialties.

Five alternative model specifications and sensitivity analyses (Tables 17B –

[55] To further assess the product innovation capability and production efficiency interaction terms, quadrant dummy variables were created to indicate corporate combinations of (a) above median acquirers and above median targets, (b) at-or-below median acquirers and above median targets, (c) above median acquirers and at-or-below median targets, or (d) at-or-below median acquirers and at-or-below median targets (the omitted contrast). A regression model that replaced the centered interaction terms with the quadrant dummy variables for pre-acquisition patent yields, PMA yields, and production efficiency rating produced three notable results. First, for both patent and PMA ratios, regression coefficients were positive (although nonsignificant) for the quadrant dummy variables representing combinations of acquiring firms and target organizations that both have above median product innovation capability. Second, the only statistically significant (p-value < .05) quadrant was acquisition of at-or-below median patent yield targets by above median patient yield acquirers (this quadrant had a negatively signed regression coefficient). Third, the quadrant representing combinations of efficiently-producing acquirers and inefficiently-producing targets had a positive (but nonsignificant) regression coefficient.

17F)[56] reveal two additional insights. First, the linkage between building product lines within major clinical specialty areas and improved cash flow performance is robust to several different estimation approaches (e.g., with and without the correction for non-independent observation, with and without outlier observations, robust and median regression, and use of R&D expenditures in the denominators of the product innovation capability ratios and the production efficiency input vector). Second, acquirers achieved positive 4-year cash flow returns by purchasing target organizations with high PMA approval counts relative to R&D expenditures. This result further evidences improved profitability and financial performance, on average, following innovation acquisition.

Assessment of Additional Control Variables. As was done with the announcement returns base model, nine regression estimations are conducted to assess the impact of including additional controls variables in the cash flow returns base model. Each of these estimations contains the base model's 15 predictor variables plus one of the following: (a) acquirer's percent of sales in the medical device industry during the last full fiscal year before the acquisition's effective date, (b) a dummy variable indicating the retrieval of at least one news article published before the event window that discusses or anticipates acquisition of the target by the acquiring firm, (c) acquirer and target debt service coverage ratio in the year before acquisition, (d) a series of dummy variables

[56] Table 17B is identical to the base model except that the correction for non-independent observations is removed. The results (that is, pattern of significant regression coefficients between Table 17A and B) is unchanged by this variation in estimation procedure. Table 17C repeats the base model estimation without outlier observations (here, three cases with deleted residual values greater than 3.724 in absolute value are excluded). Finally, three models are estimated that use R&D expenditures in the denominators of the product innovation capability ratios (H1) and in the production efficiency input vector (H2).

indicating calendar year of acquisition announcement (1997 is the omitted contrast), (e) a pair of dichotomous indicators documenting whether the acquisition was announced before or after The Safe Medical Devices Act of 1990 and The FDA Modernization Act of 1997, (f) average total review times (in days) for PMA applications and 510(k) filings during the calendar year before acquisition announcement, (g) a dichotomous indicator of accounting method (pooling of interest or purchase method), (h) a dummy variable taking on the value of one if the acquisition was "hostile," and (i) a dummy variable indicating the presence of litigation surrounding the acquisition. In eight of the nine regressions, the added controls did not contribute significantly to explaining cash flow returns. The sole significant added control variable, presence of litigation, had an unfavorable impact on market-adjusted change in pretax operating cash flow return on sales (p-value = .034). The regression estimation with litigation produced an identical pattern of significant regression coefficients among the original 15 base model predictor variables. The overall F-statistic was smaller compared with the base model in all nine regressions, and the regression results tables for the additional control variable estimations are not shown.[57]

[57] A regression estimation containing the base model's 15 predictor variables plus 12 control variables [(a) – (i) as described above with the exception of raw calendar year rather than yearly dummy variables] was also estimated. The set of 12 control variables, as a group, did not contribute significantly to the prediction of cash flow returns (partial F-statistic = 1.37, p-value = .1929) (regression results table not reported).

Are Acquirer and Target Measures Merely Reflecting the Same Underlying Construct?

Table 18 reports results of regression analyses that consolidate product innovation capability, production efficiency, acquisition experience, and Tobin's q measures into acquirer and target "asset quality" indicators in order to check whether these predictor variables are largely just manifestations of the same underlying construct. The scale reliability coefficient (Cronbach's alpha) for acquiring firms (using a six-item scale containing patent award ratio, PMA approval ratio, 510(k) clearance ratio, production efficiency rating, acquisition experience, and Tobin's q) was .616.[58] The mean absolute correlation among these six variables is .22 (n = 273). In like manner, the scale reliability coefficient for target firms (based on a five-item scale containing patent award ratio, PMA approval ratio, 510(k) clearance ratio, production efficiency rating, and Tobin's q) was .563 (and the mean absolute correlation among these five variables is .21, n = 273). Reliability coefficients below .70 (Nunnally, 1978; MacKenzie, Podsakoff, and Ahearne, 1998; Blau, 1999; Ailawadi, Neslin, and Gedenk, 2001) signal a lack of internal consistency, the existence of more than one underlying dimension, and the loss of information if the acquirer and target measures were replaced with a single, combinative measure.

Next, the acquirer and target asset quality scales (with a multiplicative interaction term) were entered into regression models to ascertain their predictive ability. When cumulative abnormal stock market return for acquirer/target portfolio combinations using the 3-day event window surrounding acquisition announcement, $CAR_{P(-1,1)}$, is the

[58] Reliability coefficients were higher using standardized items compared with unstandardized items, so standardized items are reported and entered into the regression estimations. Excluding 510(k) clearance ratios from the scales did not materially change the reliability coefficients or conclusions.

dependent variable (Table 18A), regression coefficients on all three asset quality scale variables (main effects for acquirer and target asset quality plus the interaction term) are non-significant. When the dependent variable is market-adjusted change in pretax operating cash flow return on sales for acquirer/target combinations using the 4-year post-acquisition evaluation period, $\Delta POCFROS_{P4}$ (Table 18B), the overall regression is non-significant (the F-statistic is 1.50 with a p-value of .143). This analysis demonstrates that the acquirer and target measures contribute unique information to the study.

Table 18: Results of Regression Analyses That Combine Measures of Product Innovation Capability, Production Efficiency, Acquisition Experience, and Tobin's q into a Single "Asset Quality" Indicator for Acquiring Firms and Target Organizations

		Model 18A ++ Robust Regression (with non-independence correction) Dependent Variable: $CAR_{P(-1,1)}$				Model 18B Robust Regression (with non-independence correction) Dependent Variable: $\Delta POCFROS_{P4}$			
Indep Variables:		Coef.	Std. Err.	P>|t|		Coef.	Std. Err.	P>|t|	
ASQ	acqaqual	0.002055	0.009057	0.821		0.319476	0.140078	0.025	**
ASQ	tgtaqual	0.002077	0.010789	0.848		-0.089761	0.063836	0.163	
ASQ	interaqual	0.036056	0.030660	0.242		0.254516	0.235375	0.282	
H3	plms	-0.004850	0.008952	0.589		0.001976	0.055664	0.972	
H4	lnscns	-0.004604	0.001963	0.020	**	0.010358	0.014650	0.481	
Ctl	relsize	-0.004556	0.008134	0.576		0.030223	0.026687	0.260	
Ctl	collar	-0.039579	0.017864	0.028	**	-0.213074	0.080115	0.009	***
Ctl	cash	0.009879	0.007792	0.207		-0.058682	0.035865	0.105	
Ctl	hhi	-0.258333	0.209302	0.219		1.290961	1.909938	0.501	
Ctl	m1a0	0.023394	0.009104	0.011	**	0.103239	0.057381	0.075	*
Ctl	sp6m	-0.018801	0.040175	0.641		-0.351839	0.221981	0.116	
	constant	0.111009	0.045925	0.017	**	-0.244673	0.412498	0.554	
Observations	n =	273				195			
Overall significance of regression									
	F(11, 143, .05) =	2.06				F(11, 98, .05) =	1.50		
	Prob > F	0.0268	**			Prob > F	0.1428	ns	
	R-squared =	0.0930				R-squared =	0.3819		
Power sufficiency									
	Fcrit(11, 143, .80) =	1.60	s			Fcrit(11, 98, .80) =	1.64	ns	
	Power sufficient at .80 level					Power not sufficient at .80 level			

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Subsample Regression Analyses

Smaller and Larger Corporate Combinations. In Tables 19 and 20, the study sample is divided into 136 smaller and 137 larger corporate unions based on combinative scale (defined as the sum of acquirer and target net sales in the year before acquisition announcement, adjusted using the medical care commodities CPI). The dollar value of combinative scale that splits the sample is $180 million. $CAR_{P(-1,1)}$, cumulative abnormal stock market return for acquirer/target portfolio combinations using the 3-day event window surrounding acquisition announcement, is the dependent variable in the regression analyses presented in Table 19.[59] $\Delta POCFROS_{P4}$, market-adjusted change in pretax operating cash flow return on sales for acquirer/target combinations using the 4-year post-acquisition evaluation period, is the dependent variable in Table 20.[60]

Tables 19 and 20 exhibit six findings. First, among smaller corporate combinations, consistent with results reported so far, favorable acquisition-related financial outcomes are related to (a) acquiring target organizations with a recent history

[59] Table 19A and 19B show the results of robust regression analysis with and without the correction for non-independent observations for the subsample of smaller corporate combinations. The results for these two estimation procedures are overwhelmingly similar (the significance levels are identical for all variables except one whose p-value changes from .106 in Table 19A to .069 in Table 19B. The mean absolute correlation among the predictor variables in Tables 19A and 19B is .116, and the mean and maximum variance inflation factor (VIF) values are 2.20 and 5.31 (indicating that multicollinearity is not a serious problem in these models). Table 19C presents robust regression for the larger subsample with the correction for non-independent observations. Tables 19D – 19F repeat Tables 19A – 19C using research and development expenditures in the denominators of the product innovation capability ratios (H1) and in the production efficiency input vector (H2).

[60] All the estimation models in Table 20 use robust regression with the correction for non-independent observations. Tables 20A and 20B show results with and without outlier observations for the subsample of smaller corporate combinations. Table 20C repeats Table 20A for the larger subsample. Tables 20D – 20F re-run Tables 20A – 20C using research and development expenditures in the denominators of the product innovation capability ratios (H1) and in the production efficiency input vector (H2).

Table 19: Subsample Regression Analyses
By Post-Acquisition Scale

Dependent Variable: $CAR_{P(-1,1)}$

		Model 19A ++ Smaller Post-Acquisition Scale |---Robust Regression---| (with non-independence correction)			Model 19B ++ Smaller Post-Acquisition Scale |---Robust Regression---|			Model 19C ++ Larger Post-Acquisition Scale |---Robust Regression---| (with non-independence correction)		
Indep Variables:		Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|		Coef.	Std. Err.	P>|t|	
H1	apatns	0.012809	0.008999	0.158	0.012809	0.008971	0.156		0.057628	0.068396	0.403	
H1	tpatns	0.002696	0.000765	0.001	0.002696	0.000756	0.001	***	0.011677	0.007145	0.108	
H1	intpatns	0.008501	0.003307	0.012	0.008501	0.003287	0.011	**	0.044733	0.027526	0.110	
H1	apmans	0.059597	0.089152	0.505	0.059597	0.088878	0.504		0.256088	0.204003	0.215	
H1	tpmans	0.552436	0.244705	0.026	0.552436	0.245960	0.027	**	-0.044722	0.037447	0.237	
H1	intpmans	2.223167	1.038020	0.035	2.223167	1.046132	0.036	**	-0.932013	0.564389	0.104	
H1	t510kns	0.013742	0.002320	0.000	0.013742	0.002472	0.000	***	-0.005596	0.003174	0.083	*
H2	tperns	-0.000797	0.000320	0.014	-0.000797	0.000315	0.013	**	0.000078	0.000224	0.727	
H3	plms	-0.008031	0.010579	0.450	-0.008031	0.010753	0.457		-0.000229	0.011606	0.984	
H4	lnscns	-0.000574	0.006545	0.930	-0.000574	0.006578	0.931		-0.003065	0.004249	0.474	
H5	aexp	-0.036644	0.022416	0.105	-0.036644	0.019975	0.069	*	0.068985	0.124508	0.582	
Ctl	collar	0.033153	0.035721	0.356	0.033153	0.035652	0.354		-0.026143	0.019269	0.180	
Ctl	cash	0.003300	0.010604	0.756	0.003300	0.010303	0.749		0.017085	0.010501	0.109	
Ctl	hhi	-0.347414	0.279868	0.217	-0.347414	0.284349	0.224		-0.231287	0.285407	0.421	
Ctl	m1a0	-0.004104	0.016431	0.803	-0.004104	0.016644	0.806		0.013216	0.010281	0.204	
Ctl	aq	-0.010243	0.003447	0.004	-0.010243	0.003445	0.004	***	-0.002823	0.004000	0.483	
Ctl	tq	0.002751	0.004303	0.524	0.002751	0.004153	0.509		-0.001080	0.000666	0.111	
	constant	0.077903	0.122230	0.525	0.077903	0.123181	0.528		0.063711	0.102713	0.538	
	Observations	n =	136		Observations	n =	136		Observations	n =	137	
	Overall significance of regression				Overall significance of regression				Overall significance of regression			
	F(17, 99, .05) =		796.02		F(17, 118, .05) =		812.66		F(17, 55, .05) =		10.59	
	Prob > F		0.0000	***	Prob > F		0.0000	***	Prob > F		0.0000	***
	R-squared =		0.4852		R-squared =		0.4852		R-squared =		0.1858	
	Power sufficiency				Power sufficiency				Power sufficiency			
	Fcrit(17, 99, .80) =		1.30	s	Fcrit(17, 118, .80) =		1.26	s	Fcrit(17, 55, .80) =		1.44	s
	Power sufficient at .80 level				Power sufficient at .80 level				Power sufficient at .80 level			

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Table 19: Subsample Regression Analyses
By Post-Acquisition Scale
(using R&D data in H1 and H2 measures)

Dependent Variable: $CAR_{P(-1,1)}$

		Model 19D ++ Smaller Post-Acquisition Scale	-----Robust Regression-----	(with non-independence correction)			Model 19E ++ Smaller Post-Acquisition Scale	-----Robust Regression-----			Model 19F ++ Larger Post-Acquisition Scale	-----Robust Regression-----	(with non-independence correction)		
Indep Variables:		Coef.	Std. Err.	P>|t|		Coef.	Std. Err.	P>|t|		Coef.	Std. Err.	P>|t|	
H1	apatrd	0.000118	0.000043	0.008	***	0.000118	0.000052	0.025	**	-0.000053	0.003179	0.987	
H1	tpatrd	0.000050	0.001427	0.972		0.000050	0.001896	0.979		0.001447	0.001074	0.185	
H1	apmard	-0.029064	0.019982	0.150		-0.029064	0.019969	0.149		-0.007873	0.009889	0.430	
H1	tpmard	0.115481	0.062433	0.068	*	0.115481	0.063984	0.075	*	0.001324	0.011792	0.911	
H1	intpmard	0.352228	0.170861	0.043	**	0.352228	0.174142	0.046	**	-0.010321	0.007481	0.174	
H1	t510krd	-0.000407	0.000500	0.419		-0.000407	0.000723	0.575		-0.005820	0.001805	0.002	***
H2	aperrd	-0.000511	0.000637	0.425		-0.000511	0.000754	0.500		0.001369	0.000543	0.015	**
H2	tperrd	-0.000849	0.000721	0.243		-0.000849	0.000714	0.238		-0.000104	0.000289	0.721	
H3	plms	-0.004962	0.020196	0.807		-0.004962	0.018604	0.790		-0.002194	0.012407	0.860	
H4	lnscns	-0.008549	0.008965	0.343		-0.008549	0.009030	0.347		-0.013466	0.002467	0.000	***
H5	aexp	-0.001730	0.081713	0.983		-0.001730	0.087219	0.984		-1.706217	1.036668	0.106	
Ctl	collar	-0.046038	0.032921	0.166		-0.046038	0.039390	0.246		-0.019559	0.015999	0.228	
Ctl	cash	-0.013289	0.013753	0.337		-0.013289	0.013934	0.343		0.018438	0.008646	0.038	**
Ctl	hhi	-0.167472	0.368424	0.651		-0.167472	0.397550	0.675		-0.388270	0.325631	0.239	
Ctl	m1a0	0.022136	0.021058	0.297		0.022136	0.022114	0.320		0.023978	0.009063	0.011	**
Ctl	aq	-0.005387	0.003055	0.082	*	-0.005387	0.004202	0.204		-0.005095	0.003913	0.199	
Ctl	tq	-0.002739	0.004496	0.544		-0.002739	0.004542	0.548		-0.000607	0.000244	0.017	**
	constant	0.275781	0.173375	0.116		0.275781	0.174182	0.117		0.237278	0.072784	0.002	***
	Observations	n =	99			Observations	n =	99		Observations	n =	124	
	Overall significance of regression					Overall significance of regression				Overall significance of regression			
	F(17, 73, .05) =		5.99			F(17, 81, .05) =		2.24		F(17, 47, .05) =		9.89	
	Prob > F		0.0000	***		Prob > F		0.0084	***	Prob > F		0.0000	***
	R-squared =		0.2688			R-squared =		0.2688		R-squared =		0.2917	
	Power sufficiency					Power sufficiency				Power sufficiency			
	Fcrit(17, 73, .80) =		1.35	s		Fcrit(17, 81, .80) =		1.34	s	Fcrit(17, 47, .80) =		1.49	s
	Power sufficient at .80 level					Power sufficient at .80 level				Power sufficient at .80 level			

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Table 20: Subsample Regression Analyses
By Post-Acquisition Scale

Dependent Variable: $\Delta POCFROS_{P4}$

		Model 20A ++ Smaller Post-Acquisition Scale |---Robust Regression---| (with non-independence correction)			Model 20B ++ Smaller Post-Acquisition Scale |---Robust Regression---| (with non-independence correction and outlier observations excluded)			Model 20C ++ Larger Post-Acquisition Scale |---Robust Regression---| (with non-independence correction)		
Indep Variables:		Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
H1	apatns	0.087583	0.045050	0.056 *	0.410708	0.188986	0.034 **	0.002748	0.085256	0.974
H1	tpatns	0.370370	0.258586	0.157	0.103312	0.063033	0.106	-0.011545	0.018395	0.534
H1	intpatns	0.044091	0.034131	0.201	0.367647	0.194018	0.063 *	-0.052875	0.072197	0.468
H1	apmans	0.495976	0.510322	0.335	0.715748	0.345490	0.043 **	0.220365	0.238443	0.361
H1	tpmans	1.298877	0.746340	0.087 *	1.350364	0.446245	0.004 ***	-0.020542	0.021219	0.339
H1	intpmans	1.432910	3.340581	0.669	1.571435	2.490328	0.530	0.705758	1.024438	0.495
H2	aperns	0.001308	0.002219	0.558	-0.001218	0.000783	0.125	-0.000188	0.000436	0.668
H2	tperns	-0.002834	0.001771	0.114	-0.002099	0.001090	0.059 *	-0.000293	0.000167	0.087 *
H2	intperns	-0.000081	0.000069	0.243	-0.000097	0.000047	0.045 **	-0.000003	0.000009	0.716
H3	plms	0.113014	0.060697	0.067 *	0.058919	0.034655	0.094 *	0.021686	0.008227	0.012 **
H4	lnscns	0.002858	0.017664	0.872	0.010646	0.010141	0.298	0.014225	0.004122	0.001 ***
H5	aexp	-0.115312	0.123055	0.352	-0.056552	0.043854	0.202	0.257879	0.318499	0.423
Ctl	m1a0	0.069862	0.062785	0.270	0.016455	0.028152	0.561	-0.010662	0.008004	0.190
Ctl	aq	-0.034262	0.032091	0.290	0.002222	0.008755	0.800	-0.000854	0.002208	0.701
Ctl	tq	-0.016285	0.017652	0.360	0.003659	0.009694	0.707	0.000916	0.001364	0.506
	constant	-0.052420	0.319015	0.870	-0.240120	0.183956	0.197	-0.277470	0.092525	0.005 ***
	Observations	n =	89		Observations	n =	86	Observations	n =	106
	Overall significance of regression				Overall significance of regression			Overall significance of regression		
		F(15, 64, .05) =	612.62			F(15, 61, .05) =	586.81		F(15, 40, .05) =	34.79
		Prob > F	0.0000 ***			Prob > F	0.0000 ***		Prob > F	0.0000 ***
		R-squared =	0.8268			R-squared =	0.7594		R-squared =	0.3590
	Power sufficiency				Power sufficiency			Power sufficiency		
		Fcrit(15, 64, .80) =	1.46 s			Fcrit(15, 61, .80) =	1.48 s		Fcrit(15, 40, .80) =	1.62 s
		Power sufficient at .80 level				Power sufficient at .80 level			Power sufficient at .80 level	

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Table 20: Subsample Regression Analyses
By Post-Acquisition Scale
(using R&D data in H1 and H2 measures)

Dependent Variable: $\Delta POCFROS_{P4}$

		Model 20D ++ Smaller Post-Acquisition Scale |--Robust Regression--| (with non-independence correction)			Model 20E Smaller Post-Acquisition Scale |--Robust Regression--| (with non-independence correction and outlier observations excluded)			Model 20F ++ Larger Post-Acquisition Scale |--Robust Regression--| (with non-independence correction)		
Indep Variables:		Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
H1	apatrd	-0.000078	0.000268	0.772	0.000185	0.000119	0.125	0.001329	0.003551	0.710
H1	tpatrd	0.004585	0.006961	0.513	-0.000145	0.003826	0.970	0.000236	0.001128	0.836
H1	apmard	-0.079383	0.057273	0.172	-0.023760	0.024223	0.332	-0.002801	0.011944	0.816
H1	tpmard	0.117130	0.129033	0.369	0.123361	0.133422	0.360	-0.009982	0.007526	0.193
H1	intpmard	0.554802	0.439638	0.213	0.176795	0.296551	0.554	0.012134	0.006646	0.076 *
H1	t510krd	-0.019076	0.012324	0.129	-0.008298	0.007488	0.274	0.000386	0.001390	0.783
H2	aperrd	0.000650	0.003564	0.856	-0.002879	0.001897	0.136	0.000844	0.000550	0.134
H2	tperrd	-0.018320	0.008091	0.028 **	-0.008783	0.002791	0.003 ***	-0.000172	0.000234	0.465
H2	intperrd	0.000509	0.000220	0.025 **	0.000304	0.000157	0.058 *	-0.000082	0.000022	0.001 ***
H3	plms	0.351083	0.141840	0.017 **	0.204898	0.071088	0.006 ***	0.023749	0.011469	0.046 **
H4	lnscns	-0.062242	0.048786	0.208	-0.016441	0.019708	0.409	0.007254	0.003482	0.044 **
H5	aexp	0.166289	0.265298	0.534	0.063749	0.176314	0.719	0.218082	0.390490	0.580
Ctl	m1a0	0.345167	0.144603	0.021 **	0.196372	0.091830	0.038 **	-0.011710	0.007603	0.132
Ctl	aq	0.010574	0.012214	0.391	0.017293	0.011966	0.155	-0.001437	0.001503	0.345
Ctl	tq	-0.006996	0.028444	0.807	-0.006747	0.014341	0.640	-0.000245	0.000135	0.077 *
	constant	1.926555	1.005518	0.062 *	0.876440	0.400808	0.034 **	-0.199579	0.075791	0.012 **
		Observations n = 64			Observations n = 63			Observations n = 99		
		Overall significance of regression			Overall significance of regression			Overall significance of regression		
		F(15, 46, .05) = 2.79			F(15, 45, .05) = 1.76			F(15, 36, .05) = 21.30		
		Prob > F 0.0039 ***			Prob > F 0.0736 *			Prob > F 0.0000 ***		
		R-squared = 0.6166			R-squared = 0.6224			R-squared = 0.3340		
		Power sufficiency			Power sufficiency			Power sufficiency		
		Fcrit(15, 46, .80) = 1.58 s			Fcrit(15, 45, .80) = 1.59 s			Fcrit(15, 36, .80) = 1.68 s		
		Power sufficient at .80 level			Power sufficient at .80 level			Power sufficient at .80 level		

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

of innovating and improving medical devices (as indicated by the target's pre-acquisition patent yields and PMA approval ratios), (b) the product innovation capability of the buying firm, and (c) the reciprocal influence of innovation ability among acquirer/target pairs. For corporate transactions with greater resultant scale, any single acquisition is likely to have relatively less overall financial impact on the larger post-acquisition entity. Indeed, the impact of acquisition-related product innovation capability on post-deal financial outcomes is somewhat diluted but still nearly significant (e.g., in Table 19C, the two-tailed p-values for target's patent yield and the patent interaction variable are .108 and .110, respectively).

Second, shareholder wealth diminution followed acquisition announcements of target organizations with high 510(k) clearance counts (imitative, substantially equivalent products) relative to R&D expenditures when the deal resulted in larger corporate combinations (Table 19F). In other words, the stock market devalues share prices when non-innovative, mimetic products are coupled with large-scale organizational size. Conversely, the market responded favorably to smaller corporate pairings when targets had high ratios of 510(k)s to net sales, thereby expanding the acquirer's product offerings, building scale, and achieving revenue growth (Tables 19A and 19B).

Third, the empirical evidence in Tables 19 and 20 indicates that the purchase of financially distressed and inefficient targets (as reflected in low Tobin's q values and low production efficiency ratings) increases announcement returns and cash flow returns for both smaller and larger corporate combinations.

Fourth, the positive relationship between using corporate acquisitions to build product lines along medical specialties and longer-term cash flow performance was

observed in both smaller and larger corporate unions.

Fifth, the results reveal a contradictory finding in the subsample of larger acquisitions (Tables 19F, 20C, 20F): the largest corporate combinations in the subsample were associated negative announcement returns but positive cash flow returns. In these models, the market reacted unfavorably to the largest of the large acquisitions, but in the end, these corporate unions achieved positive cash flow returns. Additional research is needed to better understand the conditions under which the largest scale acquisitions facilitated or impeded longer-term cash flow performance.

Sixth, the evidence relating acquisition-related financial outcomes with (a) acquiring the entire target firm (compared with purchasing only a portion of the target's assets such as a division or product line), (b) acquirer's production efficiency in large corporate combinations, and (c) acquisitions as a response to the acquiring firm's financial distress was less consistent (but still noteworthy).

Limiting the Analysis to Each Acquirer's Largest Acquisition Only. Tables 21 and 22 restrict the study sample to each acquirer's largest acquisition only and compare these results with the announcement returns base model (Table 16A) and cash flow returns base model (Table 17A).[61] The results impart five insights. First, the relationship between (a) buying distressed target organizations (low Tobin's q values and production efficiency ratings) and (b) acquisition-related financial outcomes becomes non-significant. Therefore, repeat acquirers are responsible for purchasing distressed target

[61] Tables 21A and 22A present results of robust regression (the correction for non-independent observations is no longer needed because each acquirer appears only once in the study sample). Table 22B is a reduced version of Table 22A.

organizations (to the benefit of shareowners and longer-term cash flow improvement). Second, the statistical link between (a) building product lines along medical specialties via corporate acquisitions and (b) positive cash flow returns similarly becomes non-significant when the regression model is restricted to each acquirer's largest acquisition only. It follows, then, that product lines within major clinical specialty areas are built from two or more corporate acquisitions. Third, the regression coefficients on acquirer's acquisition experience are negative and marginally significant (p-values are .109, .053, and .058 in Tables 21A, 22A, and 22B). Although repeat acquirers gainfully purchased distressed target organizations and built product lines along medical specialties, being a highly acquisitive firm is a tradeoff that works to hinder financial outcomes. Fourth, the market favorably revalued stock prices following announcements of acquisitions that use cash as a method of payment. However, after a four-year post-acquisition evaluation period, this effect is no longer significant. Fifth, the findings affirm the consistent result that acquisition financial outcomes are positively related to (a) acquisition of target organizations with a recent history of innovating and improving medical devices, (b) the product innovation capability of the buying firm, and (c) the interaction of acquirer/target product innovation qualities.

Table 21: Subsample Regression Analyses
Include Each Acquirer's Largest Acquisition Only

Dependent Variable: $CAR_{P(-1,1)}$

		Model 16A ++ (Base Model)	-----Robust Regression-----	(with non-independence correction)			Model 21A ++ (Largest Acquisition Only)	-----Robust Regression-----			
Indep Variables:		Coef.	Std. Err.	P>|t|		Coef.	Std. Err.	P>|t|	
H1	apatns	0.006704	0.007330	0.362		0.011100	0.009577	0.249	
H1	tpatns	0.001553	0.000754	0.041	**	0.002217	0.000949	0.021	**
H1	intpatns	0.005354	0.002835	0.061	*	0.009388	0.005397	0.084	*
H1	apmans	0.112259	0.071233	0.117		0.119244	0.093643	0.205	
H1	tpmans	0.009886	0.079855	0.902		0.249235	0.382373	0.516	
H1	intpmans	3.375508	0.774625	0.000	***	3.161987	1.659357	0.059	*
H1	t510kns	0.007107	0.003999	0.078	*	-0.025472	0.010611	0.018	**
H2	tperns	-0.000127	0.000169	0.456		-0.000239	0.000337	0.48	
H3	plms	-0.003276	0.008040	0.684		-0.008985	0.010604	0.398	
H4	Inscns	-0.002653	0.001691	0.119		-0.002265	0.002869	0.431	
H5	aexp	-0.040107	0.023176	0.086	*	-0.098576	0.061008	0.109	
Ctl	collar	-0.022589	0.017833	0.207		0.012885	0.035435	0.717	
Ctl	cash	0.012517	0.006905	0.072	*	0.020556	0.010133	0.045	**
Ctl	hhi	-0.361879	0.187717	0.056	*	-0.317770	0.316784	0.318	
Ctl	m1a0	0.013905	0.008877	0.119		0.009533	0.012733	0.455	
Ctl	aq	-0.005084	0.002687	0.061	*	-0.008194	0.004829	0.092	*
Ctl	tq	-0.001548	0.000492	0.002	***	0.000394	0.003774	0.917	
	constant	0.090060	0.041928	0.033	**	0.085650	0.068148	0.211	
	Observations	n =	273			Observations	n =	144	
	Overall significance of regression					Overall significance of regression			
	F(17, 143, .05) =		6.08			F(17, 126, .05) =		1093.2	
	Prob > F		0.0000	***		Prob > F		0.0000	***
	R-squared =		0.2873			R-squared =		0.3888	
	Power sufficiency					Power sufficiency			
	Fcrit(17, 143, .80) =		1.24	s		Fcrit(17, 126, .80) =		1.25	s
	Power sufficient at .80 level					Power sufficient at .80 level			

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Table 22: Subsample Regression Analyses
Include Each Acquirer's Largest Acquisition Only

Dependent Variable: $\Delta POCFROS_{P4}$

		Model 17A ++ (Base Model)	-----Robust Regression-----	(with non-independence correction)			Model 22A ++ (Largest Acquisition Only)	-----Robust Regression-----			Model 22B ++ (Largest Acquisition Only)	-----Robust Regression-----		
Indep Variables:		Coef.	Std. Err.	P>|t|		Coef.	Std. Err.	P>|t|		Coef.	Std. Err.	P>|t|	
H1	apatns	0.138474	0.054140	0.012	**	0.178121	0.060035	0.004	***	0.178427	0.058474	0.003	***
H1	tpatns	0.027514	0.006618	0.000	***	0.029709	0.012736	0.022	**	0.030449	0.010766	0.006	***
H1	intpatns	0.092452	0.021211	0.000	***	0.150452	0.041642	0.001	***	0.150904	0.039681	0.000	***
H1	apmans	0.566429	0.520890	0.280		0.997340	0.467820	0.036	**	1.007623	0.461465	0.032	**
H1	tpmans	0.158273	0.173431	0.364		1.251655	1.173882	0.289		1.219747	0.328581	0.000	***
H1	intpmans	5.245025	2.055094	0.012	**	-0.067427	5.106162	0.989					
H2	aperns	0.001316	0.001757	0.456		0.002912	0.002318	0.212		0.002980	0.002162	0.172	
H2	tperns	-0.001225	0.000551	0.028	**	-0.000322	0.001285	0.803		-0.000285	0.001111	0.798	
H2	intperns	-0.000045	0.000026	0.088	*	-0.000011	0.000065	0.866					
H3	plms	0.066389	0.032446	0.043	**	0.031905	0.039589	0.422		0.033189	0.037995	0.385	
H4	lnscns	-0.002900	0.004978	0.561		-0.014130	0.012171	0.249		-0.014403	0.011183	0.202	
H5	aexp	-0.165449	0.151032	0.276		-0.863023	0.440550	0.053	*	-0.858505	0.445984	0.058	*
Ctl	m1a0	0.042726	0.035720	0.235		0.056805	0.048152	0.241		0.057256	0.045906	0.216	
Ctl	aq	-0.025509	0.023410	0.279		-0.071461	0.043141	0.101		-0.072488	0.039728	0.072	*
Ctl	tq	-0.002122	0.000882	0.018	**	0.009390	0.014439	0.517		0.008488	0.014467	0.559	
	constant	0.029529	0.084004	0.726		0.256390	0.220668	0.248		0.259028	0.207637	0.216	
	Observations	n =	195			Observations	n =	90		Observations	n =	90	
	Overall significance of regression					Overall significance of regression				Overall significance of regression			
	F(15, 98, .05) =		11.55			F(15, 74, .05) =		704.75		F(13, 76, .05) =		115.26	
	Prob > F		0.0000	***		Prob > F		0.0000	***	Prob > F		0.0000	***
	R-squared =		0.7863			R-squared =		0.8665		R-squared =		0.8664	
	Power sufficiency					Power sufficiency				Power sufficiency			
	Fcrit(15, 98, .80) =		1.38	s		Fcrit(15, 74, .80) =		1.43	s	Fcrit(13, 76, .80) =		1.55	s
	Power sufficient at .80 level					Power sufficient at .80 level				Power sufficient at .80 level			

*Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10*

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

High-Technology, General Supplies, and Diversifying Acquisitions. The next set of subsample analyses splits the acquisitions sample into three groups (Table 23):

- Acquisitions that built product lines within high-technology medical specialty areas (n = 192), where the products manufactured by the buying and selling firms before acquisition announcement overlapped in at least one high-technology medical specialty area (e.g., anesthesia and pulmonary medicine, cardiovascular, gastroenterology and urology, general surgery, neurology, obstetrics and gynecology, orthopedics, otorhinolaryngology, physical medicine, radiology);[62]
- Commodity-type supplies acquisitions (n = 18), where general supplies is the only overlapping product category between the acquiring firm and target organization; and

[62] The regression estimations reported in Table 23 pool acquisitions in high-technology medical specialty areas for two reasons. First, because there are numerous medical specialty product areas, the number of acquisitions within each major clinical area is modest (e.g., only 24 cases where acquirer and target combined orthopedic products; 32 cases of combining anesthesia and pulmonary medicine products; 45 cases of combining gastroenterology and urology products; 69 cases of combining general surgical products; 79 cases of combining cardiovascular products). Second, acquirer and target products overlapped in more than one high-technology medical specialty in a majority of these cases. For example, products overlapped in three medical specialty areas (cardiovascular, gastroenterology and urology, and general surgery) in Boston Scientific's 1997 acquisition of Target Therapeutics; in five areas (anesthesia and pulmonary medicine, cardiovascular, general hospital products, neurology, and physical medicine) in Conmed's 1993 acquisition of Medtronic's Andover Medical division; and in eight areas (anesthesia and pulmonary medicine, gastroenterology and urology, general hospital products, neurology, obstetrics and gynecology, orthopedics, ophthalmology, and general surgery) in Bristol-Myers Squibb's 1990 acquisition of Concept Inc.

Table 23: Subsample Regression Analyses
Acquisitions in High-Tech Medical Specialty Areas

		Model 23A ++				Model 23B ++				Model 23C ++			
		Robust Regression				Robust Regression				Robust Regression			
		(with non-independence correction)											
		Dependent Variable: $CAR_{P(-1,1)}$				Dependent Variable: $CAR_{P(-1,1)}$				Dependent Variable: $\Delta POCFROS_{P4}$			
Indep Variables:		Coef.	Std. Err.	P>|t|		Coef.	Std. Err.	P>|t|		Coef.	Std. Err.	P>|t|	
H1	apatns	0.035534	0.004886	0.000	***	0.035534	0.005020	0.000	***	0.358039	0.017083	0.000	***
H1	tpatns	0.008470	0.001294	0.000	***	0.008470	0.001452	0.000	***	0.079140	0.005800	0.000	***
H1	intpatns	0.030815	0.004288	0.000	***	0.030815	0.004335	0.000	***	0.301910	0.022932	0.000	***
H1	t510kns	-0.009047	0.003594	0.013	**	-0.009047	0.004190	0.032	**	0.000573	0.005329	0.915	
H2	aperns	0.000461	0.000282	0.106		0.000461	0.000303	0.130		0.000894	0.000911	0.328	
H2	tperns	-0.000136	0.000194	0.484		-0.000136	0.000200	0.496		-0.000758	0.000432	0.081	*
H2	intperns	0.000014	0.000007	0.056	*	0.000014	0.000009	0.127		-0.000045	0.000024	0.061	*
H4	Inscns	-0.001530	0.002656	0.566		-0.001530	0.002692	0.570		-0.001984	0.007629	0.795	
H5	aexp	-0.023394	0.013488	0.086	*	-0.023394	0.015029	0.121		-0.005323	0.046523	0.909	
Ctl	collar	-0.033308	0.012071	0.007	***	-0.033308	0.013337	0.013	**	-0.032978	0.027742	0.237	
Ctl	m1a0	0.023293	0.012802	0.072	*	0.023293	0.012818	0.071	*	0.052136	0.034877	0.137	
Ctl	aq	-0.004156	0.002759	0.135		-0.004156	0.002649	0.118		-0.000008	0.006388	0.999	
Ctl	tq	-0.000583	0.000501	0.247		-0.000583	0.000555	0.295		-0.006092	0.000769	0.000	***
	constant	0.019081	0.051188	0.710		0.019081	0.051954	0.714		-0.037362	0.161082	0.817	
	Observations	n =	192			Observations	n =	192		Observations	n =	143	
	Overall significance of regression					Overall significance of regression				Overall significance of regression			
	F(13, 95, .05) =		26.84			F(13, 178, .05) =		25.02		F(13, 129, .05) =		1688.9	
	Prob > F		0.0000	***		Prob > F		0.0000	***	Prob > F		0.0000	***
	R-squared =		0.2578			R-squared =		0.2578		R-squared =		0.8336	
	Power sufficiency					Power sufficiency				Power sufficiency			
	Fcrit(13, 95, .80) =		1.51	s		Fcrit(13, 178, .80) =		1.43	s	Fcrit(13, 129, .80) =		1.47	s
	Power sufficient at .80 level					Power sufficient at .80 level				Power sufficient at .80 level			

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Table 23: Subsample Regression Analyses
Diversifying Acquisitions

		Model 23D ++ Robust Regression			Model 23E ++ Robust Regression		
		Dependent Variable: $CAR_{P(-1,1)}$			Dependent Variable: $\Delta POCFROS_{P4}$		
Indep Variables:		Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
H1	apatns	-0.000062	0.003893	0.987	0.067000	0.024482	0.010 ***
H1	tpatns	0.001156	0.000281	0.000 ***	0.127421	0.113070	0.269
H1	t510kns	0.016207	0.001721	0.000 ***	0.492514	0.097070	0.000 ***
H2	aperns	-0.000463	0.000325	0.161	-0.001923	0.001447	0.194
H2	tperns	-0.000765	0.000437	0.086 *	-0.008217	0.002038	0.000 ***
H4	lnscns	-0.004174	0.003502	0.239	0.018959	0.006800	0.009 ***
H5	aexp	-0.007147	0.025850	0.783	0.000353	0.104548	0.997
Ctl	aq	-0.000873	0.000936	0.355	0.065471	0.024520	0.012 **
Ctl	tq	0.002214	0.005399	0.683	0.003711	0.031033	0.906
	constant	0.118827	0.078774	0.137	-0.328328	0.156352	0.045 **
	Observations	n =	63		Observations	n =	39
	Overall significance of regression				Overall significance of regression		
		F(9, 53, .05) =	150.39			F(9, 29, .05) =	126.03
		Prob > F	0.0000 ***			Prob > F	0.0000 ***
		R-squared =	0.3789			R-squared =	0.9674
	Power sufficiency				Power sufficiency		
		Fcrit(9, 53, .80) =	1.99 s			Fcrit(9, 29, .80) =	2.26 s
		Power sufficient at .80 level				Power sufficient at .80 level	

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

- Diversifying acquisitions (n = 63), where the products sold by the acquisition partners before the corporate combination did not overlap in any medical specialty area.

High-Technology Acquisitions. Regression results point to four findings for acquisitions where the products manufactured by the buying and selling firms overlapped in at least one high-technology medical specialty (Tables 23A – 23C). First is further empirical confirmation that acquisition of target organizations with product innovation capability is positively related to both short-run and longer-term financial outcomes. Announcement returns and cash flow returns are bolstered when both acquirer and target possess product innovation capability in high-tech medical specialty areas. Second, collar provisions (adopted to protect target shareholders against downward movements in the acquiring firm's share price) are interpreted by the stock market as a signal of risk, concern, or uncertainty surrounding the transaction. Negative market reaction to the presence of a collar provision resulted in shareowner wealth diminution at the time of acquisition announcement (Tables 23A and 23B). Third, the market also responded unfavorably to corporate unions in high-tech medical specialty areas when the target organization had a high ratio of 510(k) clearances relative to net sales. A high 510(k) ratio indicates a track record of bringing imitative, non-innovative, substantially equivalent products to market, and the stock market devalues share prices when non-innovative targets are acquired within high-technology clinical areas. Fourth, acquisitions in high-technology medical specialty areas corroborate the previous finding that target

organizations exhibiting pre-acquisition financial distress and operational inefficiency (low Tobin's q values and production efficiency ratings) are associated with subsequent improvement in longer-term cash flow returns.

Diversifying Acquisitions.[63] The regression results for diversifying acquisitions (Tables 23D and 23E) exhibit two contrasts. First, unlike corporate combinations within high-tech medical specialty areas (where negative wealth changes followed purchase announcements of target organizations with a high ratio of 510(k) clearances relative to net sales), the stock market rewarded acquisitions of targets with high 510(k) ratios in diversifying acquisitions. In cases where the acquiring firm and target organization had no overlapping clinical specialty areas, the market's response suggests anticipation that diversification into new medical product areas is likely to be successful when purchasing target organizations with products that are substantially equivalent to already-marketed items. High 510(k) clearance ratios among target organizations is associated with positive longer-term cash flow returns in diversifying acquisitions as well. Second, the regression model estimating short-run announcement returns for diversifying acquisitions focuses on the target organization's product innovation capability in predicting changes in shareowner wealth. In contrast, longer-term cash flow improvement is associated with buying firms' pre-acquisition product innovation capability and financial health. However, these findings are qualified by modest subsample sizes.[64] Further investigation is indicated to clarify and substantiate these results in diversifying acquisitions.

---

[63] Regression models are not estimated for commodity-type supplies acquisitions (where general supplies is the only overlapping product category between the acquiring firm and target organization) because the sample size is only 18.

[64] n = 63 in Table 23D; n = 39 in Table 23E.

Surviving Target Organizations. Of the 273 corporate acquisitions in the study sample, 103 were mergers (acquisition of 100 percent of the target firm), leaving 170 surviving target organizations. Table 24 regresses targets' pre-acquisition product innovation capability, production efficiency, size, and Tobin's q on announcement returns and cash flow returns (Tables 24A and 24B). Neither model is statistically significant (the F-statistics for the overall regressions are 1.38 and 0.51 with p-values well above .05), indicating that the fitted models do not predict or explain a significant amount of the variation in post-transaction financial outcomes among surviving target organizations (Kleinbaum, Kupper, and Muller, 1988). Both models in Table 24 exhibit insufficient statistical power as well. Future research is needed to investigate and explain the determinants of financial outcomes among surviving target organizations.

Table 24: Subsample Regression Analyses
Surviving Target Organizations

		Model 24A	-----Robust Regression-----			Model 24B	-----Robust Regression-----		
		Dependent Variable: $CAR_{(T-1,1)}$				Dependent Variable: $\Delta POCFROS_{T4}$			
Indep Variables:		Coef.	Std. Err.	P>|t|		Coef.	Std. Err.	P>|t|	
H1	tpatns	0.026948	0.015729	0.089	*	-0.19443	0.24840	0.435	
H1	tpmans	0.563026	0.367778	0.128		0.07285	1.42441	0.959	
H1	t510kns	0.021081	0.070200	0.764		-0.08277	0.17995	0.646	
H2	tperns	-0.001566	0.000705	0.028	**	0.00478	0.00487	0.328	
H4	tscalens	0.000024	0.000057	0.669		0.00047	0.00039	0.229	
Ctl	tq	-0.000095	0.005769	0.987		-0.10212	0.07435	0.172	
	constant	0.059030	0.025620	0.022	**	-0.01217	0.07910	0.878	
Observations		n = 170				Observations	n = 136		
Overall significance of regression						Overall significance of regression			
		F(6, 163, .05) = 1.38					F(6, 129, .05) = 0.51		
		Prob > F 0.2249					Prob > F 0.8012		
		R-squared = 0.0477					R-squared = 0.0681		
Power sufficiency						Power sufficiency			
		Fcrit(6, 163, .80) = 2.31 ns					Fcrit(6, 129, .80) = 2.33 ns		
		Power not sufficient at .80 level					Power not sufficient at .80 level		

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Sensitivity to Firms with Restated Financial Reports. As a final subsample analysis, the base models (Tables 16A and 17A) were re-run without acquisitions by two prominent medical device manufacturers (Bristol-Myers Squibb and Tyco International) that have been in the news because of misleading or fraudulent accounting practices. Although the dissertation dataset was updated to reflect the most recently available restated financial data, sensitivity analysis was performed to assess the impact of these two firms on the results. The original base model regression estimations and base models without acquisitions by Bristol-Myers Squibb and Tyco International produced identical patterns of significant regression coefficients (regression results tables not reported).

Evaluation of Alternative Variable Specifications

Descriptive statistics for alternative specifications of the dependent variables are presented in Table 25A. For acquirer/target portfolio announcement returns, two sets of alternative specifications are provided: (a) standardized cumulative abnormal returns (SCARs) and (b) a generalized autoregressive conditional heteroskedastic (GARCH) market model.[65] The t-test evaluating whether standardized cumulative abnormal returns for the 3-day event window ($SCAR_{P(-1,1)}$) are different from zero yielded a significant t-statistic of 2.15 (p-value = .0324), indicating that the standardized announcement returns are statistically different from zero. Correlation coefficients among the three measures of 3-day announcement returns ($CAR_{P(-1,1)}$, $SCAR_{P(-1,1)}$, and $GCAR_{P(-1,1)}$) averaged .901.

The two alternative specifications for 2-, 3-, and 4-year cash flow returns are: (a)

[65] In 30 cases, the GARCH estimation procedure for either the acquirer or target did not converge, thereby precluding calculation of portfolio GARCH models in 11 percent of the study sample.

raw change in pretax operating cash flow return on sales (that is, the cash flow return is not market-adjusted) and (b) market-adjusted change in pretax operating cash flow return on sales, top- and bottom-coded at +1 and -1.[66] The t-test evaluating whether top-coded $\Delta POCFROS_{P4}$ values (mean = 3.79 percent) are significantly different from zero yielded a t-statistic of 3.52 (p-value = .0005, indicating significant difference from zero). Correlation coefficients among the three measures of 4-year cash flow returns ($\Delta POCFROS_{P4}$, $\Delta POCFROS_{P4,raw}$ $\Delta POCFROS_{P4,tc}$) averaged .920.

Descriptive statistics for alternative specifications of independent and control variables are shown in Table 25B. First, the alternative specifications for *product innovation capability* use research and development (R&D) expenditures (rather than net sales) in the ratio denominator. On average, during the five years before the effective dates of the acquisitions under study, target organizations averaged 19.2 patent awards, 0.82 premarket approvals (PMAs), and 14.3 510(k) clearances per $10 million in medical care commodities CPI-adjusted research and development.

Second, *production efficiency ratings* are calculated using R&D expenditures in the input vector (and shifting net sales to the output vector). The revised ratings (72 for acquiring firms and 67 for target organizations) are generally higher than the initial scores because R&D spending levels are smaller than net sales amounts.

Third, the alternative measure of *building product lines within medical specialties* documents whether acquisition of the target organization contributed new products to the

[66] Four $\Delta POCFROS_{P4}$ values were top-coded and none were bottom coded, so less than 1.5 percent of the study sample was affected.

Table 25A: Alternative Specifications for Dependent Variables

		n	Mean	Std Dev	Coeff of Variation	Median	Percent Positive
Cumulative Abnormal Stock Market Returns							
$SCAR_{P(-1,1)}$	Portfolio standardized cumulative abnormal returns (SCAR), 3-day event window (-1,1)	273	0.1310	1.1826	9.03	0.0606	53%
$SCAR_{P(-2,2)}$	Portfolio standardized cumulative abnormal returns (SCAR), 5-day event window (-2,2)	273	0.0780	1.0981	14.08	0.0613	53%
$SCAR_{P(-5,5)}$	Portfolio standardized cumulative abnormal returns (SCAR), 11-day event window (-5,5)	273	0.1210	1.0176	8.41	0.1394	58%
$GCAR_{P(-1,1)}$	Portfolio CAR, 3-day event window (-1,1), GARCH model	243	0.0085	0.0591	6.99	0.0024	54%
$GCAR_{P(-2,2)}$	Portfolio CAR, 5-day event window (-2,2), GARCH model	243	0.0062	0.0613	9.85	0.0036	55%
$GCAR_{P(-5,5)}$	Portfolio CAR, 11-day event window (-5,5), GARCH model	243	0.0108	0.0788	7.29	0.0098	58%
Change in Pretax Operating Cash Flow Return on Sales							
$\Delta POCFROS_{P2,raw}$	Portfolio, 2-yr post-acquisition evaluation period, not market-adjusted	229	0.0641	0.3341	5.21	0.0160	70%
$\Delta POCFROS_{P3,raw}$	Portfolio, 3-yr post-acquisition evaluation period, not market-adjusted	208	0.0642	0.3352	5.23	0.0233	70%
$\Delta POCFROS_{P4,raw}$	Portfolio, 4-yr post-acquisition evaluation period, not market-adjusted	195	0.0689	0.3486	5.06	0.0263	72%
$\Delta POCFROS_{P2,tc}$	Portfolio, 2-yr post-acquisition evaluation period, market adjusted, top/bottom coded at +/-1	229	0.0349	0.1543	4.43	0.0113	65%
$\Delta POCFROS_{P3,tc}$	Portfolio, 3-yr post-acquisition evaluation period, market adjusted, top/bottom coded at +/-1	208	0.0354	0.1458	4.12	0.0163	63%
$\Delta POCFROS_{P4,tc}$	Portfolio, 4-yr post-acquisition evaluation period, market-adjusted, top/bottom coded at +/-1	195	0.0379	0.1504	3.96	0.0189	64%

Table 25B: Alternative Specifications
Independent and Control Variables

		n	Mean	Std Dev	Coeff of Variation	Median
Product Innovation Capability (H1)						
(using R&D expenditures in the ratio denominator)						
Patent Awards						
H1apatrd	Ratio of patents to R&D ($M), acquirer ◊	245	5.859	46.962	8.02	1.0371
H1tpatrd	Ratio of patents to R&D ($M), target ◊	238	1.917	3.258	1.70	0.8735
H1intpatrd	Interaction, H1apatrd x H1tpatrd, centered ◊	223	-1.235	27.562	22.31	3.8935
Premarket Approvals						
H1apmard	Ratio of PMAs to R&D ($M), acquirer ◊	245	0.1571	0.4575	2.91	0.0000
H1tpmard	Ratio of PMAs to R&D ($M), target ◊	238	0.0818	0.3168	3.87	0.0000
H1intpmard	Interaction, H1apmard x H1tpmard, centered ◊	223	0.0205	0.2753	13.41	0.0128
510(k) Clearances						
H1a510krd	Ratio of 510(k)s to R&D ($M), acquirer ◊	245	7.166	58.636	8.18	0.2008
H1t510krd	Ratio of 510(k)s to R&D ($M), target ◊	238	1.430	3.732	2.61	0.3047
H1int510krd	Interaction, H1a510krd x H1t510krd, centered ◊	223	-7.304	83.695	11.46	6.2726
Production Efficiency (H2)						
(using R&D expenditures in the input vector)						
H2aperrd	Acquirer's production efficiency rating (0-100) ◊	251	72.05	13.77	0.19	72.73
H2tperrd	Target's production efficiency rating (0-100) ◊	246	67.07	16.45	0.25	69.08
H2intperrd	Interaction, H2aperrd x H2tperrd, centered ◊	233	34.50	246.70	7.15	5.73
Building Product Lines Along Medical Specialties (H3)						
$H3plms_{alt}$	Whether acquisition of the target contributed new products to the buyer's clinical specialty product line (1=yes) ◊	273	0.6337	0.4827	0.76	1.00
Post-Acquisition Scale (H4)						
H4scalens	Acquirer + target net sales (in $B) ◊	273	2.307	6.844	2.97	0.1857
H4scalens2	Mean-centered combined net sales, squared ◊	273	46.67	245.19	5.25	4.940
Prior Acquisition Experience (H5)						
$H5aexp_{n2}$	Discounted number of prior acquisitions by acquirer, 2-yr half-life, scaled by net sales ($M) ◊	273	0.0524	0.1759	3.36	0.0047
$H5aexp_{n3}$	Discounted number of prior acquisitions by acquirer, 3-yr half-life, scaled by net sales ($M) ◊	273	0.0609	0.1960	3.22	0.0060
$H5aexp_{n5}$	Discounted number of prior acquisitions by acquirer, 5-yr half-life, scaled by net sales ($M) ◊	273	0.0703	0.2176	3.10	0.0079
$H5aexp_{n6}$	Discounted number of prior acquisitions by acquirer, 6-yr half-life, scaled by net sales ($M) ◊	273	0.0732	0.2240	3.06	0.0085
$H5aexp_{v2}$	Discounted $ value of prior acquisitions by acquirer, 2-yr half-life, scaled by net sales ($M) ◊	273	0.6346	2.4021	3.79	0.0956
$H5aexp_{v3}$	Discounted $ value of prior acquisitions by acquirer, 3-yr half-life, scaled by net sales ($M) ◊	273	0.7201	2.5978	3.61	0.1352
$H5aexp_{v4}$	Discounted $ value of prior acquisitions by acquirer, 4-yr half-life, scaled by net sales ($M) ◊	273	0.7758	2.7206	3.51	0.1625
$H5aexp_{v5}$	Discounted $ value of prior acquisitions by acquirer, 5-yr half-life, scaled by net sales ($M) ◊	273	0.8151	2.8052	3.44	0.1835
$H5aexp_{v6}$	Discounted $ value of prior acquisitions by acquirer, 6-yr half-life, scaled by net sales ($M) ◊	273	0.8444	2.8672	3.40	0.1915
$H5aexp_{ind}$	Discounted number of prior acquisitions in the medical device industry by acquirer, 4-yr half-life, scaled by net sales ($M) ◊	273	0.0340	0.1450	4.27	0.0007

◊ Indicates lagged independent variable (measured in time periods prior to the focal acquisition event)

Table 25B: Alternative Specifications
Independent and Control Variables
(continued)

		n	Mean	Std Dev	Coeff of Variation	Median
Relative Size of Target to Acquirer						
No alternative specifications for this variable						
Collar Provision						
No alternative specifications for this variable						
Use of Cash as a Method of Payment						
cashonly	Whether cash was the only form of payment (1=yes)	273	0.2601	0.4395	1.69	0.00
Market Concentration						
Change in HHI	HHI_{t-1} - HHI_{t-2}, medical device industry ◊	273	-0.0033	0.0096	-2.88	-0.0020
Calendar Year of Acquisition Announcement						
yr1984	Acquisition announced in 1984 (1=yes)	273	0.0110	0.1044	9.50	0.00
yr1985	Acquisition announced in 1985 (1=yes)	273	0.0293	0.1690	5.77	0.00
yr1986	Acquisition announced in 1986 (1=yes)	273	0.0366	0.1882	5.14	0.00
yr1987	Acquisition announced in 1987 (1=yes)	273	0.0220	0.1469	6.68	0.00
yr1988	Acquisition announced in 1988 (1=yes)	273	0.0330	0.1789	5.43	0.00
yr1989	Acquisition announced in 1989 (1=yes)	273	0.0330	0.1789	5.43	0.00
yr1990	Acquisition announced in 1990 (1=yes)	273	0.0330	0.1789	5.43	0.00
yr1991	Acquisition announced in 1991 (1=yes)	273	0.0549	0.2283	4.15	0.00
yr1992	Acquisition announced in 1992 (1=yes)	273	0.0440	0.2054	4.67	0.00
yr1993	Acquisition announced in 1993 (1=yes)	273	0.0513	0.2210	4.31	0.00
yr1994	Acquisition announced in 1994 (1=yes)	273	0.0842	0.2783	3.30	0.00
yr1995	Acquisition announced in 1995 (1=yes)	273	0.1282	0.3349	2.61	0.00
yr1996	Acquisition announced in 1996 (1=yes)	273	0.1026	0.3039	2.96	0.00
yr1997	Acquisition announced in 1997 (1=yes)	273	0.1319	0.3390	2.57	0.00
yr1998	Acquisition announced in 1998 (1=yes)	273	0.1209	0.3266	2.70	0.00
yr1999	Acquisition announced in 1999 (1=yes)	273	0.0842	0.2783	3.30	0.00
Merger or Partial Acquisition						
No alternative specifications for this variable						
Acquisition Propensity						
aqtc	Tobin's q, top-coded at 20, acquirer ◊	273	2.1134	2.2615	1.07	1.4497
tqtc	Tobin's q, top-coded at 20, target ◊	273	1.7389	1.8952	1.09	1.2243
sp12m	Recent market trend (lagged 12-month change in S&P 500 index level) ◊	273	0.1779	0.1350	0.76	0.2026

◊ Indicates lagged independent variable (measured in time periods prior to the focal acquisition event)

buyer's clinical specialty product line (1 = yes in 63 percent of cases).[67]

Fourth, *post-acquisition combinative scale* is alternatively measured as the sum of acquirer and target net sales in the year before acquisition announcement, adjusted using the medical care commodities CPI (in $billions, but not in natural log form). In addition, potential curvilinearity in the relationship between post-acquisition scale and financial outcomes is assessed using the combination of (a) net sales and (b) mean-centered squared net sales (mean values 2.31 billion and 46.67 billion, respectively).

Fifth, a total of 10 alternative specifications for *acquirer's prior acquisition experience* are produced and evaluated: (a) discounted number of prior acquisitions using 2-, 3-, 5, and 6-year half-life assumptions; (b) discounted dollar volume of prior acquisitions using 2-, 3-, 4-, 5-, and 6-year half-life assumptions; and (c) acquirer's *industry* acquisition experience (whereby acquisition activity is restricted to targets with primary SIC codes of 3841, 3842, 3844, or 3845). Correlations among the acquisition experience measures are high: the mean correlation coefficient among the 2-, 3-, 4-, 5-, and 6-year half-life assumptions for discounted number of prior acquisitions is .996; the average correlation among the 2-, 3-, 4-, 5-, and 6-year half-life assumptions for discounted dollar value of prior acquisitions is also .996; and the correlation between total acquisition experience and medical device industry acquisition experience (using the 4-year half-life assumption) is .881.

---

[67] As discussed in previous chapters, the alternative measure requires that new products be added to a clinical specialty area via corporate acquisition (thereby evidencing product line extension), while the primary measure permits acquisitions that add strictly more of the same products (that is, no product line extensions but increasing market share for the acquired products within the medical specialty area).

Sixth, *use of cash as a method of payment* was re-specified to indicate whether cash was the only form of payment (1 = yes for 26 percent of the study sample).

Seventh, the mean and median lagged change in HHI were -.0033 and -.0020, indicating a small tendency toward less concentrated (more competitive) market structure. For example, the change in HHI from 1991 to 1992 was -.0020. During this time, consolidation via corporate acquisition was offset by the 1992 initial public offerings (IPOs) of Boston Scientific and Steris Corp. In addition, calendar year of acquisition announcement is evaluated as a broader and subsuming measure of industry conditions and *market concentration* during the study period.

Finally, a pair of alternative specifications for the *acquisition propensity control* were constructed: (a) following Danzon, Epstein, and Nicholson (1994), *acquirer and target Tobin's q* measures were top-coded at 20 (causing adjustment in two acquisitions in the study sample) and (b) *change in S&P 500 index level* was evaluated using the last four full calendar quarters before acquisition announcement. No alternative specifications are calculated for relative size of target to acquirer, presence of a collar provision, and whether the corporate transaction is a merger or a partial acquisition.

Regression estimations using alternative announcement return measures are presented in the three pages of Table 26. The first page compares (a) the base model (Table 16A), (b) a GARCH estimation model using the 3-day event window, $GCAR_{P(-1,1)}$ (Table 26A), and (c) a model estimating standardized cumulative abnormal returns using the 3-day event window, $SCAR_{P(-1,1)}$ (Table 26B). The second page of Table 26 arrays GARCH models for the 3-, 5-, and 11-day event windows (Tables 26A, 26C, 26D). The

Table 26: Results of Regression Analyses
Alternative Specifications for Dependent Variables

Dependent Variable: Cumulative Abnormal Stock Market Return

		Model 16A ++ (Base Model)			Model 26A ++			Model 26B ++		
		Robust Regression (with non-independence correction)			Robust Regression (with non-independence correction)			Robust Regression (with non-independence correction)		
		Dependent Variable: $CAR_{P(-1,1)}$			Dependent Variable: $GCAR_{P(-1,1)}$ (Garch)			Dependent Variable: $SCAR_{P(-1,1)}$ (Standardized)		
Indep Variables:		Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
H1	apatns	0.006704	0.007330	0.362	0.001371	0.003446	0.691	-0.009685	0.083557	0.908
H1	tpatns	0.001553	0.000754	0.041 **	0.001312	0.000606	0.032 **	0.027149	0.014711	0.067 *
H1	intpatns	0.005354	0.002835	0.061 *	0.003706	0.002200	0.095 *	0.091208	0.040773	0.027 **
H1	apmans	0.112259	0.071233	0.117	0.121852	0.062389	0.053 *	1.858954	1.009847	0.068 *
H1	tpmans	0.009886	0.079855	0.902	0.016467	0.078574	0.834	-0.630535	1.133772	0.579
H1	intpmans	3.375508	0.774625	0.000 ***	3.458700	0.761896	0.000 ***	36.262890	7.347590	0.000 ***
H1	t510kns	0.007107	0.003999	0.078 *	0.008015	0.004111	0.053 *	0.025320	0.066497	0.704
H2	tperns	-0.000127	0.000169	0.456	-0.000125	0.000186	0.500	-0.001666	0.003686	0.652
H3	plms	-0.003276	0.008040	0.684	-0.003055	0.008488	0.720	-0.126409	0.173622	0.468
H4	lnscns	-0.002653	0.001691	0.119	-0.002171	0.001791	0.228	-0.042237	0.029770	0.158
H5	aexp	-0.040107	0.023176	0.086 *	-0.023785	0.016294	0.147	-0.616320	0.247175	0.014 **
Ctl	collar	-0.022589	0.017833	0.207	-0.025356	0.017888	0.159	-0.486988	0.333040	0.146
Ctl	cash	0.012517	0.006905	0.072 *	0.009214	0.007341	0.212	0.334958	0.149407	0.027 **
Ctl	hhi	-0.361879	0.187717	0.056 *	-0.386999	0.190782	0.045 **	-7.953548	4.001548	0.049 **
Ctl	m1a0	0.013905	0.008877	0.119	0.006930	0.009156	0.451	0.286070	0.194760	0.144
Ctl	aq	-0.005084	0.002687	0.061 *	-0.003512	0.002577	0.175	-0.070784	0.045894	0.125
Ctl	tq	-0.001548	0.000492	0.002 ***	-0.001658	0.000513	0.002 ***	-0.024129	0.008568	0.006 ***
	constant	0.090060	0.041928	0.033 **	0.081459	0.043345	0.063 *	1.559592	0.716296	0.031 **
	Observations	n =	273		n =	243		n =	273	
	Overall significance of regression									
		F(17, 143, .05) =	6.08		F(17, 126, .05) =	11.20		F(17, 143, .05) =	6.56	
		Prob > F	0.0000 ***		Prob > F	0.0000 ***		Prob > F	0.0000 ***	
		R-squared =	0.2873		R-squared =	0.2934		R-squared =	0.1405	
	Power sufficiency									
		Fcrit(17, 143, .80) =	1.24 s		Fcrit(17, 126, .80) =	1.25 s		Fcrit(17, 143, .80) =	1.24 s	
		Power sufficient at .80 level			Power sufficient at .80 level			Power sufficient at .80 level		

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Table 26: Results of Regression Analyses
Alternative Specifications for Dependent Variables

Dependent Variable: Cumulative Abnormal Stock Market Return

		Model 26A ++			Model 26C ++			Model 26D ++		
		Robust Regression			Robust Regression			Robust Regression		
		(with non-independence correction)			(with non-independence correction)			(with non-independence correction)		
		Dependent Variable: $GCAR_{P(-1,1)\ (Garch)}$			Dependent Variable: $GCAR_{P(-2,2)\ (Garch)}$			Dependent Variable: $GCAR_{P(-5,5)\ (Garch)}$		
Indep Variables:		Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
H1	apatns	0.001371	0.003446	0.691	0.000304	0.003206	0.925	-0.002081	0.002672	0.438
H1	tpatns	0.001312	0.000606	0.032 **	0.001224	0.000652	0.063 *	0.001110	0.000624	0.078 *
H1	intpatns	0.003706	0.002200	0.095 *	0.005099	0.002587	0.051 *	0.002389	0.002481	0.337
H1	apmans	0.121852	0.062389	0.053 *	0.151909	0.079447	0.058 *	0.166709	0.059657	0.006 ***
H1	tpmans	0.016467	0.078574	0.834	-0.017932	0.056891	0.753	-0.030569	0.077412	0.694
H1	intpmans	3.458700	0.761896	0.000 ***	1.689587	0.342955	0.000 ***	2.679977	0.503512	0.000 ***
H1	t510kns	0.008015	0.004111	0.053 *	0.007234	0.004681	0.125	0.008986	0.004706	0.058 *
H2	tperns	-0.000125	0.000186	0.500	-0.000006	0.000235	0.981	-0.000015	0.000276	0.957
H3	plms	-0.003055	0.008488	0.720	-0.010943	0.009932	0.273	-0.008249	0.012489	0.510
H4	lnscns	-0.002171	0.001791	0.228	-0.001562	0.002036	0.444	-0.001112	0.002439	0.649
H5	aexp	-0.023785	0.016294	0.147	-0.019915	0.018304	0.279	-0.018145	0.017844	0.311
Ctl	collar	-0.025356	0.017888	0.159	-0.019877	0.016793	0.239	-0.040156	0.023610	0.091 *
Ctl	cash	0.009214	0.007341	0.212	0.010612	0.008230	0.200	0.015001	0.009729	0.126
Ctl	hhi	-0.386999	0.190782	0.045 **	-0.421261	0.215343	0.053 *	-0.104986	0.296266	0.724
Ctl	m1a0	0.006930	0.009156	0.451	0.007795	0.010242	0.448	0.003016	0.012658	0.812
Ctl	aq	-0.003512	0.002577	0.175	-0.003932	0.003355	0.244	-0.002659	0.003165	0.402
Ctl	tq	-0.001658	0.000513	0.002 ***	-0.001433	0.000587	0.016 **	-0.001136	0.000538	0.037 **
	constant	0.081459	0.043345	0.063 *	0.072065	0.049608	0.149	0.042497	0.054425	0.436
	Observations	n =	243		n =	243		n =	243	
	Overall significance of regression									
		F(17, 126, .05) =	11.20		F(17, 126, .05) =	11.97		F(17, 126, .05) =	10.61	
		Prob > F	0.0000 ***		Prob > F	0.0000 ***		Prob > F	0.0000 ***	
		R-squared =	0.2934		R-squared =	0.1566		R-squared =	0.1365	
	Power sufficiency									
		Fcrit(17, 126, .80) =	1.25 s		Fcrit(17, 126, .80) =	1.25 s		Fcrit(17, 126, .80) =	1.25 s	
		Power sufficient at .80 level			Power sufficient at .80 level			Power sufficient at .80 level		

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Table 26: Results of Regression Analyses
Alternative Specifications for Dependent Variables
(using R&D data in H1 and H2 measures)

Dependent Variable: Cumulative Abnormal Stock Market Return

		Model 16G ++			Model 26E ++			Model 26F		
		Robust Regression			Robust Regression			Robust Regression		
		(with non-independence correction)			(with non-independence correction)			(with non-independence correction		
		Dependent Variable: $CAR_{P(-1,1)}$			Dependent Variable: $GCAR_{P(-1,1)\ (Garch)}$			Dependent Variable: $CAR_{P(-2,2)}$		
Indep Variables:		Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
H1	apatrd	0.000074	0.000021	0.001 ***	0.000083	0.000022	0.000 ***	0.000000	0.000025	0.999
H1	tpatrd	0.000036	0.000788	0.964	0.000037	0.000790	0.963	0.000430	0.000859	0.617
H1	apmard	0.002889	0.010626	0.786	0.003895	0.010810	0.719	0.007094	0.009156	0.440
H1	tpmard	0.018500	0.021547	0.392	0.019988	0.022995	0.387	0.003066	0.015311	0.842
H1	t510krd	-0.001619	0.000628	0.011 **	-0.001506	0.000624	0.018 **	-0.001987	0.000746	0.009 ***
H2	tperrd	-0.000430	0.000370	0.248	-0.000347	0.000319	0.280	-0.000171	0.000296	0.566
H3	plms	-0.002949	0.011473	0.798	-0.004892	0.012748	0.702	-0.019164	0.012580	0.130
H4	lnscns	-0.004215	0.002632	0.112	-0.003248	0.002770	0.244	-0.002198	0.002119	0.302
H5	aexp	-0.007815	0.065926	0.906	0.014573	0.067723	0.830	0.000238	0.084486	0.998
Ctl	collar	-0.025898	0.014799	0.083 *	-0.027870	0.014557	0.058 *	-0.024888	0.015635	0.114
Ctl	cash	0.002132	0.008120	0.793	0.000868	0.008319	0.917	0.006634	0.008290	0.425
Ctl	hhi	-0.173299	0.229884	0.453	-0.184724	0.232143	0.428	-0.032691	0.275008	0.906
Ctl	m1a0	0.025031	0.012045	0.040 **	0.019887	0.012093	0.103	0.022436	0.011333	0.050 **
Ctl	aq	-0.002477	0.002912	0.397	-0.002016	0.003417	0.557	-0.001720	0.003659	0.639
Ctl	tq	-0.000806	0.000326	0.015 **	-0.000761	0.000334	0.025 **	-0.000511	0.000362	0.161
	constant	0.133018	0.073254	0.072 *	0.109965	0.071015	0.125	0.076124	0.055743	0.175
		Observations n = 223			Observations n = 202			Observations n = 223		
		Overall significance of regression			Overall significance of regression			Overall significance of regression		
		F(15, 113, .05) = 7.30			F(15, 99, .05) = 8.73			F(15, 113, .05) = 1.67		
		Prob > F 0.0000 ***			Prob > F 0.0000 ***			Prob > F 0.0680 *		
		R-squared = 0.1016			R-squared = 0.0895			R-squared = 0.0756		
		Power sufficiency			Power sufficiency			Power sufficiency		
		Fcrit(15, 113, .80) = 1.35 s			Fcrit(15, 99, .80) = 1.38 s			Fcrit(15, 113, .80) = 1.35 s		
		Power sufficient at .80 level			Power sufficient at .80 level			Power sufficient at .80 level		

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

third page contains models estimating $CAR_{P(-1,1)}$, $GCAR_{P(-1,1)}$, and $CAR_{P(-2,2)}$ using research and development expenditures in the denominators of the product innovation capability ratios (H1) and production efficiency input vector (H2) (Tables 16G, 26E, 26F). The regression analyses in Table 26 corroborate five findings:

- Overall, the market reacts favorably to acquisitions of target organizations with demonstrated product innovation capability (as indicated by the target's pre-acquisition patent yields). This effect weakens as the event window lengthens.
- Portfolio announcement returns are positive as well when acquiring firms possess a track record of product innovation capability.
- The impact of product innovation capability on stock price revaluations (as measured by the interaction terms for PMA approval and patent award ratios) is jointly determined through the interplay of acquiring firms and target organizations.
- Shareholder wealth was destroyed following announcement of acquisition targets with high 510(k) clearance counts relative to R&D expenditures.
- The market reacted positively to announcements that financially distressed organizations (as reflected in low Tobin's q values) are to be acquired.

In addition, the negative relationship between HHI and announcement return indicates that higher levels of market concentration are associated with lower stock price revaluations.

Regression estimations using alternative cash flow return measures are displayed in Table 27. The first page exhibits the base model (Table 17A) and re-estimations of the base model using (a) raw change in pretax operating cash flow return on sales (not market-adjusted) for the 4-year post-acquisition evaluation period, $\Delta POCFROS_{P4,raw}$ (Table 27A) and (b) market-adjusted change in pretax operating cash flow return on sales, top- and bottom-coded at +1 and -1, $\Delta POCFROS_{P4,tc}$ (Table 27B). The second page of Table 27 arrays market adjusted change in pretax operating cash flow return on sales using 2-, 3-, and 4-year post-acquisition evaluation periods (Tables 27C, 27D, 17A). The results pattern in the base model and alternative specifications are highly consistent, confirming that:

- Acquisition of target organizations with demonstrated product innovation capability (as indicated by the target's pre-acquisition patent yields) is associated with positive changes in pretax operating cash flow return on sales,
- Cash flow returns are positive for acquiring firms that also possess a track record of product innovation capability,
- The impact of product innovation capability on cash flow returns (as measured by the interaction term for patent award and PMA approval ratios) is jointly determined through acquirer/target reciprocity,
- The purchase of distressed targets (gauged by target's Tobin's q and production efficiency ratio) is related to gains in cash flow return, and
- Cash flow performance improvement is associated with using corporate acquisitions to build product lines along medical specialties.

Table 27: Results of Regression Analyses
Alternative Specifications for Dependent Variables

Dependent Variable: Change in Pretax Operating Cash Flow Return on Sales

		Model 17A ++ (Base Model)			Model 27A ++			Model 27B ++		
		Robust Regression (with non-independence correction)			Robust Regression (with non-independence correction)			Robust Regression (with non-independence correction)		
		Dependent Variable: $\Delta POCFROS_{P4}$			DV: $\Delta POCFROS_{P4}$ (not market adjusted)			DV: $\Delta POCFROS_{P4}$ (mkt adjusted, top coded at +/-1)		
Indep Variables:		Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
H1	apatns	0.138474	0.054140	0.012 **	0.137773	0.053987	0.012 **	0.047683	0.019662	0.017 **
H1	tpatns	0.027514	0.006618	0.000 ***	0.027322	0.006625	0.000 ***	0.010078	0.002500	0.000 ***
H1	intpatns	0.092452	0.021211	0.000 ***	0.092034	0.021224	0.000 ***	0.027674	0.007879	0.001 ***
H1	apmans	0.566429	0.520890	0.280	0.561455	0.521200	0.284	0.591559	0.321414	0.069 *
H1	tpmans	0.158273	0.173431	0.364	0.159187	0.171165	0.355	0.124908	0.141053	0.378
H1	intpmans	5.245025	2.055094	0.012 **	5.387922	2.047698	0.010 ***	6.463760	1.673639	0.000 ***
H2	aperns	0.001316	0.001757	0.456	0.001312	0.001761	0.458	0.000157	0.000688	0.820
H2	tperns	-0.001225	0.000551	0.028 **	-0.001182	0.000553	0.035 **	-0.000891	0.000383	0.022 **
H2	intperns	-0.000045	0.000026	0.088 *	-0.000046	0.000026	0.082 *	-0.000046	0.000017	0.009 ***
H3	plms	0.066389	0.032446	0.043 **	0.064684	0.032455	0.049 **	0.043304	0.018419	0.021 **
H4	lnscns	-0.002900	0.004978	0.561	-0.003190	0.004968	0.522	0.000017	0.003149	0.996
H5	aexp	-0.165449	0.151032	0.276	-0.153796	0.151968	0.314	-0.091515	0.068279	0.183
Ctl	m1a0	0.042726	0.035720	0.235	0.043534	0.035772	0.227	0.014334	0.015432	0.355
Ctl	aq	-0.025509	0.023410	0.279	-0.025926	0.023466	0.272	-0.007777	0.008905	0.385
Ctl	tq	-0.002122	0.000882	0.018 **	-0.002048	0.000882	0.022 **	-0.000595	0.000382	0.123
	constant	0.029529	0.084004	0.726	0.042061	0.083500	0.616	0.008445	0.061921	0.892
	Observations	n =	195		n =	195		n =	195	
	Overall significance of regression									
		F(15, 98, .05) =	11.55		F(15, 98, .05) =	11.54		F(15, 98, .05) =	9.69	
		Prob > F	0.0000 ***		Prob > F	0.0000 ***		Prob > F	0.0000 ***	
		R-squared =	0.7863		R-squared =	0.7845		R-squared =	0.6828	
	Power sufficiency									
		Fcrit(15, 98, .80) =	1.38 s		Fcrit(15, 98, .80) =	1.38 s		Fcrit(15, 98, .80) =	1.38 s	
		Power sufficient at .80 level			Power sufficient at .80 level			Power sufficient at .80 level		

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Table 27: Results of Regression Analyses
Alternative Specifications for Dependent Variables

Dependent Variable: Change in Pretax Operating Cash Flow Return on Sales, Market Adjusted

		Model 27C ++			Model 27D ++			Model 17A ++ (Base Model)		
		|---Robust Regression---|			|---Robust Regression---|			|---Robust Regression---|		
		(with non-independence correction)			(with non-independence correction)			(with non-independence correction)		
		Dependent Variable: $\Delta POCFROS_{P2}$			Dependent Variable: $\Delta POCFROS_{P3}$			Dependent Variable: $\Delta POCFROS_{P4}$		
Indep Variables:		Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
H1	apatns	0.127782	0.045863	0.006 ***	0.134294	0.050692	0.009 ***	0.138474	0.054140	0.012 **
H1	tpatns	0.029113	0.006139	0.000 ***	0.027084	0.006101	0.000 ***	0.027514	0.006618	0.000 ***
H1	intpatns	0.093637	0.018394	0.000 ***	0.091324	0.019715	0.000 ***	0.092452	0.021211	0.000 ***
H1	apmans	0.634337	0.469091	0.179	0.578126	0.498181	0.248	0.566429	0.520890	0.280
H1	tpmans	0.105186	0.190796	0.582	0.148981	0.171244	0.386	0.158273	0.173431	0.364
H1	intpmans	5.815673	1.992740	0.004 ***	5.416388	1.978902	0.007 ***	5.245025	2.055094	0.012 **
H2	aperns	0.000859	0.001549	0.580	0.001173	0.001692	0.490	0.001316	0.001757	0.456
H2	tperns	-0.000174	0.000658	0.792	-0.001040	0.000512	0.045 **	-0.001225	0.000551	0.028 **
H2	intperns	-0.000074	0.000026	0.005 ***	-0.000052	0.000024	0.036 **	-0.000045	0.000026	0.088 *
H3	plms	0.019236	0.024929	0.442	0.054028	0.027299	0.050 **	0.066389	0.032446	0.043 **
H4	lnscns	-0.007509	0.005486	0.174	-0.003235	0.004447	0.469	-0.002900	0.004978	0.561
H5	aexp	-0.178334	0.145756	0.224	-0.158783	0.138359	0.254	-0.165449	0.151032	0.276
Ctl	m1a0	0.046310	0.023824	0.054 *	0.040972	0.030522	0.182	0.042726	0.035720	0.235
Ctl	aq	-0.023407	0.018462	0.207	-0.022842	0.021519	0.291	-0.025509	0.023410	0.279
Ctl	tq	-0.002379	0.000857	0.006 ***	-0.002088	0.000850	0.016 **	-0.002122	0.000882	0.018 **
	constant	0.135497	0.102868	0.190	0.040706	0.073790	0.582	0.029529	0.084004	0.726
	Observations	n = 229			Observations	n = 208		Observations	n = 195	
	Overall significance of regression				Overall significance of regression			Overall significance of regression		
	F(15, 118, .05) =	7.88			F(15, 105, .05) =	12.76		F(15, 98, .05) =	11.55	
	Prob > F	0.0000 ***			Prob > F	0.0000 ***		Prob > F	0.0000 ***	
	R-squared =	0.7970			R-squared =	0.7995		R-squared =	0.7863	
	Power sufficiency				Power sufficiency			Power sufficiency		
	Fcrit(15, 118, .80) =	1.34 s			Fcrit(15, 105, .80) =	1.37 s		Fcrit(15, 98, .80) =	1.38 s	
	Power sufficient at .80 level				Power sufficient at .80 level			Power sufficient at .80 level		

Unstandardized coefficients and two-tailed t-tests are reported; *** p<.01; ** p<.05; * p<.10

++ indicates rejection of overall model hypotheses (a) Ho: no signif rel'p bet the dep var and the set of indep vars AND (b) Ho: insufficient power to detect effects

Table 27 also demonstrates that the impact of production efficiency on portfolio cash flow returns is interactively determined.

Regression estimations using alternative specifications of independent and control variables. First, regression estimations using the R&D-based alternative measures for *product innovation capability* and *production efficiency* appear in Tables 16, 17, 19, 20, and 26, and have already been discussed.

Second, substituting the alternative measure for *building product lines within medical specialties* into the announcement returns base model altered neither the pattern nor strength of results (regression tables not shown). Entering the alternative product line measure into the cash flow returns base model produced (a) a poorer overall fit to the data (F-statistics were 10.95 for the alternative specification compared with 11.55 for the original base model) and (b) a higher p-value on the individual product line regression coefficient (indicating that product line depth is more strongly associated with cash flow performance improvement than product line breadth).

Third, measuring *post-acquisition scale* without logarithmic transformation produced no changes in the cash flow returns regression results. The non-logarithmic measure was more negatively associated with announcement returns compared with the logarithmic representation (indicating diseconomies of scale with increasing size), however logarithmic scale is the *a priori* preferred form of this variable. To assess curvilinearity in the relationship between post-acquisition scale and financial outcomes, a three-step analysis was conducted. First, corporate unions were divided into three equal-sized groups based on post-acquisition scale. Parametric and nonparametric mean

comparison tests indicated no significant difference in announcement returns among the three size categories (although the largest size category had the smallest mean announcement returns). Second, a pair of dummy variables (indicating the smallest and largest third of deals) replaced ln(sales) in the announcement returns and cash flow returns base models. For both dependent variables, the size category measures were non-significant both singly (based on the significance of individual regression coefficients) and jointly (based on partial F-tests). Finally, the base models were re-estimated with the sales and squared sales measures replacing ln(sales). In both the announcement returns and cash flow returns models, scale and squared scale were non-significant predictors of financial outcomes. These analyses do not corroborate a curvilinear relationship between post-acquisition scale and financial outcomes. Regression results tables using the non-logarithmic specifications are not reported.

Fourth, substituting acquirer's *industry acquisition experience* (whereby acquisition activity is restricted to targets with primary SIC codes of 3841, 3842, 3844, or 3845) into the announcement returns base model yielded a somewhat poorer fit to the data (F-statistics were 6.08 for the original base model and 5.78 for the alternative specification). Examination of the t-statistics and p-values on the original and alternative variable specifications indicates that shareowner wealth destruction is more strongly associated with a firm's *total* acquisition experience compared with the narrower medical device *industry* acquisition experience measure (signaling unfavorable market response to high-frequency and diversifying acquisition records). Both the original and alternative measures of acquisition experience were non-significant (but still negatively signed) in the cash flow returns model. All half-life assumptions (2-, 3-, 4-, 5-, and 6-years) used to

discount the number of total prior acquisitions produced identical results patterns. Acquisition experience measures based on dollar *volume* of acquisitions (compared with those based on *number* of acquisitions) were more strongly and significantly negatively associated with both announcement returns and longer-term cash flow returns (indicating, again, that a highly acquisitive record leads, on average, to unfavorable financial outcomes), but transaction value was unavailable for a large number of acquisitions in the histories of acquirers in the study sample. Regression results tables from alternative specifications of acquisition experiences measures are not reported.

Fifth, re-specifying the announcement returns base model to include a dummy variable indicating whether cash was the *only* form of payment produced a weaker (but still positive) regression coefficient.

Sixth, substituting lagged change in HHI for lagged HHI level in the announcement returns base model produced a poorer overall fit (F-value of 5.77 versus 6.08 in the base model) and the coefficient on lagged change in HHI was non-significant (p-value = .520). In like manner, lagged HHI level and change in HHI were jointly non-significant (and overall model fit declined) when change in HHI was added to the announcement returns base model. Change in HHI was even more strongly non-significant in the cash flow returns model. The second alternative specification for market concentration was calendar year of acquisition announcement. Nearly 53 percent of the variation in HHI is explained by calendar year of acquisition announcement. When the series of yearly dummy variables (using 1997, the calendar year with the most acquisitions, as the omitted contrast) was substituted for HHI in the announcement returns base model, the partial F-test was found to be not significant (the 15 degrees of

freedom for year dummy variables had a p-value of .257). In addition, when raw calendar year was added to the base model, HHI and year were jointly non-significant (2 degrees of freedom and p-value =.122). Finally, (a) adding the yearly dummy variables to the cash flow returns base model produced a partial F-test p-value of .570 and (b) HHI and raw calendar year together were jointly non-significant (p-value =.436) (regression tables not shown).

Finally, controlling for acquisition propensity using top-coded acquirer and target Tobin's q measures in the cash flow returns base model resulted in an identical results pattern among the independent variables compared with the original base model. Similarly, the original and alternative measures of recent trend in stock market prices produced the same results patterns in both short-term announcement returns and longer-term cash flow returns.

Next, the Discussion chapter summarizes the research results, discusses implications, acknowledges limitations, provides directions for further investigation, and concludes.

CHAPTER 5: DISCUSSION

Summary of Results

Hypotheses and empirical results are summarized in Table 28 (next page). This table also records five levels of evidence strength: (a) strong and consistent evidence, (b) preponderance of evidence, (c) conditional evidence, (d) intermittent or partial evidence, and (e) weak or no evidence.

Product Innovation Capability: Patent Awards and PMA Approvals (H1).

Sourcing innovation via acquisition of target organizations with demonstrated ability to develop and improve medical devices (as indicated by the target's pre-acquisition patent yields and PMA approval ratios) is a consistent predictor of both (a) favorable stock price revaluations at the time of acquisition announcement and (b) positive longer-term cash flow returns. A significant finding to emerge from this doctoral research is that buying product innovation capability via corporate acquisition has indeed been a value-creating strategy among medical device makers.

A track record of product innovation capability by the acquiring firm also predicts gainful short-run and longer-term financial outcomes. In fact, in addition to significant main effects, the impact of product innovation capability on announcement returns and cash flow returns is jointly determined through the interaction of acquiring firms and target organizations (that is, the relationship between acquisition-related financial results and *acquirer* product innovation is conditional on the *target* organization's product innovation and, equivalently, the relationship between financial results and *target* product

Table 28: Summary of Hypothesized Relationships and Results

Independent Variables	Hypothesized Relationship	Effect on Post-Acquisition Financial Outcomes: Observed: Short-Term Announcement Returns	Observed: Longer-Term Cash Flow Returns
H1: Product Innovation Capability Patent and PMA yields	+	**A: + T: +** Strong Evidence for Acquirers, Tgts, and Interactions	**A: + T: +** Strong Evidence for Acquirers, Tgts, and Interactions
H1: Product Innovation Capability 510(k) yields	-	**A: ns T: -** Conditional Evidence for Targets No Ev for Acq'rs	**A: ns T: ns** Weak or No Evidence for Acquirers and Targets
H2: Production Efficiency	**A: + T: -**	**A: + T: -** Conditional Evidence for Acquirers and Targets	**A: ns T: -** Strong Evidence for Targets; Signif Interaction
H3: Building Product Lines Along Medical Specialties	+	**ns** Weak or No Evidence	**+** Strong Evidence
H4: Post-Acquisition Scale	+	**-** Conditional Evidence	**+** Conditional Evidence
H5: Prior Acquisition Experience	+	**-** Intermittent Evidence	**-** Intermittent Evidence
Major Control Variables			
Ctl: Relative Size of Target to Acquirer		**ns** Weak or No Evidence	**ns** Weak or No Evidence
Ctl: Collar Provision		**-** Conditional Evidence	**ns** Weak or No Evidence
Ctl: Use of Cash as a Method of Payment		**+** Intermittent Evidence	**ns** Weak or No Evidence
Ctl: Market Concentration		**ns** Weak or No Evidence	**ns** Weak or No Evidence
Ctl: Merger (versus Partial Acquisition)		**+** Intermittent Evidence	**+** Conditional Evidence
Ctl: Acquisition Propensity Tobin's q		**A: - T: -** Intermittent Ev for Acquirers; Preponderance of Ev for Targets	**A: ns T: -** Weak or No Ev for Acquirers; Intermittent Ev for Targets
Ctl: Acquisition Propensity Recent Trend in Stock Market Performance		**ns** Weak or No Evidence	**ns** Weak or No Evidence

Evidence Categories:
Strong and Consistent Evidence; Preponderance of Evidence; Conditional Evidence; Intermittent or Partial Evidence; Weak or No Evidence

innovation is conditional on the *acquiring firm's* product innovation). In the medical device industry, external innovation sourcing pays.

Product Innovation Capability: 510(k) Clearances (H1). A second notable research finding is that shareholder wealth was destroyed following announcement of acquisition targets with high 510(k) clearance counts relative to R&D expenditures. The stock market devalues corporate acquisitions when the target organization has a history of bringing to market too many imitative products that were deemed by the FDA to be "substantially equivalent" to already available predicate devices. This result highlights the importance of theoretically and empirically categorizing product regulatory approval categories in the medical device industry. The dissertation is the first empirical study to distinguish and measure the impact of *innovative* product introductions (patent awards and FDA premarket application (PMA) approvals) and *imitative* product introductions (FDA 510(k) clearances) on acquisition-related financial outcomes.

Production Efficiency (H2). Target organizations exhibiting pre-acquisition operational inefficiency (low production efficiency ratings) were consistently associated with positive cash flow returns. This finding evidences corporate turnarounds, and the impact of production efficiency on cash flow returns was jointly determined through acquirer/target interaction. Similarly, favorable announcement returns were identified with (a) small, inefficiently-producing target organizations and (b) larger, more efficiently producing acquirers to carry out the operational improvement.

Building Product Lines Along Medical Specialties (H3). Using corporate acquisitions to build product lines along medical specialties was a strong and consistent predictor of positive changes in market-adjusted pretax operating cash flow return on sales. The results also indicate that (a) product lines within major clinical specialty areas are built from two or more corporate acquisitions and (b) product line depth is more important to cash flow returns than product line breadth. In contrast, however, announcements of acquisition that build product lines along medial specialties was not a significant predictor of event window stock price revaluations. A question for further investigation is why announcement returns are not more responsive to building product lines along medical specialties.

Post-Acquisition Scale (H4). The subsample regression analyses revealed a contradictory finding among large acquisitions. On the one hand, the biggest corporate combinations in the subsample of large acquisitions were associated with *negative* announcement returns (indicating market expectations for production quantities beyond optimal scale, a convex total cost curve, an upward sloping average cost curve, and decreasing returns to scale) (Nicholson, 1987; Pindyck and Rubinfeld, 1992; Carlton and Perloff, 1994). However, on the other hand, scale within the subsample of large corporate unions was identified with *positive* longer-term cash flow returns. Additional research is needed to better understand and reconcile the conflicting influence of large post-acquisition combinatory scale on market expectations and longer-term realized accounting performance.

Prior Acquisition Experience (H5). Intermittent evidence suggests that being a highly acquisitive firm works to hinder financial outcomes. Acquirers that completed one, two, or three acquisitions during the study period had a median $CAR_{P(-1,1)}$ (cumulative abnormal stock market return for acquirer/target portfolio combinations using the 3-day event window) of .0030. Acquirers completing four, five, or six acquisitions had a higher median $CAR_{P(-1,1)}$ of .0042. In contrast, the most highly acquisitive firms (those completing seven or more acquisitions during the study period) had the lowest median $CAR_{P(-1,1)}$, .0008. Therefore, it appears that acquisition experience creates value up to a threshold level of acquisition activity, then overload and diminishing returns set in (Haunschild, 1993). Furthermore, acquisition experience measures based on dollar *volume* of acquisitions (compared with those based on *number* of acquisitions) were even more strongly and significantly negatively associated with both announcement returns and longer-term cash flow returns (indicating, again, that a highly acquisitive record contributes to unfavorable financial outcomes). In addition, shareowner wealth destruction tends to be more strongly associated with a firm's *total* acquisition experience compared with the narrower medical device *industry* acquisition experience measure (signaling unfavorable market response to high-frequency and diversifying acquisition records).

Relative Size of Target to Acquirer. The multivariate regression analyses offered no evidence that relative size plays a significant role in explaining acquisition-related financial outcomes among medical device manufacturers.

Collar Provision. Conditional evidence identified negative market reaction to the presence of a collar provision in high-technology acquisitions. Collar provisions (which are adopted to protect target shareholders against downward movements in the acquiring firm's share price) are interpreted by the financial markets as a signal of risk, concern, or uncertainty surrounding the transaction, and this negative reaction is strongest in high-technology acquisitions. Managers and directors are therefore warned against the value-destroying signal conveyed by a collar provision surrounding high-technology acquisitions, and are advised to further communicate value-creating strategic rationale (in the case of speculative, high-risk acquisitions) or forego use of a collar provision (in the case of lower-risk acquisitions). The impact of collar provisions on cash flow returns is non-significant after a four-year post-acquisition evaluation period (and two- and three-year evaluation periods as well).

Use of Cash as a Method of Payment. Analyses produced intermittent evidence that the market favorably revalued stock prices following announcements of acquisitions that use cash as a method of payment. However, after two-, three-, and four-year post-acquisition cash flow evaluation periods, this effect is no longer significant.

Market Concentration. No evidence was found connecting pre-acquisition market concentration with change in pretax operating cash flow return on sales, and only weak evidence was ascertained for announcement returns. In the few regression estimations where a significant relationship was detected, lower stock price revaluations were associated with higher levels of market concentration. Mean and median year-to-year

changes in HHI were -.0033 and -.0020, indicating tendency toward less concentrated (more competitive) market structure. Consolidation via corporate acquisition during the study period was offset by (a) initial public offerings (IPOs) of previously privately owned companies such as Boston Scientific and Steris Corp (both of these firms conducted IPOs in 1992) and (b) sales growth among other small- to medium-sized publicly traded medical device manufacturers.

Merger (versus Partial Acquisition). Intermittent evidence was found linking positive stock price revaluations and acquisition of entire target firms (compared with purchasing only a portion of the target's assets such as a division or product line). The market anticipates greater ability among acquiring firms to effectively leverage acquired assets, technology, and strengths when all (and not just a portion) of the target organization is purchased. In longer-term models of cash flow returns, this effect is shown to be concentrated in small target organizations engaged in research and development activities.

Acquisition Propensity. The two controls for acquisition propensity were (a) acquirer and target Tobin's q (ratio of market-to-book value of assets) and (b) recent trend in overall stock market performance (change in S&P 500 index level during the last two full calendar quarters before acquisition announcement).

Target's Tobin's q. The market reacted positively to news that financially distressed organizations (as reflected in low Tobin's q values) are to be acquired. The pre-acquisition difficulties experienced by target organizations represent an optimistic

turnaround opportunity for the new corporate ownership. Acquisition of distressed targets is also related to subsequent improvement in longer-term cash flow returns, although this evidence is more intermittent.

Acquirer's Tobin's q. Among acquiring firms, partial evidence was found linking acquirer's financial distress with positive announcement returns (again evidencing expected operational improvement). However, acquirer's Tobin's q has little ability to predict cash flow returns.

Recent trend in overall stock market performance. The multivariate regression analyses offered no evidence that recent trend in overall stock market performance is a significant factor in explaining acquisition-related financial outcomes among medical device manufacturers.

Additional Implications

Implications for the Medical Device Literature. The most important finding from this doctoral research is strong and consistent empirical evidence that buying product innovation capability via corporate acquisition has been a value-creating strategy among medical device makers. Externally sourcing innovation via acquisition of target organizations with demonstrated ability to develop and improve medical devices (as indicated by the target's pre-acquisition patent yields and PMA approval ratios) predicts both favorable stock price revaluations at the time of acquisition announcement and positive longer-term cash flow returns. In the medical device industry, innovations that (a) improve diagnostic capabilities or therapeutic techniques; (b) extend life expectancy; (c) enhance quality of life; (d) prevent medical errors; (e) improve ease-of-use and labor

productivity among physicians, technicians, nurses, and therapists; (f) facilitate patient services in less expensive outpatient settings; (g) shorten patient recovery times; (h) reduce inpatient lengths of stay; (i) or avoid future inpatient hospitalizations are fundamental drivers of sales and earnings growth (Pollard and Persinger, 1987; Littell, 1994; Centers for Medicare and Medicaid Services, 2003; Burns, 2005; First Research, 2004; Gold, 2005; Iglehart, 2005; Pauly, 2005; Pearson and Rawlins, 2005). However, the cost of medical device technology is a problem for hospitals and other provider organizations.

Managing the Cost of Innovative Medical Devices. Given that (a) sourcing innovation via corporate acquisition has been a frequent and value-creating approach among medical device makers, (b) demand and cost growth persist for medical device technologies, and (c) physician preference items (PPIs) such as orthopedic implants and cardiac devices are, at present, the most expensive and under-managed types of medical products, *a six-point recommendation* is offered to hospitals, health systems, and physicians for identifying and achieving needed PPI cost controls (Burns et al, 2002; McGinnity, 2003; Burns 2005; World Research Group, 2006):

- Organize senior management leadership, materials management representatives, and key physicians into a well-supported, collaborative, and high-urgency teamwork approach;
- Engage physicians' attention and involvement with objective, clearly presented data on (a) procedure- and vendor-specific price, cost, reimbursement, margin,

volume, and physician preference profiles, and (b) variability in medical device pricing across and within hospitals, health systems, and physician practices;

- Involve physicians in negotiating with their preferred vendor(s) for lower pricing and other contracting terms;
- Strike a balance somewhere between the extremes of strict single-source product standardization and unlimited physician choice for medical devices (e.g., contract with a prudent number of vendors);
- Align physician-management incentives and interests (e.g., reinvest a significant proportion of achieved savings resulting from renegotiated prices and other cost control efforts back into the clinical specialty area); and
- Preserve and balance patient centricity, clinical quality, and financial responsibility.[68]

In addition, medical device innovation and costs imply (a) a personal responsibility shared by every American to make healthy lifestyle choices and (b) federal, state, and local support for health policies and programs that promote health and prevent disease.

[68] A simple but motivating PPI price renegotiation scenario follows. A multi-hospital system's anticipated spending on physician preference items during fiscal years 2007, 2008, 2009, and 2010, based on current contracts, is $40M, $44M, $49M, and $55M. If 1¾ percent of these amounts were avoided through PPI price contract renegotiations, the total overall savings would be $3.3M. Alternatively, a more conservative 1¼ percent reduction equates to a four-year savings of $2.4M. More optimistically, avoiding 2 percent in PPI prices paid would save a total of $3.8M.

Research Issues Arising from Contrasting the Medical Device Industry and Pharmaceutical/Biotechnology Sectors. In both the medical device and pharmaceutical/ biotechnology industries, (a) innovation is fundamental to revenue and earnings growth, (b) research and development require sizable investment in time and resources, and (c) waves of corporate acquisition activity have occurred and ongoing consolidation continues (Burns et al, 2002, Burns, 2005). The dissertation gives rise to three questions when the medical device industry is contrasted with the pharmaceutical/biotechnology sectors. First, why is interfirm strategic alliance activity more pervasive in the pharmaceutical/biotechnology sectors? Studies of alliance rationales, formation, composition, and performance among pharmaceutical and biotechnology firms are abundant (e.g., Baum, Calabrese, and Silverman, 2001; Oliver, 2001; George, Zahra, and Wood, 2002; Pangarkar, 2003; Rothaermel and Deeds, 2004; Danzon, Nicholson, and Pereira, 2005; Nicholson, Danzon, and McCullough, 2005; Santoro and McGill, 2005), but lacking in the medical device literature. Is the nature of alliance activity different in the medical device sector (e.g., greater emphasis among device firms on collaborating with selected physician experts versus larger scale interfirm collaboration)? Second, are patent awards more valuable in the pharmaceutical realm than in the medical device industry? One might expect this to be the case, especially with "patents around the composition of matter for new chemical entities" (Burns, 2005, p. 59). Third, do 510(k)-approved medical device products and "me-too" drugs (both imitative responses to competitors' R&D efforts and marketed products [Burns, 2005, p. 231]) have similar economic potential and limitations in the marketplace?

Implications for the Strategic Management Literature. The dissertation offers four findings of interest to the general strategic management literature. First, the strong result that externally sourcing product innovation capability via corporate acquisition has been a value-creating strategy among medical device makers provides insight into understanding "antecedents for predicting post-acquisition performance" (King et al, 2004, p. 187) and invites further related research in other industry contexts. Second, use of regulatory approval categories to derive indicators of innovation capability may also spur research questions in other regulated industries. Third, the thesis found positive and significant correlation coefficients between announcement returns (a measure of expected performance) and cash flow returns (a measure of realized performance). Specifically, the correlation coefficient between (a) cumulative abnormal stock market return for portfolio combinations of acquirer/target pairs using the 3-day event window, $CAR_{P(-1,1)}$, and (b) market-adjusted change in pretax operating cash flow return on sales using the 4-year post-acquisition period, $\Delta POCFROS_{P4}$, was .36 (p-value < .0001). This result provides evidence on the predictive association between stock market valuations around the announcement date and subsequent realized financial accounting performance, and corroborates the market efficiency hypothesis.[69] Fourth, the dissertation furnishes

[69] The short-run and longer-term regression estimations agreed that (a) buying innovation via corporate acquisition and operational turnarounds of financially distressed or inefficiently producing target organization are value-creating strategies and (b) being a high-frequency acquirer generally is a value-destroying approach. Nevertheless, differences in the strength and direction of predicted effects were found for several independent variables. For example, regression coefficients for target's pre-acquisition 510(k) clearance yields, presence of a collar provision, and use of cash as a method of payment were significant in announcement return models, but not significant in cash flow return models. Additional research is needed to discern whether (a) the magnitude of the effects faded from the short-term to the longer-term simply because of the passage of time and other corporate developments or (b) the market was over-sensitive to these

evidence that acquisition experience creates value up to a threshold level of acquisition activity, then overload and diminishing returns set in.

Reasonable and Questionable Motives for Corporate Acquisitions. The results of this dissertation research indicate that three *reasonable acquisition motives* in the medical device industry are (a) buying innovation, (b) improving the operations of a financially distressed or inefficiently producing target organization, and (c) building product lines along medical specialties. In contrast, (a) purchasing non-innovative target organizations with high 510(k) clearance counts relative to R&D expenditures, (b) being a high-frequency and diversifying acquirer, and (c) unduly adopting a collar provision are three *questionable acquisition moves*.

Limitations and Directions for Further Research

The research is subject to at least nine limitations (each of which offers opportunities for further study). First, additional variables that might be expected to influence acquisition-related financial outcomes (e.g., process and performance measures of pre-acquisition planning and due diligence; process and performance measures of post-acquisition integration; management style, experience, and skill; cultural fit between the acquiring and acquired organizations; product performance; sales and distribution infrastructure [Burns, 2005]) are unavailable. Omitted variables that (a) explain or predict performance and (b) are correlated with included measures will tend to affect the

---

effects at the time of announcement. In addition, building product lines along medical specialties was a non-significant measure around the time of acquisition announcement but predictive of cash flow returns in the longer-term models. This raises the question of whether the market systematically under-estimated the value of this approach.

accuracy of estimates by inflating the observed relationships.

Second, contemporaneous corporate news and events that are not directly related to the focal corporate union but occur during the announcement return event window or cash flow return evaluation period may confound the acquisition-related financial outcome measures. This is another form of omitted variable bias.

Third, selection bias is incompletely corrected for in the thesis. Snail and Robinson (1998) and Danzon, Epstein, and Nicholson (2004) observe that propensity to enter into an acquisition agreement and choice of acquisition partner are influenced by ex-ante organizational and industry conditions. The dissertation develops and assesses two measures to control for acquisition propensity: lagged Tobin's q and recent trend in equity market performance. Nevertheless, additional unmeasured characteristics of medical device firms and their senior managers further explain (a) whether and when to acquire, (b) whether and when to be acquired, and (c) choice of corporate partner. Decisions regarding whether, when, and with whom to partner remain endogenous and self-selected (Shaver, 1998), and the impact of selection bias on the results is not known.

Fourth, recent news reports of misleading and fraudulent accounting practices have reduced confidence in the accuracy and transparency of financial information reported in 10-K filings and annual reports. In response, the dissertation has incorporated Compustat's most recent restated financial data; however, the overall prevalence and impact of improper revenue recognition and earnings reporting on financial studies is unknown.

Fifth, the unit of analysis is the corporate transaction, but many of the available financial variables are at the overall firm level rather than the specific business unit level.

This limitation applies in acquisitions of less than 100 percent of the target organization (e.g., purchase of selected operations such as a division or subsidiary) where firm-level data are used in the analyses because transaction-specific revenue and expense data are not available.

Sixth, the post-acquisition evaluation period extends only four years after the transaction's effective date. This may not be long enough to complete post-acquisition integration processes and therefore may not capture the full, long-term impact of acquisition activity on firm financial performance. Nevertheless, the longer the announcement return event window or cash flow return evaluation period, the more difficult it becomes to isolate the impact of a corporate acquisition on financial performance.

Seventh, because fewer than one-quarter of the corporate transactions in the study (n = 63, or 23 percent) were diversifying acquisitions, this modest subsample is too small for reliable analysis and conclusions.

Eighth, the study sample consists of publicly owned medical device companies only. Complete and comparable historical financial data (e.g., annual pretax operating cash flow, annual research and development expenditures) for privately owned acquiring firms or target organizations are not available.

Ninth, because the research investigates firms producing in a single industry

(medical devices), it may be criticized for uncertain generalizability to other industries. Similarly, the results many not generalize to future periods within the medical device industry.[70]

---

[70] The annual number of corporate acquisitions in the medical device industry announced and completed during 2000-2005 (post-study years) was lower than the peak 1995-1998 period, comparable to the 1992-1994 period and the year 1999, and greater than the 1984-1991 period. The dissertation research will be extended into subsequent years as financial data for additional post-acquisition evaluation periods become available (e.g., the four-year post-acquisition evaluation period for corporate combinations completed during 2003 will extend through 2007). Forty examples of medical device industry acquisitions announced and completed during the period 2000-2005 include:

(i) Advanced Neuromodulation Systems Inc acquisition of Micronet Medical Inc; (ii) ArthroCare Corp acquisition of Opus Medical Inc; (iii) Baxter International Inc acquisition of Fusion Medical Technologies Inc; (iv) Biomet Inc acquisition of Interpore International Inc; (v) Boston Scientific Corp acquisition of Interventional Technologies Inc; (vi) Boston Scientific Corp acquisition of Advanced Bionics Corp; (vii) Cardiac Science Inc acquisition of Quinton Cardiology Systems Inc; (viii) Cardinal Health Inc acquisition of Alaris Medical Systems Inc; (ix) CONMED Corp acquisition of the endoscopic technologies product line of CR Bard Inc; (x) CR Bard Inc acquisition of the vena cava filter business of NMT Medical Inc; (xi) DJ Orthopedics Inc acquisition of the bone growth stimulation business of Orthologic Corp; (xii) Edwards Lifesciences Corp acquisition of the percutaneous heart valve technology of EV3 Inc; (xiii) Encore Medical Corp acquisition of EMPI Inc; (xiv) Endocare Inc acquisition of TIMM Medical Technologies Inc; (xv) GE Medical Systems acquisition of Imatron Inc; (xvi) Guidant Corp acquisition of X Technologies Inc; (xvii) Guidant Corp acquisition of AFx Inc; (xviii) Interpore International acquisition of American OsteoMedix Corp; (xix) Inverness Medical Technology Inc acquisition of Integ Inc; (xx) Johnson & Johnson acquisition of Heartport Inc; (xxi) Johnson & Johnson acquisition of the diabetes business of Inverness Medical Technology Inc; (xxii) MedAmicus Inc acquisition of BIOMEC Cardiovascular Inc; (xxiii) MedSource Technologies Inc acquisition of Cycam Inc; (xxiv) Medtronic Inc acquisition of Percusurge Inc; (xxv) Medtronic Inc acquisition of MiniMed Inc; (xxvi) Medtronic Inc acquisition of Medical Research Group Inc; (xxvii) Medtronic Inc acquisition of Spinal Dynamics; (xxviii) Medtronic Inc acquisition of Transneuronix Inc; (xxix) RITA Medical Systems Inc acquisition of Horizon Medical Products Inc; (xxx) SpectRx Inc acquisition of Sterling Medivations Inc; (xxxi) St Jude Medical Inc acquisition of Epicor Medical Inc; (xxxii) St Jude Medical Inc acquisition of Endocardial Solutions Inc; (xxxiii) St Jude Medical Inc acquisition of Advanced Neuromodulation Systems Inc; (xxxiv) Stryker Corp acquisition of the spinal implants business of Surgical Dynamics Inc, a unit of Tyco International; (xxxv) Stryker Corp acquisition of SpineCore Inc; (xxxvi)

Beyond the research opportunities suggested by these limitations, nine additional related post-dissertation research questions include:

- What determines whether acquisition or strategic alliance is selected as the corporate partnering type?
- What determines whether strategic alliance formation leads to corporate acquisition or partnership termination?
- What lessons can be learned from subsequent divestiture of previously acquired firms?
- Why are announcement returns not more responsive to building product lines along medical specialties?
- What explains the contradictory finding that large post-acquisition scale predicts (a) *negative* announcement returns (indicating market expectations for production quantities beyond optimal scale, a convex total cost curve, an upward sloping average cost curve, and decreasing returns to scale) (Nicholson, 1987; Pindyck and Rubinfeld, 1992; Carlton and Perloff, 1994) and (b) *positive* longer-term cash flow returns?

UTI Corp acquisition of MedSource Technologies Inc; (xxxvii) Viasys Healthcare Inc acquisition of Pulmonetic Systems Inc; (xxxviii) Vital Signs Inc acquisition of the disposable airway management device business of Baxter International Inc; (xxxix) Welch Allyn acquisition of Protocol Systems Inc; and (xl) Zimmer Holdings Inc acquisition of Implex Corp (source: Thomson One Banker).

- What are the determinants of financial outcomes among surviving target organizations?
- How should health care supply chain processes be designed and executed to better manage the cost of expensive and innovative physician preference items?
- What determines whether medical device firms (a) focus on internal research and development of new products and technologies (and refrain from external acquisitions), (b) focus on external acquisition of new products and technologies (and refrain from internal R&D), or (c) simultaneously pursue a dual strategy of internal R&D and external acquisition activity? How and why do these emphases change over time? In the long-run, is more financial success achieved by medical device firms through internal R&D or external acquisition?
- What policy implications and recommendations result from the tensions and trade-offs between (a) *profitability* in the medical device industry (e.g., shareowner wealth generation and funding corporate investment in further research and development to produce the next generation of medical technologies) and (b) *societal welfare and ethical concerns* (e.g., affordability of and wider access to innovative medical technology, especially among lower-income and/or uninsured citizens)?

Conclusion

The fundamental objective of this dissertation research is to investigate and explain conditions under which corporate acquisitions in the medical device industry have enhanced or eroded shareholder wealth and financial accounting performance. The work offers seven contributions to the health care, product innovation, strategic management, and financial economics literatures.

First, the thesis reports that buying product innovation capability via corporate acquisition has indeed created value for medical device manufacturers.

Second, medical device innovation capability among acquiring firms and target organizations is operationalized in an original way by distinguishing and evaluating the impact of *innovative* product introductions (measured by patent awards and FDA premarket application (PMA) approvals) and *imitative* product introductions (measured by FDA 510(k) clearances) on acquisition-related financial outcomes.

Third, the dissertation found:

- Strong evidence that building product lines along medical specialties via corporate acquisitions is antecedent to improvement in cash flow returns;
- Consistent evidence for corporate turnarounds and operational improvement among (a) target organizations with pre-acquisition production inefficiency and (b) targets and acquirers with low pre-acquisition Tobin's q values;
- Conditional evidence that the presence of a collar provision in high-technology acquisitions triggers negative market reaction;
- Intermittent evidence that (a) being a highly acquisitive firm works to hinder

financial outcomes, (b) use of cash as a method of payment contributes to favorable stock price revaluation, and (c) the ability to leverage acquired assets, technology, and strengths is greater when all (and not just a portion) of the target organization is purchased;

- Weak or no ability for (a) the relative size of the acquisition partners, (b) pre-acquisition market concentration, and (c) recent trend in overall stock market performance to explain acquisition-related financial outcomes among medical device manufacturers.

Fourth, these conclusions respond to King et al's (2004) challenge that "Empirical research has not consistently identified antecedents for predicting post-acquisition performance" (p. 187), Zollo and Singh's (2004) appeal that "...explanation of the variance around the mean is still very much in need of both theoretical and empirical work" (p. 1233), and Carow, Heron, and Saxton's (2004) observation that "the determination of factors that influence acquisition success remains an important research question" (p. 563).

Fifth, the research found a positive and significant association between announcement returns (a measure of expected performance) and cash flow returns (a measure of realized performance), thereby providing evidence in support of the market efficiency hypothesis.

Sixth, although (a) U.S. manufacturers shipped $69.24 billion in medical device products in 2004 (U.S. Census Bureau, 2005b), (b) medical device production accounted for 1.623 percent of total 2004 U.S. manufacturing output (U.S. Census Bureau, 2005a,

2005b), (c) the value of medical device product shipments nearly quintupled from $14.01 billion in 1983 to $69.24 billion in 2004 (equating to an annualized nominal growth rate of 7.9 percent), (d) medical device product shipments accounted for 0.590 percent of 2004 U.S. gross domestic product (that is, $1 of every $169.47 in overall output of goods and services was medical device manufacturing), and (e) firms in the medical device industry maintained an acquisition pace of one every three weeks during the dissertation study period, this segment of the health industry is strikingly underrepresented in the health services management literature (Burns, 2005).

Seventh, the realities of persistent demand and cost growth for innovative medical devices imply the practical recommendations (described earlier in this chapter) aimed at hospitals, health systems, physicians, and policymakers for controlling expenditures on physician preference items.

Appendix 1:
Coverage and Gaps in the Medical Device Literature

Despite its clinical importance and economic significance, the medical device industry is strikingly underrepresented in the health services management literature (Burns, 2005). The purpose of this appendix is to demonstrate an unresearched gap in the existing body of work concerning medical devices that is addressed by the dissertation. Published literature that investigates or addresses medical devices can be classified into 10 categories. Among the published studies and articles that incorporate medical devices, none examine the impact of corporate acquisitions on stock price and profitability, or whether externally sourcing product innovation via corporate acquisitions has been a value-creating strategy among medical device makers.

The first body of work, authored by Will Mitchell and colleagues, studies medical product firms to investigate operational expansion and contraction; organizational capabilities development; resource reconfiguration; firm and business unit survival; and market share performance. Investigations of medical device companies by Mitchell et al include:

- Recommendations for selling American medical equipment in Japan (Foote and Mitchell, 1989),
- Probability and timing of incumbents' entry into new diagnostic imaging subfields (Mitchell, 1989),
- Impact of market entry order on survival and market share among incumbents and newcomers in diagnostic imaging subfields (Mitchell, 1991),
- Consequences of growing or curbing international expansion on survival and market share in medical product sectors (Mitchell, Shaver, and Yeung, 1992; Mitchell, Shaver, and Yeung, 1993),

- Foreign entrant survival and market share penetration in U.S. medical product and health services markets (Mitchell, Shaver, and Yeung, 1994),
- Influence of business size and age on product market exits among medical product manufacturers (Mitchell, 1994),
- Effect of expanding into technical subfields on firm survival and market share among manufacturers of diagnostic imaging equipment (Mitchell and Singh, 1993; Mitchell and Singh, 1995),
- Impact of incremental product innovation on firm survival and market share among cardiac pacemaker producers (Banbury and Mitchell, 1995),
- Dynamics of new product design introductions in the early magnetic resonance imaging market (Martin and Mitchell, 1998),
- Internal and external methods of acquiring technological know-how for three types of technological change (encompassing, complementary, and incremental) among lithotripter manufacturers (Nagarajan and Mitchell, 1998),
- Resource-deepening and resource-extending reconfiguration of acquired product lines among medical product firms (Karim and Mitchell, 2000), and
- Retention, reconfiguration, and divestment of internally developed and externally acquired business units at Johnson & Johnson (Karim and Mitchell, 2004).

Prominent in this research stream is the use of nominal dependent variables to assess the occurrence and timing of events (e.g., whether a business unit was retained, whether a business unit was reconfigured, whether and when an organization introduced a new product design, whether and when an organization exited a product market). In the latter two articles, the dependent variables were (a) "the retention or disposal of a target's product line by the acquirer" (Karim and Mitchell, 2000, p. 1070) and (b) business unit retention or reconfiguration (Karim and Mitchell, 2004); neither measured actual value creation or value destruction. Additional outcome measures presented by Mitchell et al include years of participation in a product market, market share attained, and change in

market share percentage. The dissertation is distinguished from Mitchell's research in its use of acquisition-related stock price revaluations and financial accounting performance changes to demonstrate value creation or value destruction. The financial outcome measures in the dissertation feature a greater level of variance around mean values, thereby permitting analyses that capitalize on performance heterogeneity to assess conditions under which corporate acquisitions have enhanced or eroded shareholder wealth and financial accounting performance.

The second branch of the medical device literature is embedded in policy discussions concerning the relationships and trade-offs among (a) the additional clinical benefit provided by medical innovation, (b) further growth in national health expenditure levels, and (c) health status (Pollard and Persinger, 1987; Burns, 2005; Iglehart, 2005; Lubitz, 2005; Pauly, 2005; Pearson and Rawlins, 2005; Shekelle et al, 2005).

The third sector presents to specialized physicians clinical and procedural advances using new devices. Seven representative titles from this clinical practice literature are "A New Device for Safe and Easy Dilatation of the Carpal Canal in Endoscopic Surgical Treatment of the Carpal Tunnel Syndrome" (Horch, 1996), "Development of a 23.5 kHz Ultrasonically Activated Device for Laparoscopic Surgery" (Kanehira et al, 1998), "Heart Failure Management Using Implantable Devices for Ventricular Resynchronization" (Bristow, Feldman, and Saxon, 2000), "Radially-Expanding Access Device for Laparoscopic Surgery: Efficacy and Safety in Comparison with Sharp Laparoscopic Cannulae" (Galen, 2000), "Percutaneous Repair of Abdominal Aortic Aneurysms Using the AneuRx Stent Graft and the Percutaneous Vascular Surgery Device" (Howell et al, 2002), "Laparoscopic Gastric Bypass Surgery: Equipment and

Necessary Tools" (Carbonell et al, 2003), and "Hepatic Resections Using a Water-Cooled, High-Density, Monopolar Device: A New Technology for Safer Surgery" (DiCarlo et al, 2004).

The fourth category comprises meeting abstracts and full articles published in the medical literature that report the latest clinical outcome and cost-effectiveness findings involving medical devices. For example, a steady stream of clinical and economic assessments centering on coronary stents appears in journals such as Circulation, Heart, Journal of Invasive Cardiology, and Journal of the American College of Cardiology (e.g., Heuser et al, 2000; Bakhai et al, 2004; Cohen et al, 2004; Machecourt et al, 2004; Nathoe, Stella, and de Jaegere, 2005; van Hout et al, 2005).

The fifth category investigates innovation adoption by physicians and provider organizations. These writings address (a) diffusion of surgical technology and associated impact on physician productivity, cost, and clinical outcomes (e.g., Sloan et al, 1986; Ho, 2002; Cutler and Huckman, 2003; Knipp et al, 2004; Upchurch et al, 2004); (b) diffusion and adoption of expensive diagnostic imaging technology (Hillman and Schwartz, 1985, 1986; Teplensky et al, 1995), (c) impact of managed care, reimbursement incentives, and government policies on technology diffusion and adoption (Foote, 1992; Ramsey and Pauly, 1997; Baker, 2001; Baker and Phibbs, 2002), and (d) decision-making processes and timing of technology acquisition (Kimberly and Evanisko, 1981; Escarce, 1996; Friedman and Goes, 2000; Denis et al, 2002). Innovations presented to physicians outlined in the previous paragraph help stimulate the subject of this research area.

The sixth area of literature describes advances in design and production techniques. Many of these publications are the product of collaboration between

manufacturers and university faculty. Illustrative titles include "Process Optimisation in Pulsed Laser Micromachining with Applications in Medical Device Manufacturing" (Chen and Yao, 2000), "A Concurrent Engineering Approach for the Development of Medical Devices" (Das and Almonor, 2000), "Development of Surgical Instruments for Implanting a Flexible Fixation Device for the Lumbar Spine" (Leahy et al, 2000), "Application of Electron Spectroscopy and Surface Modification Techniques in the Development of Anti-Microbial Coatings for Medical Devices" (Sodhi, Sahi, and Mittelman, 2001), "Advanced Lithium Batteries for Implantable Medical Devices: Mechanistic Study of SVO Cathode Synthesis" (Takeuchi et al, 2003), "Production Planning for Medical Devices with an Uncertain Regulatory Approval Date" (Hill and Sawaya, 2004), and "Nanostructured Ceramics in Medical Devices: Applications and Prospects" (Narayan et al, 2004).

Seventh is a broad category that disseminates regulatory and patient safety information. These articles (a) provide updates, summaries, critiques, and guidance on pre- and post-market medical device regulations (e.g., Samuel, 1991; Pennington et al, 1996; Smith, 2001; Feigal, Gardner, and McClellan, 2003; Alfa and Castillo, 2004; Kessler et al, 2004; Maisel, 2004; Small, 2004; Malenka et al, 2005; Samore et al, 2005),[71] (b) describe manufacturing practices to enhance product performance and patient safety (Rooney, 2001; Schnoll, 2001), and (c) detail insights from cleaning and sterilization research to inform the Sterile Processing Departments of hospitals and surgery centers (Merritt, Hitchins, and Brown, 2000; Fichet et al, 2004; Kanemitsu et al,

[71] For example, Malenka et al (2005) and Samore et al (2005) review, critique, and recommend post-marketing surveillance practices and improved information sharing among providers, manufacturers, and regulatory agencies regarding adverse incidents and medical device risk.

2005). A synopsis of the medical device industry's regulatory, reimbursement, patent, and litigation environments begins on page 20.

Supply chain issues confronting medical device manufacturers and their trading partners is the eighth literature area. Specific areas of device manufacturer attention include (a) demand forecasting and production planning; (b) component sourcing and supplier selection; (c) upstream (supplier) and downstream (customer) contracting and pricing; (d) receiving and fulfilling customer orders; (e) product packaging; (f) product movement and storage; (g) inventory management; (h) customer training, support, maintenance, and repair services; (i) product marketing; (j) inter-organizational electronic data exchange and information systems; and (k) monitoring and influencing supply chain initiatives adopted by provider organizations, distributors, group purchasing entities, and other manufacturers; and (l) developing and using performance metrics to pursue margin-enhancing improvements in supply chain coordination, efficiency, and cost (Burns et al, 2002; Siau, 2003; Amini, Retzlaff-Roberts, and Bienstock, 2005; McKone-Sweet, Hamilton, and Willis, 2005).

The ninth category calls for further investment in medical equipment and supplies in developing nations. Three representative titles are "Medical Technologies in Developing Countries: Issues of Technology Development, Transfer, Diffusion and Use" (Bonair, Rosenfield, and Tengvald, 1989), "Selecting Medical Devices and Materials for Development in Korea: The Analytic Hierarchy Process Approach" (Cho and Kim, 2003), and "Achieving Appropriate Design and Widespread Use of Health Care Technologies in the Developing World" (Free, 2004).

The tenth set of medical device literature is a small residual category containing a

modicum of management studies written exclusive of Will Mitchell. Six such studies are (a) Robert Faulkner's (1998) documentation of superior post-IPO stock price performance for medical device start-up firms that had secured a PMA approval compared with start-ups having only premarket 510(k) clearance (Faulkner, 1998a, 1998b; Burns, 2005), (b) Gobeli and Rudelius' (1985) discussion of three stages in the innovation process (discovery, decision to pursue, and development) based on analysis of five cardiac pacemaker producers; (c) Teplensky et al's (1993) study of market entry strategies among magnetic resonance imaging manufacturers; (d) Rasheed, Datta, and Chinta's (1997) investigation of initial public offering pricing in the medical diagnostics and devices industry; (e) Yeheskel et al's (2001) analysis of strategic alliances among Israeli medical technology firms; and (f) Morrissey's (2004) assessment and clarification of medical device malfunction risk in hospitals posed by electromagnetic interference from cellular telephones and other wireless technologies.

Review of these ten medical device publication categories identifies a gap in the existing medical device research that is addressed by the dissertation: assessment of (a) acquisition-related stock price revaluations and financial accounting performance changes following corporate unions among medical device manufacturers and (b) value-creation following externally sourcing product innovation via corporate acquisitions.

Appendix 2:
Study Sample of Corporate Acquisitions

	Announcement Date	Acquirer Name	Target Name
1	05/18/84	Biomet Inc	Diasonics-OEC Orthopedic
2	10/22/84	Wakefield Engineering Inc	Birtcher Corp-Industrial Prod
3	12/07/84	Bristol-Myers Co	AMSCO/Hall Surgical
4	03/01/85	Baxter Travenol Laboratories	Compucare Corp
5	03/07/85	Sybron Corp	Cryogenic Associates Inc
6	03/18/85	Kendall Co(Colgate-Palmolive)	Procter & Gamble-Boundry Line
7	06/21/85	Baxter Travenol Laboratories	American Hospital Supply Corp
8	07/31/85	Electro-Biology Inc	Intermedics Inc-Scolitron Line
9	09/17/85	Kendall Co(Colgate-Palmolive)	American Hosp Supply-McGaw Div
10	12/19/85	International Minerals & Chem	Mallinckrodt Inc(Avon Products)
11	12/30/85	Teleflex Inc	Franklin Medical Ltd
12	01/24/86	CooperVision Inc	Cilco Inc,Richards Medical Co
13	03/06/86	Becton Dickinson & Co	Deseret Medical Inc
14	07/02/86	Circon Corp	American Cytoscope Makers
15	08/20/86	PPG Industries Inc	Hellige GmbH-Med Electronics
16	08/20/86	PPG Industries Inc	Honeywell-Medical Electronics
17	08/22/86	Revlon Group Inc	Frigitronics Inc
18	09/05/86	Pfizer Inc	Infusaid Inc(Intermedics Inc)
19	09/17/86	American Home Products Corp	Chesebrough-Pond's-Hosp Prod
20	10/14/86	ARTRA Group Inc	Sargent-Welch Scientific Co
21	12/01/86	Pfizer Inc	Angiomedics Inc
22	02/19/87	3M	Baxter Travenol Labs-Staplers
23	05/05/87	PPG Industries Inc	Allegheny Intl Medical
24	05/11/87	Baxter Travenol Laboratories	Caremark Inc
25	05/26/87	Stryker Corp	Hexcel Medical Corp(Hexcel)
26	09/09/87	Kendall McGaw Laboratories Inc	Quest Med-Intravenous Device
27	09/28/87	Biomet Inc	Electro-Biology Inc
28	01/21/88	Pfizer Inc	Cooper Lasersonics-Cavitron
29	05/27/88	Millipore Corp	Biosearch Inc
30	10/25/88	Wendt-Bristol Co	Temco Home Health Products
31	11/15/88	St Jude Medical Inc	Aries Medical Inc

Appendix 2:
Study Sample of Corporate Acquisitions
(continued)

	Announcement Date	Acquirer Name	Target Name
32	11/30/88	Birtcher Corp	Circadian Inc
33	12/06/88	Becton Dickinson & Co	Marion Lab-Scientific Prod Div
34	12/14/88	Mallinckrodt Inc(Avon)	Molecular Biosystems Inc
35	12/19/88	National Medical Care Inc	Infusion Care Inc(Avon Prod)
36	12/30/88	Bristol-Myers Squibb Co	Cooper Cos-Breast Implant
37	01/27/89	Varian Associates Inc	Machlett Laboratories
38	02/02/89	Bio-Medicus Inc	HemoTec Inc
39	03/17/89	Abbott Laboratories	Pancretec Inc
40	04/04/89	GENDEX Corp	Universal/Allied Imaging
41	07/05/89	American Shared Hospital Svcs	Northern California Vascular
42	08/24/89	CONMED Corp	Aspen Laboratories Inc
43	10/12/89	LecTec Corp	New Dimensions in Medicine
44	10/23/89	Birtcher Corp	CR Bard-Bard/EMS Electrosurgry
45	11/16/89	New Image Industries Inc	McGhan Instrumed Corp(Inamed)
46	01/16/90	SpaceLabs Inc	First Medical Devices Corp
47	01/31/90	ALZA Corp	Medtronic-Electrotransport Bus
48	04/09/90	Taunton Technologies Inc	VISX Inc
49	04/20/90	Bristol-Myers Squibb Co	Concept Inc
50	05/16/90	Medtronic Inc	Bio-Medicus Inc
51	07/10/90	Henley International Inc	White Knight Healthcare Inc
52	10/24/90	Air & Water Technologies Corp	Laser Precision-Analytical Div
53	11/15/90	Graham-Field Health Products	Bunn/Xorbox Group-Most Assets
54	12/05/90	Basic American Medical Inc	Kinetic Concepts-Certain Asts
55	02/28/91	CONMED Corp	Linvatec Corp-Certain Assets
56	03/01/91	HTL Industries Inc	Xcor Intl-Patents,Trademarks
57	03/20/91	Hycor Biomedical Inc	Ventrex Laboratories Inc
58	04/04/91	Becton Dickinson & Co	Collaborative-Biomedical Div
59	05/10/91	Hanger Orthopedic Group Inc	Snell's Limb & Brace
60	05/30/91	Quest Medical Inc	Healthdyne Cardiovascular-Asts
61	06/05/91	Stryker Corp	Prab Robots-Robot Prodn Plant
62	06/10/91	Avecor Inc(MA Hanna Co)	SciMed Life Sys-Surgical Div

Appendix 2:
Study Sample of Corporate Acquisitions
(continued)

	Announcement Date	Acquirer Name	Target Name
63	06/12/91	Henley International Inc	Argon Medical Corp-Cert Asts
64	07/22/91	GENDEX Corp	Philips Dental Sys SRL
65	09/20/91	Teleflex Inc	Pilling Co(Healthdyne)
66	11/06/91	Vital Signs Inc	Biomedical Dynamics Corp
67	11/12/91	ALZA Corp	Bio-Electro Systems Inc
68	11/18/91	NovaCare Inc	Orthopedic Services Inc
69	12/19/91	Hanger Orthopedic Group Inc	York Prosthetics Inc
70	03/02/92	Hanger Orthopedic Group Inc	Caretenders-DOBI-Simplex Div
71	03/13/92	Cabot Medical Corp	Surgitek(Bristol-Myers Squibb)
72	04/30/92	Zimmer Inc(Bristol-Myers Co)	Origin Medsystems-Orthopedic
73	05/14/92	Medical Technology Systems Inc	Vangard Labs(Ownes & Minor)
74	06/17/92	Tecnol Medical Products Inc	Becton Dickinson-Product Line
75	08/03/92	Mentor O&O Inc(Mentor Corp)	Bio-Rad Labs-Opthalmic Div
76	08/18/92	Hanger Orthopedic Group Inc	Advanced Orthopedic Appliance
77	09/30/92	Sensormatic Electronics Corp	Security Tag Systems Inc
78	10/29/92	Staodyn Inc	Technical Medical Dev-Med Thpy
79	11/18/92	Empi Inc	Medtronic Inc-Nortech Division
80	12/18/92	NAMIC USA Corp	Sherwood Medical
81	12/31/92	Hanger Orthopedic Group Inc	Lenox Hill (3M)
82	02/02/93	Bausch & Lomb Inc	Dahlberg Inc
83	05/03/93	Fisher Imaging Corp	Varian Assoc Inc-X-Ray
84	05/24/93	Maxxim Medical Inc	Johnson & Johnson Medl-Sterile
85	06/04/93	EG&G Inc	Wallac(Pharmacia AB)
86	06/08/93	Boston Scientific Corp	Datascope Corp-Angioplasty Div
87	06/11/93	CONMED Corp	Andover Medical Inc
88	06/17/93	Meridian Diagnostics Inc	Ortho Diagnostic Sys-Prod Line
89	06/23/93	Corning Inc	Costar Corp
90	09/01/93	Hanger Orthopedic Group Inc	3M Health Care-Knee Brace Bus
91	09/27/93	Innovex	Daig Corp-Permanent Lead Wire
92	10/07/93	Spectranetics Corp	Advanced Interventional Sys
93	11/16/93	Teleflex Inc	Edward Weck Inc-Certain Assets

Appendix 2:
Study Sample of Corporate Acquisitions
(continued)

	Announcement Date	Acquirer Name	Target Name
94	11/19/93	Medtronic Inc	Electromedics Inc
95	12/13/93	Sparta Surgical Corp	Storz Inst-Certain Assets
96	01/03/94	Arrow Electronics Inc	Field Oy
97	01/20/94	Health o meter Products Inc	Mr. Coffee Inc
98	02/10/94	Advanced Technology Labs	Interspec Inc
99	02/10/94	ADAC Laboratories	Philips Medical Systems-Patent
100	03/15/94	Innovex	Possis Medical-Pacemaker Leads
101	03/31/94	Baxter International Inc	Intramed Laboratories Inc
102	04/08/94	Marquette Electronics Inc USA	Corometrics Medical Systems
103	05/31/94	Community Health Computing	DuPont-DuPont Radiology Info
104	06/03/94	Protocol Systems Inc	Stuart Medical Inc-Patents
105	06/27/94	Biomet Inc	Kirschner Medical Corp
106	06/30/94	Bio-Logic Systems Corp	Neuro Diagnostics Inc
107	07/14/94	Tyco International Ltd	Kendall International Inc
108	08/31/94	Boston Scientific Corp	Cardiovascular Imaging Systems
109	09/20/94	Palomar Medical Technologies	Spectrum Technologies Inc
110	09/21/94	Minntech Corp	CR Bard-Interventional-Endosco
111	10/13/94	Varian Associates Inc	Eureka X-Ray Tube-X-Ray Tube
112	10/31/94	Pfizer Inc	NAMIC USA Corp
113	11/03/94	CONMED Corp	Becton Dickinson Vascular-EKG
114	11/03/94	CONMED Corp	Birtcher Medical Systems Inc
115	11/08/94	Boston Scientific Corp	SciMed Life Systems Inc
116	12/09/94	Alba-Waldensian Inc	Baxter Healthcare-Pulsatile
117	12/16/94	Mallinckrodt Group Inc	JT Baker Inc(Richardson-Vicks)
118	12/20/94	Physics International Co	Hewlett-Packard Co-Flash X-Ray
119	01/04/95	Johnson & Johnson	Mitek Surgical Products
120	02/06/95	Medtronic Inc	Johnson & Johnson Interven Sys
121	02/16/95	Maxxim Medical Inc	COBE Cardiovascular(COBE Lab)
122	02/23/95	EBI Medical Systems(Biomet)	Personal Diagnost-Mnfring Asts
123	03/06/95	Fidelity Medical Inc	Chester Holdings-Certain Asts
124	03/06/95	Chiron Vision(Chiron Corp)	IOLAB-Ophthalmic Surgical Div

Appendix 2:
Study Sample of Corporate Acquisitions
(continued)

	Announcement Date	Acquirer Name	Target Name
125	04/25/95	Minntech Corp	Amicon Inc-Hemoconcentrator
126	04/25/95	Circon Corp	Cabot Medical Corp
127	05/03/95	Advanced NMR Systems	Medical Diagnostics Inc
128	05/08/95	ICN Pharmaceuticals Inc	Becton Dickinson-Division
129	05/09/95	Aequitron Medical Inc	CNS Inc-Sleep Disorders Diagno
130	05/22/95	Nellcor Inc	Puritan-Bennett
131	05/24/95	CR Bard Inc	MedChem Products Inc
132	06/01/95	Maxxim Medical Inc	Becton Dickinson & Co-Worlwide
133	06/09/95	Thermo Electron Corp	Bird Medical Technologies Inc
134	07/28/95	Thera-Kinetics Inc(MEDIQ Inc)	Heart Labs of Amer-Continuous
135	08/01/95	Baxter Healthcare Corp	Advanced Cardiovascular Sys-In
136	08/15/95	Isolyser Co Inc	White Knight Healthcare Inc
137	08/30/95	Boston Scientific Corp	Heart Technology Inc
138	09/12/95	UroHealth Systems Inc	Advanced Surgical Inc
139	09/20/95	US Surgical Corp	3M Health Care-Internal Stapli
140	10/03/95	Tokos Medical Corp	Healthdyne Inc
141	10/04/95	Coherent Inc	Applied Laser Sys-Laser Diode
142	10/05/95	Cordis Corp	Scherer Healthcare Inc-Certain
143	10/06/95	Boston Scientific Corp	EP Technologies Inc
144	10/18/95	CONMED Corp	New Dimensions in Med-Certain
145	10/19/95	Johnson & Johnson	Cordis Corp
146	11/06/95	Marquette Electronics Inc USA	E For M Corp
147	11/07/95	US Surgical Corp	Surgical Dynamics Inc(E-Z-EM)
148	11/15/95	Cantel Industries Inc	MediVators Inc
149	12/01/95	AlaTenn Resources Inc	Chiron Vision(Chiron Corp)
150	12/11/95	Tecnol Medical Products Inc	Sparta Surgical Corp-Wound
151	12/12/95	CR Bard Inc	St Jude Medical Inc-Cardiac
152	12/18/95	Steris Corp	AMSCO International
153	12/18/95	Del Global Technologies Corp	Gendex Medical-Certain Assets
154	01/18/96	Pfizer Inc	Corvita Corp
155	01/26/96	Boston Scientific Corp	Symbiosis(American Home Prods)

Appendix 2:
Study Sample of Corporate Acquisitions
(continued)

	Announcement Date	Acquirer Name	Target Name
156	01/30/96	St Jude Medical Inc	Daig Corporation
157	02/05/96	Thermo BioAnalysis(Thermo)	Dynatech Laboratories
158	02/20/96	International Remote Imaging	UroHealth Systems Inc-Davstar
159	02/20/96	Protocol Systems Inc	Pyron Corp(Zemex Corp)
160	02/26/96	Maxxim Medical Inc	Sterile Concepts Inc
161	03/11/96	Nellcor Puritan-Bennett	Infrasonics Inc
162	03/14/96	Fuqua Enterprises Inc	LUMEX Division(Lumex Inc)
163	03/18/96	Isolyser Co Inc	Microtek Medical Inc
164	03/25/96	Medtronic Inc	InStent Inc
165	03/29/96	Abbott Laboratories	MediSense Inc
166	04/08/96	ReSound Corp	MN Mining&Mnfr-Hearing Health
167	04/17/96	Kendall Intl(Tyco Intl)	Nashua Corp-Tape Products Div
168	06/17/96	Graham-Field Health Products	Everest & Jennings Intl
169	06/17/96	US Diagnostic Labs Inc	MediTek Health Corp
170	07/19/96	Hologic Inc	FluoroScan Imaging Systems
171	07/22/96	Orthologic Corp	Sutter Corp(Smith Labs Inc)
172	08/26/96	Advanced Medical Inc	IVAC Medical Systems Inc
173	09/10/96	Nellcor Puritan-Bennett	Aequitron Medical Inc
174	10/01/96	Tecnol Medical Products Inc	Ballard Medical-Safety Shield
175	10/02/96	NovaCare Inc	Advanced Orthopedic Tech
176	10/04/96	Medtronic Inc	Raychem Corp-Patents & Related
177	10/23/96	Diametrics Medical Inc	Biomedical Sensors(Pfizer Inc)
178	10/23/96	St Jude Medical Inc	Ventritex
179	11/13/96	FCY Inc	Medex Inc
180	11/27/96	Steris Corp	Calgon Vestal Lab-Infection
181	12/04/96	Baxter International Inc	Research Medical Inc
182	01/16/97	SelfCare Inc	Amer Home Products-Nutritional
183	01/20/97	Boston Scientific Corp	Target Therapeutics Inc
184	01/27/97	EndoSonics Corp	Cardiometrics Inc
185	02/11/97	Johnson & Johnson	Innotech Inc
186	03/12/97	Orthologic Corp	Danninger Medical-Continous

Appendix 2:
Study Sample of Corporate Acquisitions
(continued)

	Announcement Date	Acquirer Name	Target Name
187	03/14/97	Vital Signs Inc	Marquest Medical Products Inc
188	03/21/97	Megas Beauty Care Inc	American White Cross-Cotton
189	03/31/97	Thermo Cardiosystems Inc	International Technidyne Corp
190	04/09/97	UroMed Corp	Johnson & Johnson Med-Introl
191	04/16/97	GE Medical Systems	Lockheed Martin Medical
192	04/21/97	UroHealth Systems Inc	Imagyn Medical Inc
193	05/08/97	Nicolet Biomedical Inc	Imex Medical Systems Inc
194	05/22/97	Johnson & Johnson	Biopsys Medical Inc
195	07/15/97	Thermo Optek Corp	Spectronic Instruments Inc
196	07/24/97	Mallinckrodt Inc	Nellcor Puritan-Bennett
197	07/31/97	Allegiance Healthcare Corp	Kendall Health-Respiratory
198	08/12/97	Steris Corp	Isomedix Inc
199	08/19/97	GE Medical Systems	Advanced NMR Sys-Whole Body
200	08/25/97	SpaceLabs Medical Inc	Ameritech Knowledge Data Inc
201	09/04/97	Kimberly-Clark Corp	Tecnol Medical Products Inc
202	10/01/97	US Surgical Corp	Alexion Pharm-Xenograft Mnfr
203	10/01/97	Henley Healthcare	CYBEX Intl-Isokinetic
204	10/06/97	Guidant Corp	EndoVascular Technologies Inc
205	10/20/97	Bausch & Lomb Inc	Chiron Vision(Chiron Corp)
206	10/20/97	MiniMed Inc	Home Medical Supply Inc
207	10/22/97	Bausch & Lomb Inc	Storz Instrument Co
208	11/05/97	Arrow International Inc	Boston Scientific-Cardiac
209	11/11/97	Respironics Inc	Healthdyne Technologies Inc
210	11/11/97	Medical Action Industries Inc	3M-Sterilization Pouches
211	11/21/97	Becton Dickinson & Co	MedPlus Inc-IntelliCode
212	11/26/97	CONMED Corp	Linvatec Corp(Bristol-Myers)
213	12/02/97	Rehabilicare Inc	Staodyn Inc
214	12/09/97	US Surgical Corp	Valleylab Inc(Pfizer Inc)
215	12/17/97	InvaCare Corp	Suburban Ostomy Supply Co Inc
216	12/22/97	Tyco International Ltd	Sherwood-Davis & Geck
217	12/29/97	Hewlett-Packard Co	Heartstream Inc

Appendix 2:
Study Sample of Corporate Acquisitions
(continued)

	Announcement Date	Acquirer Name	Target Name
218	01/20/98	Rofin-Sinar Technologies Inc	Palomar Technologies Ltd
219	01/29/98	Becton Dickinson & Co	Ohmeda-Medical Devices Div
220	02/12/98	Interpore International	Cross Medical Products Inc
221	05/20/98	GE Medical Systems	InnoServ Technologies
222	05/20/98	ALARIS Medical Inc	InvaCare Infusion Systems
223	05/25/98	Tyco International Ltd	US Surgical Corp
224	06/16/98	Boston Scientific Corp	Schneider Worldwide
225	06/29/98	Medtronic Inc	Physio-Control International
226	07/09/98	Arterial Vascular Engineering	CR Bard Inc-Coronary Catheter
227	07/13/98	Medtronic Inc	AVECOR Cardiovascular Inc
228	07/21/98	Johnson & Johnson	Depuy Inc(Corange Ltd)
229	07/21/98	Stryker Corp	Howmedica(Pfizer Inc)
230	07/30/98	Utah Medical Products Inc	Bard Access Systems Inc
231	07/31/98	American Dental Technologies	Dental Vision Direct Inc
232	08/03/98	Eastman Kodak Co Inc	Imation-Medical Imaging Bus
233	08/04/98	Guidant Corp	InControl Inc
234	08/07/98	Rehabilicare Inc	Henley Healthcare Inc-Homecare
235	08/10/98	Arrow International Inc	CR Bard Inc-Intra-Aortic
236	09/11/98	GE Medical Systems	Elscint-Nuclear & MRI Business
237	09/18/98	Horizon Medical Products Inc	Ideas for Medicine-Prod Line
238	09/18/98	GE Medical Systems	Marquette Medical Systems Inc
239	09/21/98	Guidant Corp	SulzerMedica-Electrophysiology
240	10/01/98	Summit Technology Inc	Autonomous Technologies Corp
241	10/05/98	Johnson & Johnson	FemRx Inc
242	10/14/98	Becton Dickinson & Co	Luther Medical Products Inc
243	10/22/98	Escalon Medical Corp	Cardiovascular Dynamics-Unit
244	10/22/98	Eclipse Surgical Technologies	CardioGenesis Corp
245	11/02/98	Medtronic Inc	Sofamor Danek Group Inc
246	11/02/98	Coherent Inc	Star Medical Technologies Inc
247	11/20/98	Maxxim Medical Inc	Circon Corp
248	11/30/98	Medtronic Inc	Arterial Vascular Engineering

Appendix 2:
Study Sample of Corporate Acquisitions
(continued)

	Announcement Date	Acquirer Name	Target Name
249	12/21/98	LifeQuest Medical Inc	Dexterity Inc(Teleflex Inc)
250	12/23/98	Kimberly-Clark Corp	Ballard Medical Products
251	02/05/99	St Jude Medical Inc	Tyco Intl Ltd-Angio-Seal Bus
252	02/23/99	Medical Action Industries Inc	Acme United-Med Products Div
253	02/26/99	Sterile Recoveries Inc	National Service-NPAC Div
254	03/16/99	Plexus Corp	SeaMED Corp
255	04/05/99	Hanger Orthopedic Group	NovaCare Orthotics
256	06/03/99	Chemfab Corp	Uroquest Medical Corp
257	06/29/99	Sabratek Corp	SRS Labs Inc
258	07/08/99	Abbott Laboratories	Perclose Inc
259	07/12/99	Lifestream International Inc	Minntech-Cert Cardio Assets
260	07/13/99	CONMED Corp	3M Healthcare-Powered Instr
261	07/16/99	Applied Imaging Corp	Vysis Inc-Cytogenic Imaging
262	07/21/99	Merit Medical Systems Inc	Mallinckrodt-Diagnostic Prod
263	08/09/99	GE Medical Systems	OEC Medical Systems Inc
264	08/23/99	Tyco International Ltd	General Surgical Innovations
265	08/26/99	Xomed Surgical Products Inc	Mentor Corp-Opthalmic Business
266	08/27/99	Medtronic Inc	Xomed Surgical Products Inc
267	08/30/99	Guidant Corp	CardioThoracic Systems Inc
268	09/23/99	Angeion Corp	Medical Graphics Corp
269	10/05/99	PerkinElmer Inc	Vivid Technologies Inc
270	10/18/99	Pardigm Medical Industries	Mentor Corp-Ophthalmics Phaco
271	11/09/99	Johnson & Johnson	Innovasive Devices Inc
272	11/18/99	Ortho-McNeil Pharmaceutical	Cygnus Inc-Drug Delivery
273	11/29/99	GE Medical Systems	Mecon Inc

Appendix 3
SDC Database of Worldwide Mergers and Acquisitions
Completeness Check

Cardinal Health, Inc.
Acquisition Activity, 1978-1995

Acquisitions by Cardinal Health, 1978-1995 (n = 12)

	Year	Target Name	Target's Primary 4-Digit SIC Code
1	1979	Bailey Drug Company	5122: Wholesale Trade / Non-Durable Goods / Drugs
2	1984	Ellicott Drug Company	5122: Wholesale Trade / Non-Durable Goods / Drugs
3	1986	James W. Daly, Inc.	5122: Wholesale Trade / Non-Durable Goods / Drugs
4	1987	Marmac Distributors, Inc.	5122: Wholesale Trade / Non-Durable Goods / Drugs
5	1990	Ohio Valley-Clarksburg, Inc.	5122: Wholesale Trade / Non-Durable Goods / Drugs
6	1991	Chapman Drug Company	5122: Wholesale Trade / Non-Durable Goods / Drugs
7	1993	Solomons Company	5122: Wholesale Trade / Non-Durable Goods / Drugs
8	1993	Whitmire Distribution Corporation	5122: Wholesale Trade / Non-Durable Goods / Drugs
9	1993	PRN Services, Inc.	5122: Wholesale Trade / Non-Durable Goods / Drugs
10	1994	Humiston-Keeling, Inc.	5122: Wholesale Trade / Non-Durable Goods / Drugs
11	1994	Behrens, Inc.	5122: Wholesale Trade / Non-Durable Goods / Drugs
12	1995	Medicine Shoppe International, Inc.	5912: Retail Trade / Drug Stores and Proprietary Stores

Appendix 4:
Statement on the Importance of Shareowner Value Creation

Shareowner value creation by businesses (including medical device manufacturers) underlies the health, stability, and growth of our society. Roberto Goizueta, the late Chairman and Chief Executive Officer of The Coca-Cola Company, articulated this view in the 1996 Annual Report to Shareowners:

> "Our publicly stated mission is to create value over time for the owners of our business. In fact, in our society, that is the mission of any business: to create value for its owners. Why? The answer can be summed up in three reasons. First, increasing shareowner value over time is the job our economic system demands of us. Creating value is a core principle on which our economic system is based. A sick company is a drag on the social order of things. It cannot sustain jobs, much less widen the opportunities available to its employees. It cannot serve customers. It cannot give to philanthropic causes. Second, if we do our jobs, we can contribute to society in very meaningful ways. Among our owners are university endowments, philanthropic foundations, and other similar nonprofit organizations. If The Coca-Cola Company is worth more, those foundations have more to give. There is a beneficial ripple effect throughout society. Third, focusing on creating value over the long term keeps us from acting shortsighted. The exercise of what is commonly referred to as "corporate responsibility" is a rational, logical corollary of a company's essential responsibility to the long-term interests of its shareowners."

REFERENCES CITED

Aiken, Leona S. and Stephen G. West (1991) Multiple Regression: Testing and Interpreting Interactions. Newbury Park, CA: Sage Publications.

Ailawadi, Kusum L., Scott A. Neslin and Karen Gedenk (2001) "Pursuing the Value-Conscious Consumer: Store Brands versus National Brand Promotions" Journal of Marketing. Vol. 65, No. 1, pp. 71-89.

Alexander, Jeffrey A., John R.C. Wheeler, Tammie A. Nahra, and Christy Harris Lemak (1998) "Managed Care and Technical Efficiency in Outpatient Substance Abuse Treatment Units" Journal of Behavioral Health Services and Research. Vol. 25, No. 4, pp. 377-396.

Alfa, Michelle J. and Janet Castillo (2004) "Impact of FDA Policy Change on the Reuse of Single-Use Medical Devices in Michigan Hospitals" American Journal of Infection Control. Vol. 32, No. 6, pp. 337-341.

Allison, Paul D. (1978) "Measures of Inequality" American Sociological Review. Vol. 43, No. 6, pp. 865-880.

Amini, M. Mehdi, Donna Retzlaff-Roberts, and Carol C. Bienstock (2005) "Designing a Reverse Logistics Operation for Short Cycle Time Repair Services" International Journal of Production Economics. Vol. 96, No. 3, pp. 367-380.

Anand, Jaideep and Harbir Singh (1997) "Asset Redeployment, Acquisitions and Corporate Strategy in Declining Industries" Strategic Management Journal. Vol. 18, Special Issue, pp. 99-118.

Appelbaum, A.L. (1979) "Cost Containment Pressures Make Suppliers Partners in Productivity" Hospitals. Vol. 53, No. 1 pp. 75-78.

Asquith, Paul, Robert F. Bruner, and David W. Mullins, Jr. (1983) "The Gains to Bidding Firms from Merger" Journal of Financial Economics. Vol. 11, No. 1-4, pp. 121-139.

Bain, Joe S. (1951) "Relation of Profit Rate to Industry Concentration: American Manufacturing, 1936-1940" Quarterly Journal of Economics. Vol. 65, pp. 293-324.

Baker, Laurence C. (2001) "Managed Care and Technology Adoption in Health Care: Evidence from Magnetic Resonance Imaging" Journal of Health Economics. Vol. 20, No. 3, pp. 395-421.

Baker, Laurence C. and Ciaran S. Phibbs (2002) "Managed Care, Technology Adoption, and Health Care: The Adoption of Neonatal Intensive Care" Rand Journal of Economics. Vol. 33, No. 3, pp. 524-548.

Bakhai, A., G. Stone, M.A. Clark, T. Lavelle, C.X. Shi, F. Berezin, M. Lacey, and D. Cohen (2004) "Cost-Effectiveness of the TAXUS (TM) Paclitaxel-Eluting Coronary Stent System vs. Bare Stent Implantation in Patients Without Routine Angiographic Follow-up: The TAXUS-IV Trial" Circulation. Vol. 110, No. 17, p. 826.

Banbury, Catherine and Will Mitchell (1995) "The Effect of Introducing Important Incremental Innovations on Market Share and Business Survival" Strategic Management Journal. Vol. 16, Special Issue, pp. 161-182.

Barney, Jay (1991) "Firm Resources and Sustained Competitive Advantage" Journal of Management. Vol. 17, No. 1, pp. 99-120.

Baum, Joel A.C., Tony Calabrese, and Brian S. Silverman (2000) "Don't Go It Alone: Alliance Network Composition and Startups' Performance in Canadian Biotechnology" Strategic Management Journal. Vol. 21, No. 3, pp. 267-294.

Baum, Joel A.C. and Paul Ingram (1998) "Survival-Enhancing Learning in the Manhattan Hotel Industry, 1989-1980" Management Science. Vol. 44, No. 7, pp. 996-1016.

Bergh, Donald D. (2001) "Executive Retention and Acquisition Outcomes: A Test of Opposing Views on the Influence of Organizational Tenure" Journal of Management. Vol. 27, No. 5, pp. 603-622.

Berk, Richard A. (1990) "A Primer on Robust Regression" in Modern Methods of Data Analysis (John Fox and J. Scott Long, eds). Newbury Park, CA: Sage Publications.

Berkovitch, Elazar and M.P. Narayanan (1990) "Competition and the Medium of Exchange in Takeovers" Review of Financial Studies. Vol. 3, No. 2, pp. 153-174.

Blau, Gary (1999) "Testing the Longitudinal Impact of Work Variables and Performance Appraisal Satisfaction on Subsequent Overall Job Satisfaction" Human Relations. Vol. 52, No. 8, pp 1099-1113.

Bonair A., P. Rosenfield, and K. Tengvald (1989) "Medical Technologies in Developing Countries: Issues of Technology Development, Transfer, Diffusion and Use" Social Science & Medicine. Vol. 28, No. 8, pp. 769-781.

Bowers, Helen M. and Robert E. Miller (1990) "Choice of Investment Banker and Shareholders' Wealth of Firms Involved in Acquisitions" Financial Management. Vol. 19, No. 4, pp. 34-44.

Bradley, Michael, Anand Desai, and E. Han Kim (1988) "Synergistic Gains from Corporate Acquisitions and Their Division Between the Stockholders of Target and Acquiring Firms" Journal of Financial Economics. Vol. 21, No. 1, pp. 3-40.

Brealey, Richard A. and Stewart C. Myers (1988) Principles of Corporate Finance (3rd Edition). New York: McGraw-Hill.

Bristow M.R., A.M. Feldman, and L.A. Saxon (2000) "Heart Failure Management Using Implantable Devices for Ventricular Resynchronization" Journal of Cardiac Failure. Vol. 6, No. 3, pp. 276-285.

Brous, Peter A. and Omesh Kini (1994) "The Valuation Effects of Equity Issues and the Level of Institutional Ownership: Evidence from Analysis Earnings Forecasts" Financial Management. Vol. 23, No. 1, pp. 33-46.

Broussard, John P., Sheree A. Buchenroth, and Eugene A. Pilotte (2004) "CEO Incentives, Cash Flow, and Investment" Financial Management. Vol. 33, No. 2, pp. 51-70.

Brown, David T. and Michael D. Ryngaert (1991) "The Mode of Acquisition in Takeovers: Taxes and Asymmetric Information" Journal of Finance. Vol. 46, No. 2, pp. 653-669.

Brown, Stephen J. and Jerold B. Warner (1985) "Using Daily Stock Returns: The Case of Event Studies" Journal of Financial Economics. Vol. 14, No. 1, pp. 3-31.

Bruton, Garry D., Benjamin M. Oviatt, and Margaret A. White (1994) "Performance of Acquisitions of Distressed Firms" Academy of Management Journal. Vol. 37, No. 4, pp. 972-989.

Burns, Lawton R. (2005) The Business of Healthcare Innovation. Cambridge: Cambridge University Press.

Burns, Lawton R., Jon A. Chilingerian, and Douglas R. Wholey (1994) "The Effect of Physician Practice Organization on Efficient Utilization of Hospital Resources" Health Services Research. Vol. 29, No. 5, pp. 583-603.

Burns, Lawton R., Sean Nicholson, and John Evans (2005) "Mergers, Acquisitions, and the Advantages of Scale in the Pharmaceutical Industry" Chapter 3 in Burns, Lawton R. (ed.), The Business of Healthcare Innovation by Cambridge: Cambridge University Press.

Burns, Lawton R. and Wharton School Colleagues (2002) The Health Care Value Chain: Producers, Purchasers, and Providers. San Francisco: Jossey-Bass.

Campbell, John Y., Andrew W. Lo, and A. Craig MacKinlay (1997) The Econometrics of Financial Markets. Princeton: Princeton University Press.

Cannella, Albert A. and Wei Shen (2001) "So Close and Yet So Far: Promotion Versus Exit for CEO Heirs Apparent" Academy of Management Journal. Vol. 44, No. 2, pp. 252-270.

Capron, Laurence (1997) "Value Creation Mechanisms in Horizontal Mergers and Acquisitions: A Test of Efficiency, Market Power, and Resource-Based Arguments" Working Paper, Richard Ivey School of Business, University of Western Ontario.

Capron, Laurence, Pierre Dussauge, and Will Mitchell (1998) "Resource Redeployment Following Horizontal Acquisitions in Europe and North America, 1988-1992" Strategic Management Journal. Vol. 19, No. 7, pp. 631-661.

Capron, Laurence and Nathalie Pistre (2002) "When Do Acquirers Earn Abnormal Returns?" Strategic Management Journal. Vol. 23, No. 9, pp. 781-794.

Carbonell, Alfredo M., Charles S. Joels, Ronald F. Sing, and B. Todd Heniford (2003) "Laparoscopic Gastric Bypass Surgery: Equipment and Necessary Tools" Journal of Laparoendoscopic and Advanced Surgical Techniques. Vol. 13, No. 4, pp. 241-245.

Carlton, Dennis W. and Jeffrey M. Perloff (1994) Modern Industrial Organization (2nd Edition). New York: HarperCollins.

Carow, Kenneth, Randall Heron, and Todd Saxton (2004) "Do Early Birds Get the Return? An Empirical Investigation of Early-Mover Advantages in Acquisitions" Strategic Management Journal. Vol. 25, No. 6, pp. 563-585.

Carow, Kenneth and Glen Larsen (1997) "The Effect of FDICIA Regulation on Bank Holding Companies" Journal of Financial Research. Vol. 20, No. 2, pp. 159-174.

Center for Devices and Radiological Health, U.S. Food and Drug Administration, 510(k) Database. Accessed online at http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMN/pmn.cfm.

Center for Devices and Radiological Health, U.S. Food and Drug Administration, Premarket Approval (PMA) Database. Accessed online at http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMA/pma.cfm.

Center for Devices and Radiological Health, U.S. Food and Drug Administration (1998) "Is The Product a Medical Device?" Accessed online at http://www.fda.gov/cdrh/devadvice/312.html.

Center for Devices and Radiological Health, U.S. Food and Drug Administration (2002) "Premarket Approval Overview" Accessed online at http://www.fda.gov/cdrh/devadvice/pma/.

Center for Devices and Radiological Health, U.S. Food and Drug Administration (2004) "Premarket Notification [510(k)]" Accessed online at http://www.fda.gov/cdrh/devadvice/314.html.

Center for Research in Security Prices database, University of Chicago.

Center for Research in Security Prices (2005) Data Description Guide. University of Chicago.

Centers for Medicare and Medicaid Services (2002) "Health Care Industry Market Update: Medical Devices and Supplies" Issued October 10, 2002, Accessed online at http://www.cms.hhs.gov/reports/hcimu/hcimu_10102002.pdf.

Centers for Medicare and Medicaid Services (2003) "Health Care Industry Market Update: Medical Devices and Supplies" Issued December 3, 2003, Accessed online at http://www.cms.hhs.gov/reports/hcimu/hcimu_12052003.pdf.

Charnes, Abraham, W.W. Cooper, and E. Rhodes (1978) "Measuring Efficiency of Decision-Making Units" European Journal of Operational Research. Vol. 2, November, pp. 429-444.

Chatman, Jennifer A. and Francis J. Flynn (2001) "The Influence of Demographic Heterogeneity on the Emergence and Consequences of Cooperative Norms in Work Teams" Academy of Management Journal. Vol. 44, No. 5, pp. 956-974.

Chatterjee, Sayan, Michael H. Lubatkin, David M. Schweiger, and Yaakov Weber (1992) "Cultural Differences and Shareholder Value in Related Mergers: Linking Equity and Human Capital" Strategic Management Journal. Vol. 13, Vol. 5, pp. 319-334.

Chaudhuri, Saikat (2005) "The Innovation-Through-Acquisition Strategy: Why the Pay-Off Isn't Always There" Interview in Knowledge@Wharton. Accessed online at http://knowledge.wharton.upenn.edu/article/1311.cfm.

Chen K. and Y.L. Yao (2000) "Process Optimisation in Pulsed Laser Micromachining with Applications in Medical Device Manufacturing" International Journal of Advanced Manufacturing Technology. Vol. 16, No. 4, pp. 243-249.

Chern, Jin-Yuan and Thomas T.H. Wan (2000) "The Impact of the Prospective Payment System on the Technical Efficiency of Hospitals" Journal of Medical Systems. Vol. 24, No. 3, pp. 159-172.

Chicago Board Options Exchange (2002) "Who Should Use Equity Collars?" Accessed online at http://www.cboe.com/Strategies/pdf/EquityCollarStrategy.pdf.

Cho, Keun-Tae and Sung-Min Kim (2003) "Selecting Medical Devices and Materials for Development in Korea: The Analytic Hierarchy Process Approach" International Journal Of Health Planning And Management. Vol. 18, No. 2, pp. 161-174.

Choi, Dosoung (1991) "Toehold Acquisitions, Shareholder Wealth, and the Market for Corporate Control" Journal of Financial and Quantitative Analysis. Vol. 26, No. 3, pp. 391-407.

Clarke Roger and Chistos Ioannidis (1996) "On the Relationship Between Aggregate Merger Activity and the Stock Market: Some Further Empirical Evidence" Economics Letters. Vol. 53, No. 3, pp. 349-356.

Cleverly, William O, and Paul C. Nutt (1984) "The Effectiveness of Group-Purchasing Organizations" Health Services Research. Vol. 19, No. 1, pp. 65-81.

Cloninger, Dale O. and Edward R. Waller (2000) "Corporate Fraud, Systematic Risk, and Shareholder Enrichment" Journal of Socio-Economics. Vol. 29, No. 2, pp. 189-201.

Coca-Cola Company. 1996 Annual Report.

Cohen, David J., Ameet Bakhai, Chunxue Shi, Louise Githiora, Tara Lavelle, et al (2004) "Cost-Effectiveness of Sirolimus-Eluting Stents for Treatment of Complex Coronary Stenoses: Results from the Sirolimus-Eluting Balloon Expandable Stent in the Treatment of Patients with De Novo Native Coronary Artery Lesions (SIRIUS) Trial" Circulation. Vol. 110, No. 5, pp. 508-514.

Cohen, Wesley M. and Daniel A. Levinthal (1989) "Innovation and Learning: The Two Faces of R&D" The Economic Journal. Vol. 99, No. 397, pp. 569-596.

Cohen, Wesley M. and Daniel A. Levinthal (1990) "Absorptive Capacity: A New Perspective on Learning and Innovation" Administrative Science Quarterly. Vol. 35, No. 1, pp. 128-152.

Corhay, A. and A. Tourani Rad (1996) "Conditional Heteroskedasticity Adjusted Market Model and an Event Study" Quarterly Review of Economics and Finance. Vol. 36, No. 4, pp. 529-538.

Cutler, David M. and Robert S. Huckman (2003) "Technological Development and Medical Productivity: The Diffusion of Angioplasty in New York State" Journal of Health Economics. Vol. 22, No. 2, pp. 187-217.

Cybo-Ottone, Alberto and Maurizio Murgia (2000) "Mergers and Shareholder Wealth in European Banking" Journal of Banking and Finance. Vol. 24, No. 6, pp. 831-859.

Danzon, Patricia M., Andrew Epstein, and Sean Nicholson (2004) "Mergers and Acquisitions in the Pharmaceutical and Biotech Industries" NBER Working Paper No. 10536.

Danzon, Patricia M., Sean Nicholson, and Nuno Sousa Pereira (2005) "Productivity in Pharmaceutical-Biotechnology R&D: The Role of Experience and Alliances" Journal of Health Economics. Vol. 24, No. 2, pp. 317-339.

Das, Sanchoy and Jean Benoit Almonor (2000) "A Concurrent Engineering Approach for the Development of Medical Devices" International Journal of Computer Integrated Manufacturing. Vol. 13, No. 2, pp. 139-147.

Das, Somnath, Pradyot K. Sen, and Sanjit Sengupta (1998) "Impact of Strategic Alliances on Firm Valuation" Academy of Management Journal. Vol. 41, No. 1, pp. 27-41.

Davidson,Wallace N. and Dipa Dutia (1989) "A Note on the Behavior of Security Returns: A Test of Stock Market Overreaction and Efficiency" Journal of Financial Research. Vol. 12, No. 3, pp. 245-252.

Denis Jean-Louis, Yann Hebert, Ann Langley, Daniel Lozeau, and Louise-Helene Trottier (2002) "Explaining Diffusion Patterns for Complex Health Care Innovations" Health Care Management Review. Vol. 27, No. 3, pp. 60-73.

DiCarlo I., F. Barbagallo, A. Toro, M. Sofia, T. Guastella, and F. Latteri (2004) "Hepatic Resections Using a Water-Cooled, High-Density, Monopolar Device: A New Technology for Safer Surgery" Journal of Gastrointestinal Surgery. Vol. 8, No. 5, pp. 596-600.

D'Mello, Ranjan, Oranee Tawatnuntachai, and Devrim Yaman (2003) "Does the Sequence of Seasoned Equity Offerings Matter? Financial Management. Vol. 32, No. 4, pp. 59-86.

Dodd, Peter and Jerold B. Warner (1983) "On Corporate Governance: A Study of Proxy Contests" Journal of Financial Economics. Vol. 11, pp. 401-438.

Dushnitsky, Gary and Michael J. Lenox (2005) "When Do Firms Undertake R&D by Investing in New Ventures?" Strategic Management Journal. Vol. 26, No. 10, pp. 947-965.

ECRI Health Devices Sourcebook. Annual series 1983-1998, Plymouth Meeting, PA.

Elton, Edwin J. and Martin Gruber (1987) Modern Portfolio Theory and Investment Analysis. New York: Wiley.

Emery, Gary W. and Jeannette A. Switzer (1999) "Expected Market Reaction and the Choice of Method of Payment for Acquisitions" Financial Management. Vol. 28, No. 4, pp. 73-86.

Escarce, Jose J. (1996) "Externalities in Hospitals and Physician Adoption of a New Surgical Technology: An Exploratory Analysis" Journal of Health Economics. Vol. 15, No. 6, pp. 715-734.

Faulkner, Robert C. (1998a) "How to Evaluate Medical Device Technologies" Medical Device & Diagnostic Industry Magazine. August issue. Accessed online at http://www.devicelink.com/mddi/archive/98/08/006.html.

Faulkner, Robert C. (1998b) "Go Where the Value Will Be" Presentation at the Wharton School, December 1998.

Federal Register (1999) "Guidance for Industry on Qualifying for Pediatric Exclusivity" Vol. 64, No. 195, pp. 54903.

Fee, C. Edward and Shawn Thomas (2004) "Sources of Gains in Horizontal Mergers: Evidence from Customer, Supplier, and Rival Firms" Journal of Financial Economics. Vol. 74, No. 3, pp. 423-460.

Feigal, David W., Susan N. Gardner, and Mark McClellan (2003) "Ensuring Safe and Effective Medical Devices" New England Journal of Medicine. Vol. 348, No. 3, pp. 191-192.

Fein, Adam J. (1997) Shakeout and Consolidation in Wholesale Distribution. Dissertation, The Wharton School, University of Pennsylvania.

Feroz, Ehsan H., Sungsoo Kim, and Raymond Raab (2003) "Financial Statement Analysis: A Data Envelopment Analysis Approach" Journal of the Operational Research Society. Vol. 54, No. 1, pp. 48-58.

Ferrier, Gary D. and Vivian G. Valdmanis (2004) "Do Mergers Improve Hospital Productivity?" Journal of the Operational Research Society. Vol. 55, No. 10, pp. 1071-1080.

Fichet, Guillaume, Emmanuel Comoy, Christelle Duval, Kathleen Antloga, Capucine Dehen, et al (2004) "Novel Methods for Disinfection of Prion-Contaminated Medical Devices" Lancet. Vol. 364, No. 9433, pp. 521-526.

Finkelstein, Sydney and Jerayr Haleblian (2002) "Understanding Acquisition Performance: The Role of Transfer Effects" Organization Science. Vol. 13, No. 1, pp. 36-47.

First Research (2004) "Industry: Medical Supplies and Devices" Issued November 1, 2004, Accessed online at http://www.firstresearch.com/Industry-Analysis.html.

First Research (2005) "Industry: Medical Supplies and Devices" Issued May 2, 2005, Accessed online at http://www.firstresearch.com/Industry-Analysis.html.

Fizel, John L. and Thomas S. Nunnikhoven (1993) "The Efficiency of Nursing Home Chains" Applied Economics. Vol. 25, No. 1, pp. 49-55.

Foote, Susan Bartlett (1992) Managing the Medical Arms Race: Public Policy and Medical Device Innovation. Berkeley: University of California Press.

Foote, Susan Bartlett and Will Mitchell (1989) "Selling American Medical Equipment in Japan" California Management Review. Vol. 31, No. 4, pp. 146-161.

Fowler, Karen L. and Dennis R. Schmidt (1989) "Determinants of Tender Offer Post-Acquisition Financial Performance" Strategic Management Journal. Vol. 10, No. 4, pp. 339-350.

Frame, W. Scott and William D. Lastrapes (1998) "Abnormal Returns in the Acquisition Market: The Case of Bank Holding Companies, 1990-1993" Journal of Financial Services Research. Vol. 14, No. 2, pp. 145-163.

Franks, Julian, Robert Harris, and Sheridan Titman (1991) "The Post-Merger Share Price Performance of Acquiring Firms" Journal of Financial Economics. Vol. 29, No. 1, pp. 81-96.

Frech, H.E. III, and Lee Rivers Mobley (2000) "Efficiency, Growth, and Concentration: An Empirical Analysis of Hospital Markets" Economic Inquiry. Vol. 38, No. 3, pp. 369-384.

Free M.J. (2004) "Achieving Appropriate Design and Widespread Use of Health Care Technologies in the Developing World" International Journal Of Gynecology & Obstetrics. Vol. 85, Suppl. 1, pp. S3-S13.

Friedman, Leonard H. and James B. Goes (2000) "The Timing of Medical Technology Acquisition: Strategic Decision Making in Turbulent Environments" Journal of Healthcare Management. Vol. 45, No. 5, pp. 317-330.

Galen, D.I. (2000) "Radially-Expanding Access Device for Laparoscopic Surgery: Efficacy and Safety in Comparison with Sharp Laparoscopic Cannulae" Minimally Invasive Therapy and Allied Technologies. Vol. 10, No. 1, pp. 51-54.

Gatling, Robert R., Director of Program Operations Staff, Office of Device Evaluation, Center for Devices and Radiological Health, U.S. Food and Drug Administration. Telephone interview, April 2006.

George, Gerard, Shaker A. Zahra, and D. Robley Wood (2002) "The Effects of Business-University Alliances on Innovative Output and Financial Performance: A Study of Publicly Traded Biotechnology Companies" Journal of Business Venturing. Vol. 17, No. 6, pp. 577-609.

Gerety Mason, Chun-Keung Hoi, and Ashok Robin (2001) "Do Shareholders Benefit from the Adoption of Incentive Pay for Directors?" Financial Management. Vol. 30, No. 4, pp. 45-61.

Ghosh, Aloke (2001) "Does Operating Performance Really Improve Following Corporate Acquisitions?" Journal of Corporate Finance. Vol. 7, No. 2, pp. 151-178.

Gillen, David and Ashish Lall (1997) "Developing Measures of Airport Productivity and Performance: An Application of Data Envelopment Analysis" Transportation Research Part E – Logistics and Transportation Review. Vol. 33, No. 4, pp. 261-273.

Given, Ruth S. (1996) "Economies of Scale and Scope as an Explanation of Merger and Output Diversification Activities in the Health Maintenance Organization Industry" Journal of Health Economics. Vol. 15, No. 6, pp. 685-713.

Gobeli, David H. and William Rudelius (1985) "Managing Innovation: Lessons from the Cardiac Pacing Industry" Sloan Management Review. Vol. 26, No. 4, p. 29-43.

Gold, Robert (2005) "Standard & Poor's Industry Surveys: Healthcare Products & Supplies" Volume 173, No. 10, Issued March 10, 2005. New York: Standard & Poor's.

Grannemann, Thomas W., Randall S. Brown, and Mark V. Pauly (1986) "Estimating Hospital Costs: A Multiple Output Analysis" Journal of Health Economics. Vol. 5, pp. 107-127.

Graves, Samuel B. and Nan S. Langowitz (1993) "Innovative Productivity and Returns to Scale in the Pharmaceutical Industry" Strategic Management Journal. Vol. 14, No. 8, pp. 593-605.

Greene, William H. (2000) Econometric Analysis 4th edition. Upper Saddle River, NJ: Prentice Hall.

Groover, Mikell P. (2002) Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 2nd Edition. New York: John Wiley & Sons.

Hagedoorn, John and Geert Duysters (2002) "External Sources of Innovative Capabilities: The Preference for Strategic Alliances or Mergers and Acquisitions" Journal of Management Studies. Vol. 39, No. 2, pp. 167-188.

Haleblian, Jerayr and Sydney Finkelstein (1999) "The Influence of Organizational Acquisition Experience on Acquisition Performance: A Behavioral Learning Perspective" Administrative Science Quarterly. Vol. 44, No. 1, pp. 29-56.

Hamburg, Morris (1987) Statistical Analysis for Decision Making, 4th Edition. San Diego: Harcourt Brace Jovanovich.

Hao, Steve and C. Carl Pegels (1994) "Evaluating Relative Efficiencies of Veterans Affairs Medical Centers Using Data Envelopment, Ratio, and Multiple Regression Analysis" Journal of Medical Systems. Vol. 18, No. 2, pp. 55-67.

Harrigan, K. (1981) "Entry Barriers and Competitive Strategies. Strategic Management Journal. Vol. 2, No. 4, pp. 395-412.

Harris, Ira C. and Katsuhiko Shimizu (2004) "Too Busy to Serve? An Examination of the Influence of Overboarded Directors" Journal of Management Studies. Vol. 41, No. 5, pp. 775-798.

Haunschild, Pamela R. (1993) "Inter-Organizational Imitation: The Impact of Interlocks on Corporate Acquisition Activity" Administrative Science Quarterly. Vol. 38, No. 4, pp. 564-592.

Haunschild Pamela R. and Christine M. Beckman (1998) "When Do Interlocks Matter?: Alternate Sources of Information and Interlock Influence" Administrative Science Quarterly. Vol. 43, No. 4, pp. 815-844.

Haveman, Heather A. (1995) "The Demographic Metabolism of Organizations: Industry Dynamics, Turnover, and Tenure Distributions" Administrative Science Quarterly. Vol. 40, No. 4, pp. 586-618.

Hayward, Mathew L.A. (2002) "When Do Firms Learn From Their Acquisition Experience? Evidence From 1990-1995" Strategic Management Journal. Vol. 23, No. 1, pp. 21-39.

Hayward, Mathew L.A. (2003) "Professional Influence: The Effects on Investment Banks on Clients' Acquisition Financing and Performance" Strategic Management Journal. Vol. 24, No. 9, pp. 783-801.

Hayward, Mathew L.A. and Donald C. Hambrick (1997) "Explaining the Premiums Paid for Large Acquisitions: Evidence of CEO Hubris" Administrative Science Quarterly. Vol. 42, No. 1, pp. 103-127.

Healy, Paul M., Krishna G. Palepu, and Richard S. Ruback (1992) "Does Corporate Performance Improve After Mergers?" Journal of Financial Economics. Vol. 31, pp. 135-175.

Healy, Paul M., Krishna G. Palepu, and Richard S. Ruback (1997) "Which Takeovers Are Profitable? Strategic or Financial? Sloan Management Review. Vol. 38, No. 4, pp. 45-57.

Henderson, Rebecca and Iain Cockburn (1994) "Measuring Competence? Exploring Firm Effects in Pharmaceutical Research" Strategic Management Journal. Vol. 15, Special Issue, pp. 63-84.

Henle, Christine A. (2005) "Predicting Workplace Deviance from the Interaction Between Organizational Justice and Personality" Journal of Management Issues. Vol. 17, No. 2, pp. 247-263.

Heuser R., F. Houser, S.D. Culler, E.R. Becker, S.L. Battaglia, L. Tarkington, and A.W. Simon (2000) "A Retrospective Study of 6,671 Patients Comparing Coronary Stenting and Balloon Angioplasty" Journal of Invasive Cardiology. Vol. 12, No. 7, pp. 354-362.

Hill, Arthur V. and William J. Sawaya III (2004) "Production Planning for Medical Devices with an Uncertain Regulatory Approval Date" IIE Transactions. Vol. 36, No. 4, pp. 307-317.

Hillman, Alan L. and J. Sanford Schwartz (1985) "The Adoption and Diffusion of CT and MRI in the United States: A Comparative Analysis" Medical Care. Vol. 23, No. 11, pp. 1283-1294.

Hillman, Alan L. and J. Sanford Schwartz (1986) "The Diffusion of MRI: Patterns of Siting and Ownership in an Era of Changing Incentives" American Journal of Roentgenology. Vol. 146, No. 5, pp. 963-969.

Hitt, Michael A., Robert E. Hoskisson, and R. Duane Ireland (1990) "Mergers and Acquisitions and Managerial Commitment to Innovation in M-Form Firms" Strategic Management Journal. Vol. 11, Special Issue, Summer, pp. 29-47.

Hitt, Michael A., Robert E. Hoskisson, Richard A. Johnson, and Douglas D. Moesel (1996) "The Market for Corporate Control and Firm Innovation" Academy of Management Journal. Vol. 39, No. 5, pp. 1084-1119.

Ho, Vivian (2002) "Learning and the Evolution of Medical Technologies: The Diffusion of Coronary Angioplasty" Journal of Health Economics. Vol. 21, No. 5, pp. 873-885.

Hoel, Paul G. (1984) Introduction to Mathematical Statistics, 5th Edition. New York: John Wiley & Sons.

Hollander, Myles and Douglas A. Wolfe (1973) Nonparametric Statistical Methods. New York: John Wiley & Sons.

Honjo, Yuji (2004) "Growth of New Start-Up Firms: Evidence from the Japanese Manufacturing Industry" Applied Economics. Vol. 36, No. 4, pp. 343-355.

Horch R. (1996) "A New Device for Safe and Easy Dilatation of the Carpal Canal in Endoscopic Surgical Treatment of the Carpal Tunnel Syndrome" Minimally Invasive Neurosurgery. Vol. 39, No. 2, pp. 60-62.

Hotchkiss, Edith S. (1995) "Postbankruptcy Performance and Management Turnover" Journal of Finance. Vol. 50, No. 1, pp. 3-21.

Houston, Joel F. and Michael D. Ryngaert (1994) "The Overall Gains from Large Bank Mergers" Journal of Banking and Finance. Vol. 18, No. 6, pp. 1155-1176.

Howell, Marcus, Kathy Doughtery, Neil Strickman, and Zvonimir Krajcer (2002) "Percutaneous Repair of Abdominal Aortic Aneurysms Using the AneuRx Stent Graft and the Percutaneous Vascular Surgery Device" Catheterization and Cardiovascular Interventions. Vol. 55, Vol. 3, pp. 281-287.

Hubbard, R. Glenn and Darius Palia (1995) "Benefits of Control, Managerial Ownership, and the Stock Returns of Acquiring Firms" RAND Journal of Economics. Vol. 26, No. 4, pp. 782-792.

Huck Steffen, Kai A. Konrad, and Wieland Muller (2004) "Profitable Horizontal Mergers Without Cost Advantages: The Role of Internal Organization, Information and Market Structure" Economica. Vol. 71, No. 284, pp. 575-587.

Hughes, Edward F.X. (1978) Hospital Cost Containment Programs: A Policy Analysis. Cambridge, MA: Ballinger.

Iglehart, John K. (2005) "Grasping the Role of Technology: A Conversation with Ron Dollens" Health Affairs. Web Exclusives, Vol. 24, Supplement 1, pp. W5 296-313.

Ingram, Paul and Joel A.C. Baum (1997) "Opportunity and Constraint: Organizations' Learning from the Operating and Competitive Experience of Industries" Strategic Management Journal. Vol. 18, Summer Special Issue, pp. 75-98.

Jarrell, Gregg A. and Annette B. Poulsen (1989) "The Returns to Acquiring Firms in Tender Offers: Evidence from Three Decades" Financial Management. Vol. 18, No. 3, pp. 12-19.

Jensen, Michael (1988) "Takeovers: Their Causes and Consequences" Journal of Economic Perspectives. Vol. 2, No. 1, pp. 21-48.

Jensen, Michael C. and Richard S. Ruback (1983) "The Market for Corporate Control: The Scientific Evidence" Journal of Financial Economics. Vol. 11, pp. 5-50.

Judge, George G., R. Carter Hill, William E. Griffiths, Helmut Lutkepohl, and Tsoung-Chao Lee (1988) Introduction to the Theory and Practice of Econometrics 2nd edition. New York: John Wiley & Sons.

Jurgens, Rick (2000) "Texas Instruments Executives: Burr-Brown to Boost Company in Analog" Dow Jones News Service. June 21, 2000.

Kale, Prashant, Jeffrey H. Dyer, and Harbir Singh (2002) "Alliance Capability, Stock Market Response, and Long-Term Alliance Success: The Role of the Alliance Function" Strategic Management Journal. Vol. 23, No. 8, 747-767.

Kanehira E., K. Omura, T. Kinoshita, M. Sasaki, T. Watanabe, K. Kawakami, and Y. Watanabe (1998) "Development of a 23.5 kHz Ultrasonically Activated Device for Laparoscopic Surgery" Minimally Invasive Therapy & Allied Technologies. Vol. 7, No. 4, pp. 315-319.

Kanemitsu K., H. Kunishima, T. Saga, H. Harigae, T. Imasaka, Y. Hirayama, and M. Kaku (2005) "Residual Formaldehyde on Plastic Materials and Medical Equipment Following Low-Temperature Steam and Formaldehyde Sterilization. Journal of Hospital Infection. Vol. 59, No. 4, pp. 361-364.

Kang, Jun-Koo (1993) "The International Market for Corporate Control: Mergers and Acquisitions of U.S. Firms by Japanese Firms" Journal of Financial Economics. Vol. 34, No. 3, pp. 345-371.

Kantor, Jeffrey and Shlomo Maital (1999) "Measuring Efficiency by Product Group: Integrating DEA with Activity-Based Accounting in a Large Mideast Bank" Interfaces. Vol. 29, No. 3, pp. 27-36.

Karim, Samina and Will Mitchell (2000) "Path-Dependent And Path-Breaking Change: Reconfiguring Business Resources Following Acquisitions In The US Medical Sector, 1978-1995" Strategic Management Journal. Vol. 21, No. 10/11, pp. 1061-1081.

Karim, Samina and Will Mitchell (2004) "Innovating Through Acquisition And Internal Development: A Quarter-Century Of Boundary Evolution At Johnson & Johnson" Long Range Planning. Vol. 37, No. 6, pp. 525-547.

Kaufman, H.H. (1983) "Voluntary Standardization of Medical Devices and Procedures" Neurosurgery. Vol. 13, No. 4, pp. 464-470.

Keats, Barbara W. and Michael A. Hitt (1988) "A Causal Model of Linkages Among Environmental Dimensions" Academy of Management Journal. Vol. 31, No. 3, pp. 570-598.

Keeler, Emmett B., Glenn Melnick, and Jack Zwanziger (1999) "The Changing Effects of Competition on Non-Profit and For-Profit Hospital Pricing Behavior" Journal of Health Economics. Vol. 18, No. 1, pp. 69-86.

Kessler, Larry, Scott D. Ramsey, Sean Tunis, and Sean D. Sullivan (2004) "Clinical Use of Medical Devices in the 'Bermuda Triangle' " Health Affairs. Vol. 23, No. 1, pp. 200-207.

Kimberly, John R. and Michael J. Evanisko (1981) "Organizational Innovation: The Influence of Individual, Organizational, and Contextual Factors on Hospital Adoption of Technological and Administrative Innovations" Academy of Management Journal. Vol. 24, No. 4, pp. 689-713.

King, David R., Dan R. Dalton, Catherine M. Daily, and Jeffrey G. Covin (2004) "Meta-Analyses of Post-Acquisition Performance: Indications of Unidentified Moderators" Strategic Management Journal. Vol. 25, No. 2, pp. 187-200.

Kingsdale, J. (1978) "Marrying Regulatory and Competitive Approaches to Health Care Cost Containment" Journal of Health Politics Policy and Law. Vol. 3, No. 1, pp. 20-42.

Kleinbaum, David G., Lawrence L. Kupper, and Keith E. Muller (1988) Applied Regression Analysis and Other Multivariate Methods. Belmont, CA: Duxbury Press.

Kleinsorge, Ilene K. and Dennis F. Karney (1992) "Management of Nursing Homes Using Data Envelopment Analysis" Socio-Economic Planning Sciences. Vol. 26, No. 1, pp. 57-71.

Knipp, Brian S., Justin B. Dimick, Jonathan L. Eliason, John A. Cowan, Peter K. Henke, Mary S. Proctor, James C. Stanley, and Gilbert R. Upchurch (2004) "Diffusion of New Technology for the Treatment of Renovascular Hypertension in the United States: Surgical Revascularization versus Catheter-based Therapy, 1988-2001" Journal of Vascular Surgery. Vol. 40, No. 4, pp. 717-723.

Kogut, Bruce and Udo Zander (1992) "Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology" Organization Science. Vol. 3, No. 3, pp. 383-397.

Kotler, Philip (1988) Marketing Management: Analysis, Planning, Implementation, and Control. (6th Edition). Englewood Cliffs, New Jersey: Prentice Hall.

Krishnan, Jayanthi and Eric Press (2003) "The North American Industry Classification System and Its Implications for Accounting Research" Contemporary Accounting Research. Vol. 20, No. 4, pp. 685-717.

Laine Juha, U. Harriet Finne-Soveri, Magnus Bjorkgren, Miika Linna, Anja Noro, and Unoto Hakkinen (2005) "The Association Between Quality of Care and Technical Efficiency in Long-Term Care" International Journal for Quality in Health Care. Vol. 17, No. 3, pp. 259-267.

Landgarten, S. (1979) "Medical Staff Helps Set Priorities for Equipment Purchases" Hospitals. Vol. 53, No. 5, pp. 89-90.

Larsson, Rikard and Sydney Finkelstein (1999) "Integrating Strategic, Organizational, and Human Resource Perspectives on Mergers and Acquisitions: A Case Survey of Synergy Realization" Organization Science. Vol. 10, No. 1, pp. 1-26.

Leahy J.C., E.C. Stevenson, D.W.L. Hukins, K.J. Mathias, D.E.T. Shepherd, and D. Wardlaw (2000) "Development of Surgical Instruments for Implanting a Flexible Fixation Device for the Lumbar Spine" Proceedings of the Institution of Mechanical Engineers Part H-Journal of Engineering in Medicine. Vol. 214, No. H3, pp. 325-328.

Levitt, Barbara and James C. March (1988) "Organizational Learning" Annual Review of Sociology. Vol. 14, pp. 319-340.

Lille, K. and W. Danco (1976) "AHA Recommends Cost-Containment Committees" Hospitals. Vol. 50, No. 10, pp. 69-72.

Linn, Scott C. and Jeanette A. Switzer (2001) "Are Cash Acquisitions Associated with Better Post-Combination Operating Performance than Stock Acquisitions?" Journal of Banking and Finance. Vol. 25, No. 6, pp. 1113-1138.

Littell, Candace L. (1994) "Innovation in Medical Technology: Reading the Indicators" Health Affairs. Vol. 13, No. 3, pp. 226-235.

Loughran, Tim and Anand M. Vijh (1997) "Do Long-Term Shareholders Benefit From Corporate Acquisitions?" Journal of Finance. Vol. 52, No. 5, pp. 1765-1790.

Lubitz, James (2005) "Health, Technology, and Medical Care Spending" Health Affairs. Web Exclusive, Vol. 24, Supp. 2, pp. W5 R81-85.

Lubove, Seth H. (1986) "PPG Plan to Buy Units Is Aimed At Diversification" Wall Street Journal, August 22.

Lunde, Asger and Allan Timmermann (2004) "Duration Dependence in Stock Prices: An Analysis of Bull and Bear Markets" Journal of Business and Economic Statistics. Vol. 22, No. 3, pp. 253-273.

Lytle, Laurian Casson and O. Maurice Joy (1996) "The Stock Market Impact of Social Pressure: The South African Divestment Case" Quarterly Review of Economics and Finance. Vol. 36, No. 4, pp. 507-527.

Machecourt, J., J.M. Lablanche, N. Danchin, J.M. Fauvel, P. Coste, G. Vanzetto, J.P. Monassier, and H. Eltchaninoff (2004) "The EVASTENT Study: A Direct Comparison of Safety and Cost-Effectiveness of Drug Eluting Stents in Diabetic and Nondiabetic Patients According to the Amount of Vessel Disease" Circulation. Vol. 110, No. 17, p. 735.

MacKenzie, Scott B., Philip M. Podsakoff, and Michael Ahearne (1998) "Some Possible Antecedents and Consequences of In-Role and Extra-Role Salesperson Performance" Journal of Marketing. Vol. 62, No. 3, pp. 87-98.

Maisel, William H. (2004) "Medical Device Regulation: An Introduction for the Practicing Physician" Annals of Internal Medicine. Vol. 140, No. 4, pp. 296-302.

Malenka, David J., Aaron V. Kaplan, Sandra M. Sharp, and John E. Wennberg (2005) "Postmarketing Surveillance of Medical Devices Using Medicare Claims" Health Affairs. Vol. 24, No. 4, pp. 928-937.

Markides, Constantinos C. (1992) "Consequences of Corporate Refocusing: Ex Ante Evidence" Academy of Management Journal. Vol. 35, No. 2, pp. 398-412.

Martin, Xavier and Will Mitchell (1998) "The Influence Of Local Search And Performance Heuristics On New Design Introduction In A New Product Market" Research Policy. Vol. 26, Vol. 7/8, pp. 753-771.

Mathur, Lynette Knowles and Ike Mathur (1996) "Is Value Associated with Initiating New Advertising Agency-Client Relations? Journal of Advertising. Vol. 25, No. 3, pp. 1-12.

McDonald, James T. (1999) "The Determinants of Firm Profitability in Australian Manufacturing" The Economic Record. Vol. 75, No. 229, pp. 115-126.

McGinnity, Eileen (2003) "Managing the Cost of Physician Preference Items" Healthcare Purchasing News. November issue, accessed online at: http://www.medassets.com/NR/rdonlyres/EBDF0DB8-BD28-43E7-B9A4-4A491CC29CEF/0/112003HPN.pdf.

McKone-Sweet, Kathleen E., Paul Hamilton, and Susan B. Willis (2005) "The Ailing Healthcare Supply Chain: A Prescription for Change" Journal of Supply Chain Management. Vol. 41, No. 1, pp. 4-17.

McLaughlin, Robyn, Assem Safieddine, and Gopala K. Vasudevan (1996) "The Operating Performance of Seasoned Equity Issuers: Free Cash Flow and Post-Issue Performance" Financial Management. Vol. 25, No. 4, pp. 41-53.

Medical Economics Company Medical Device Register. Annual series 1983-1999, Ramsey, NJ.

Megginson, William L., Angela Morgan, and Lance Nail (2004) "The Determinants of Positive Long-Term Performance in Strategic Mergers: Corporate Focus and Cash" Journal of Banking and Finance. Vol. 28, No. 3, pp. 523-552.

Mehra, Ajay, Martin Kilduff, and Daniel J. Brass (2001) "The Social Networks of High and Low Self-Monitors: Implications for Workplace Performance" Administrative Science Quarterly. Vol. 46, No. 1, pp. 121-146.

Melicher, Ronald W., Johannes Ledolter, and Louis J. D'Antonio (1983) "A Time Series Analysis of Aggregate Merger Activity" Review of Economies and Statistics. Vol. 65, No. 3, pp. 423-430.

Merritt, Katharine, Victoria M. Hitchins, and Stanley A. Brown (2000) "Safety and Cleaning of Medical Materials and Devices" Journal of Biomedical Materials Research. Vol. 53, No. 2, pp. 131-136.

Mitchell, Will (1989) "Whether and When? Probability and Timing of Incumbents' Entry into Emerging Industrial Subfields" Administrative Science Quarterly. Vol. 34, No. 2, pp. 208-230.

Mitchell, Will (1991) "Dual Clocks: Entry Order Influences on Incumbent and Newcomer Market Share and Survival When Specialized Assets Retain Their Value" Strategic Management Journal. Vol. 12, No. 2, pp. 85-100.

Mitchell, Will (1994) "The Dynamics of Evolving Markets: The Effects of Business Sales and Age on Dissolutions and Divestitures" Administrative Science Quarterly. Vol. 39, No. 4, pp. 575-602.

Mitchell, Will, J. Myles Shaver, and Bernard Yeung (1992) "Getting There in a Global Industry: Impacts on Performance of Changing International Presence" Strategic Management Journal. Vol. 13, No. 6, pp. 419-432.

Mitchell, Will, J. Myles Shaver, and Bernard Yeung (1993) "Performance Following Changes of International Presence in Domestic and Transition Industries" Journal of International Business Studies. Vol. 24, No. 4, pp. 647-669.

Mitchell, Will, J. Myles Shaver, and Bernard Yeung (1994) "Foreign Entrant Survival and Foreign-Market Share: Canadian Companies Experience in United States Medical Sector Markets" Strategic Management Journal. Vol. 15, No. 7, pp. 555-567.

Mitchell, Will and Kulwant Singh (1993) "Death of the Lethargic: Effects of Expansion Into New Technical Subfields on Performance in a Firm's Base Business" Organization Science. Vol. 4, No. 2, pp. 152-180.

Mitchell, Will and Kulwant Singh (1995) "Spillback Effects of Expansion When Product-Types and Firm-Types Differ" Journal of Management. Vol. 21, No. 1, pp. 81-100.

Modern Healthcare (1994) Newsbriefs, January 17th issue.

Moeller Sara B., Frederik P. Schlingemann, and Rene M. Stulz (2004) "Firm Size and the Gains from Acquisitions" Journal of Financial Economics. Vol. 73, No. 2, pp 201-228.

Morrissey, Joseph J. (2004) "Mobile Phones in the Hospital: Improved Mobile Communication and Mitigation of EMI Concerns Can Lead to an Overall Benefit to Healthcare" Health Physics. Vol. 87, No. 1, pp. 82-88.

Murphy, Kevin R. and Brett Myors (1998) Statistical Power Analysis. Mahwah, NJ: Lawrence Erlbaum Associates.

Myers, Steward C. and Nicholas S. Majluf (1984) "Corporate Financing and Investment Decisions When Firms Have Information that Investors Do Not Have" Journal of Financial Economics. Vol. 13, No. 2, pp. 187-221.

Nagarajan, Anuradha and Will Mitchell (1998) "Evolutionary Diffusion: Internal And External Methods Used To Acquire Encompassing, Complementary, And Incremental Technological Changes In The Lithotripsy Industry" Strategic Management Journal. Vol. 19, No. 11, pp. 1063-1077.

Narayan, R.J., P.N. Kumta, C. Sfeir, D.H. Lee, D. Olton, D.W. Choi (2004) "Nanostructured Ceramics in Medical Devices: Applications and Prospects" Journal of Minerals, Metals, and Materials (JOM). Vol. 56, No. 10, pp. 38-43.

Nash, Robert C. and Joseph F. Sinkey (1997) "On Competition, Risk, and Hidden Assets in the Market for Bank Credit Cards" Journal of Banking and Finance. Vol. 21, No. 1, pp. 89-112.

Nathoe, H.M., P.R. Stella, and P.P.T. de Jaegere (2005) "Standard Compared with Selective Coronary Stent-Implantation Improves Cardiac Outcome and Cost-Effectiveness" Journal of the American College of Cardiology. Vol. 45, No. 3, p. 35A.

Nayyar, Praveen R. (1993) "Stock Market Reactions to Related Diversification Moves by Service Firms Seeking Benefits from Information Asymmetry and Economies of Scope" Strategic Management Journal. Vol.. 14, No. 8, pp. 569-591.

Nelson, Ralph L. (1959) Merger Movements in American Industry, 1895-1956. Princeton, NJ: Princeton University Press.

Nelson, Richard R. (1991) "Why Do Firms Differ, And How Does It Matter?" Strategic Management Journal. Vol. 12, Sp. Iss., pp. 61-74.

Nelson, Richard R. and Sidney G. Nelson (1982) An Evolutionary Theory of Economic Change. Cambridge, Massachusetts: Belknap Press.

Nicholson, Sean, Patricia M. Danzon, and Jeffrey McCullough (2005) "Biotech-Pharmaceutical Alliances as a Signal of Asset and Firm Quality" Journal of Business. Vol. 78, No. 4, pp. 1433-1464.

Nicholson, Walter (1987) Intermediate Microeconomics and Its Application. 4th Edition. Chicago: Dryden Press.

Nunnally, Jum C. (1978) Psychometric Theory, 2nd edition. New York: McGraw-Hill.

Odagiri, Hiroyuki, and Tatsuo Hase (1989) "Are Mergers and Acquisitions Going to be Popular in Japan Too?" International Journal of Industrial Organization. Vol. 7, No. 1, pp. 49-72.

Office of Device Evaluation, Center for Devices and Radiological Health, U.S. Food and Drug Administration (1986-2005) Annual Reports for fiscal years 1985-2004, Accessed online at http://www.fda.gov/cdrh/ode/odeannualreports.html.

Officer, Micah S. (2004) "Collars and Renegotiation in Mergers and Acquisitions" Journal of Finance. Vol. 59, No. 6, pp. 2719-2743.

Oliver, Amalya L. (2001) "Strategic Alliances and the Learning Life-Cycle of Biotechnology Firms" Organization Studies. Vol. 22, No. 3, pp. 467-489.

Opler, Tim C. (1992) "Operating Performance in Leveraged Buyouts: Evidence from 1985-1989" Financial Management. Vol. 21, No. 1, pp. 27-34.

Ozcan, Yasar A. and Roice D. Luke (1993) "A National Study of the Efficiency of Hospitals in Urban Markets" Health Services Research. Vol. 27, No. 6, pp. 719-739.

Ozcan, Yasar A. and Michael J. McCue (1996) "Development of a Financial Performance Index for Hospitals: DEA Approach" Journal of the Operational Research Society. Vol. 47, No. 1, pp. 18-26.

Palepu, Krishna (1985) "Diversification Strategy, Profit Performance, and the Entropy Measure" Strategic Management Journal. Vol. 6, No. 3, pp. 239-255.

Pangarkar, Nitin (2003) "Determinants of Alliance Duration in Uncertain Environments: The Case of the Biotechnology Sector" Long Range Planning. Vol. 36, No. 3, pp. 269-284.

Parkan, Celik (1996) "Measuring the Performance of Hotel Operations" Socio-Economic Planning Science. Vol. 30, No. 4, pp. 257-292.

Paulter, Paul A. (2003) "Evidence on Mergers and Acquisitions" Antitrust Bulletin. Vol. 48, No. 1, pp. 119-221.

Pauly, Mark V. (2005) "Competition and New Technology" Health Affairs. Vol. 24, No. 6, pp. 1523-1535.

Pearson, Steven D. and Michael D. Rawlins (2005) "Quality, Innovation, and Value for Money: NICE and the British National Health Service" Journal of the American Medical Association. Vol. 294, No. 20, pp. 2618-2622.

Pennington D.G., D.B. Burlington, J.G. Copeland, E.J. Flannery, J.D. Hill et al (1996) "Discussion of FDA Regulation of Medical Devices" Annals of Thoracic Surgery. Vol. 61, No. 1, pp. 493-498.

Pilloff, Steven J. (1996) "Performance Changes and Shareholder Wealth Creation Associated with Mergers of Publicly Traded Banking Institutions" Journal of Money, Credit & Banking. Vol. 28, No. 3, pp. 294-310.

Pindyck, Robert S. and Daniel L. Rubinfeld (1992) Microeconomics. 2nd Edition. New York: Macmillan Publishing.

Pisano, Gary P. (1990) "The Research and Development Boundaries of the Firm: An Empirical Analysis" Administrative Science Quarterly. Vol. 35, No. 1, pp. 153-176.

Pollard, T. (1977) "Growth and Development of a Group Purchasing Program" Hospitals. Vol. 51, No. 9, pp. 89.

Pollard, Michael R. and Gary S. Persinger (1987) "Investment in Health-Care Innovation" Health Affairs. Vol. 6, No. 2, pp. 93-106.

Porrini, Patrizia (2004) "Can a Previous Alliance Between an Acquirer and a Target Affect Acquisition Performance?" Journal of Management. Vol. 30, No. 4, pp. 545-562.

Porter, Michael E. (1980) Competitive Strategy: Techniques for Analyzing Industries and Competitors. New York: Free Press.

Ramaswamy, Kannan (1997) "The Performance Impact of Strategic Similarity in Horizontal Mergers: Evidence from the U.S. Banking Industry" Academy of Management Journal. Vol. 40, Vol. 3, pp. 697-715.

Ramsey, Scott D. and Mark V. Pauly (1997) "Structural Incentives and Adoption of Medical Technologies in HMO and Fee-For-Service Health Insurance Plans" Inquiry. Vol. 34, No. 3, pp. 228-236.

Ranft, Annette L. and Michael D. Lord (2002) "Acquiring New Technologies and Capabilities: A Grounded Model of Acquisition Implementation" Organization Science. Vol. 13, No. 4, pp. 420-441.

Raphaelson, A.H. and C.P. Hall (1978) "Politics and Economics of Hospital Cost Containment" Journal of Health Politics Policy and Law. Vol. 3, No. 1, pp. 87-111.

Rappaport, Alfred and Mark L. Sirower (1999) "Stock or Cash: The Trade-Offs for Buyers and Sellers in Mergers and Acquisitions" Harvard Business Review. Vol. 77, No. 6, pp. 147-158.

Rasheed Abdul, Deepak Datta, and Ravi Chinta (1997) "Determinants of Price Premiums: A Study of Initial Public Offerings in the Medical Diagnostics and Devices Industry" Journal of Small Business Management. Vol. 35, No. 4, pp. 11-23.

ReVelle, Jack B., ed. (2002) Manufacturing Handbook of Best Practices: An Innovation, Productivity and Quality Focus. Boca Raton, FL: St. Lucie Press.

Rhodes-Kropf, Matthew and S. Viswanathan (2004) "Market Valuation and Merger Waves" Journal of Finance. Vol. 59, No. 6, pp. 2685-2718.

Richards, G. (1982) "From Light-Bulbs to CT Scanners: Group Purchasing is Filling the Bill at a Lower Price" Hospitals. Vol. 56, No. 2, pp. 81.

Robinson, James C. (2004) "Consolidation and the Transformation of Competition in Health Insurance" Health Affairs. Vol. 23, No. 6, pp. 11-24.

Robinson Sandra L. and Anne M. O'Leary-Kelly (1998) "Monkey See, Monkey Do: The Influence of Work Groups on the Antisocial Behavior of Employees" Academy of Management Journal. Vol. 41, No. 6, pp. 658-672.

Rooney, James J. (2001) "7 Steps to Improved Safety for Medical Devices: Prevent Problems and Shorten Inspections with HACCP" Quality Progress. Vol. 34, No. 9, pp. 33-41.

Rosenman Robert and Daniel Friesner (2004) "Scope and Scale Inefficiencies in Physician Practices" Health Economics. Vol. 13, No. 11, pp. 1091-1116.

Rosenman, Robert, Kris Siddharthan, and Melissa Ahern (1997) "Output Efficiency of Health Maintenance Organizations in Florida" Health Economics. Vol. 6, No. 3, pp. 295-302.

Rothaermel, Frank T. and David L. Deeds (2004) "Exploration and Exploitation Alliances in Biotechnology: A System of New Product Development" Strategic Management Journal. Vol. 25, No. 3, pp. 201-221.

Rousseeuw, Peter J. and Annick M. Leroy (1987) Robust Regression and Outlier Detection. New York: John Wiley & Sons.

Ruback, Richard S. (1988) "Do Target Shareholders Lose in Unsuccessful Control Contests?" Chapter 5 in Alan J. Auerbach (ed.) Corporate Takeovers: Causes and Consequences. Chicago: University of Chicago Press.

Rumelt, Richard P. (1974) Strategy, Structure, and Economic Performance. Boston, Massachusetts: Harvard University.

Rumelt, Richard P. (1982) "Diversification Strategy and Profitability" Strategic Management Journal. Vol. 3, No. 4, pp. 359-369.

Rumelt, Richard P. (1984) "Toward a Strategic Theory of the Firm" pp. 556-570 in Lamb, R. (ed.), Competitive Strategic Management. Englewood Cliffs, NJ: Prentice Hall.

Rundall, Thomas G., Huw T.O. Davies, Claire-Louise Hodges (2004) "Doctor-Manager Relationships in the United States and the United Kingdom" Journal of Healthcare Management. Vol. 49, No. 4, pp. 251-268.

Salehirad, Neda and Taraneh Sowlati (2005) "Performance Analysis of Primary Wood Producers in British Columbia Using Data Envelopment Analysis" Canadian Journal of Forest Research. Vol. 35, No. 2, pp. 285-294.

Salter, Malcom S. and Wolf A. Weinhold (1979) Diversification Through Acquisitions: Strategies for Creating Economic Value. New York: Free Press.

Samore, Matthew H., R. Scott Evans, April Lassen, Patricia Gould, James Lloyd, et al (2005) "Surveillance of Medical Device-Related Hazards and Adverse Events in Hospitalized Patients" Journal of the American Medical Association. Vol. 291, No. 3, pp. 325-334.

Samuel, Frank E. (1991) "Safe Medical Devices Act of 1990" Health Affairs. Vol. 10, No. 1, pp. 192-195.

Sanchez, David A., Richard C. Allen, and Walter T. Kyner (1983) Differential Equations: An Introduction. Reading, MA: Addison-Wesley Publishing.

Santerre, Rexford E. and Stephen P. Neun (2000) Health Economics: Theories, Insights, and Industry Studies. Orlando: Dryden Press, Harcourt Brace & Company.

Santoro, Michael D. and Joseph P. McGill (2005) "The Effect of Uncertainty and Asset Co-Specialization on Governance in Biotechnology Alliances" Strategic Management Journal. Vol. 26, No. 13, pp. 1261-1269.

Scanlan, Kevin P., Jack W. Trifts, and Richard H. Pettway (1989) "Impacts of Relative Size and Industrial Relatedness on Returns to Shareholders of Acquiring Firms" Journal of Financial Research. Vol. 12, No. 2, pp. 103-112.

Scheraga, Carl A. (2004) "Operational Efficiency versus Financial Mobility in the Global Airline Industry: A Data Envelopment and Tobit Analysis" Transportation Research Part A – Policy and Practice. Vol. 38, No. 5, pp. 383-404.

Scherer, F.M. (1970) Industrial Market Structure and Economic Performance. Chicago: Rand McNally.

Schnoll, Les (2001) "Corrective and Preventive Action in Medical Device Manufacturing" Quality Progress. Vol. 34, No. 11, pp. 75-82.

Securities Data Corporation (SDC) Worldwide Mergers and Acquisitions database, New York: Thompson Financial.

Seth, Anju (1990) "Sources of Value Creation in Acquisitions: An Empirical Investigation" Strategic Management Journal. Vol. 11, No. 6, pp. 431-446.

Seth, Anju, Kean P. Song, and Richardson Pettit (2002) "Value Creation and Destruction in Cross-Border Acquisitions: An Empirical Analysis of Foreign Acquisitions of U.S. Firms" Strategic Management Journal. Vol. 23, No. 10, pp. 921-940.

Shaver, J. Myles (1998) "Accounting for Endogeneity When Assessing Strategy Performance: Does Entry Mode Choice Affect FDI Survival?" Management Science. Vol. 44, No. 4, pp. 571 -585.

Shahrur, Husayn (2005) "Industry Structure and Horizontal Takeovers: Analysis of Wealth Effects on Rivals, Suppliers, and Corporate Customers" Journal of Financial Economics. Vol. 76, No. 1, pp. 61-98.

Shekelle, Paul G., Eduardo Ortiz, Sydne J. Newberry, Michael W. Rich, Shannon L. Rhodes, Robert H. Brook, and Dana P. Goldman (2005) "Identifying Potential Health Care Innovations for the Future Elderly" Health Affairs. Web Exclusive, Vol. 24, Supp. 2, pp. W5 R67-80.

Shukla, Rohit, Victor Hwang, Ketaki Sood, and James Klein (2003) "The Medical Device Industry: A Larta White Paper" Accessed at http://www.larta.org/Research/MedDevicePaper.asp.

Siau, Keng (2003) "Interorganizational Systems and Competitive Advantages: Lessons from History" Journal of Computer Information Systems. Vol. 44, No. 1, pp. 33-39.

Sicherman, Neil W. and Richard H. Pettway (1992) "Wealth Effects for Buyers and Sellers of the Same Divested Assets" Financial Management. Vol. 21, No. 4, pp. 119-128.

Singh, Harbir and Cynthia A. Montgomery (1987) "Corporate Acquisition Strategies and Economic Performance" Strategic Management Journal. Vol. 8, No. 4, pp. 377-386.

Singh, Harbir and Maurizio Zollo (1997) "Learning to Acquire: Knowledge Accumulation Mechanisms and the Evolution of Post-Acquisition Integration Strategies" Working Paper 97-10-B, Department of Management, The Wharton School, University of Pennsylvania.

Sloan F.A., J. Valvona, J.M. Perrin, and K.W. Adamache (1986) "Diffusion of Surgical Technology: An Exploratory Study" Journal of Health Economics. Vol. 5, No. 1, pp. 31-61.

Slovin, Myron B. and Marie E. Sushka (1998) "The Economics of Parent-Subsidiary Mergers: An Empirical Analysis" Journal of Financial Economics. Vol. 49, No. 2, pp. 255-279.

Small, Stephen D. (2004) "Medical Device: Associated Safety and Risk: Surveillance and Stratagems" Journal of the American Medical Association. Vol. 291, No. 3, pp. 367-370.

Smith, John J. (2001) "Regulation of Medical Devices in Radiology: Current Standards and Future Opportunities" Radiology. Vol. 218, No. 2, pp. 329-335.

Smith, P. (1990) "Data Envelopment Analysis Applied to Financial Statements" Omega International Journal of Management Science. Vol. 18, No. 2, pp. 131-138.

Snail, Timothy S. and James C. Robinson (1998) "Organizational Diversification in the American Hospital" Annual Review of Public Health. Vol. 19, pp. 417-453.

Sodhi, Rana N.S., V.P. Sahi, and M.W. Mittelman (2001) "Application of Electron Spectroscopy and Surface Modification Techniques in the Development of Anti-Microbial Coatings for Medical Devices" Journal of Electron Spectroscopy and Related Phenomena. Vol. 121, No. 1-3, pp. 249-264.

Song, Moon H. and Ralph A. Walkling (1993) "The Impact of Managerial Ownership on Acquisition Attempts and Target Shareholder Wealth" Journal of Financial and Quantitative Analysis. Vol. 28, No. 4, pp. 439-456.

Standard & Poor's Compustat database. New York: McGraw-Hill.

Standard & Poor's Industry Surveys (1998) "Healthcare: Products and Supplies." Issued September 10, 1998.

Standard & Poor's (2005) "S&P Index Table" accessed online at http://www2.standardandpoors.com.

Standard Industrial Classification Manual (1987) Washington D.C.: U.S. Government Office of Management and Budget.

Stewart, James (1991) Calculus, 2nd Edition. Pacific Grove, CA: Brooks/Cole Publishing.

Suk, David Y. and Hyun Mo Sung (1997) "The Effects of the Method of Payment and the Type of Offer on Target Returns in Mergers and Tender Offers" The Financial Review. Vol. 32, No. 3, pp. 591-607.

Takeuchi, K.J., R.A. Leising, M.J. Palazzo, A.C. Marschilok, and E.S. Takeuchi (2003) "Advanced Lithium Batteries for Implantable Medical Devices: Mechanistic Study of SVO Cathode Synthesis" Journal of Power Sources. Vol. 119, Special Issue, pp. 973-978.

Teplensky, Jill D., John R. Kimberly, Alan L. Hillman, and J. Sanford Schwartz (1993) "Scope, Timing and Strategic Adjustment in Emerging Markets: Manufacturer Strategies and the Case of MRI" Strategic Management Journal. Vol. 14, No. 7, pp. 505-527.

Teplensky, Jill D., Mark V. Pauly, John R. Kimberly, Alan L. Hillman, and J. Sanford Schwartz (1995) "Hospital Adoption of Medical Technology: An Empirical Test of Alternative Models" Health Services Research. Vol. 30, No. 3, pp. 437-465.

Thakor, Anjan V. (1996) "Capital Requirements, Monetary Policy, and Aggregate Bank Lending: Theory and Empirical Evidence" Journal of Finance. Vol. 51, No. 1, pp. 279-324.

Thompson One Banker database of Mergers and Acquisitions, accessed online at http://proxy.library.upenn.edu:8447/ta/?ExpressCode=upenn.

Thore, Sten, George Kozmetsky, and Fred Phillips (1994) "DEA of Financial Statements Data: The U.S. Computer Industry" The Journal of Productivity Analysis. Vol. 5, No. 3, pp. 229-248.

Travlos, Nickolaos G. (1987) "Corporate Takeover Bids, Methods of Payment, and Bidding Firms' Stock Returns" Journal of Finance. Vo. 42, No. 4, pp. 943-963.

Upchurch, Gilbert R., Justin B. Dimick, Reid M. Wainess, Jonathan L. Eliason, Peter K. Henke, John A. Cowan, Matthew J. Eagleton, Sunita D. Srivastava, and James C. Stanley (2004) "Diffusion of New Technology in Health Care: The Case of Aorto-Iliac Occlusive Disease" Surgery. Vol. 136, No. 4, pp. 812-816.

U.S. Bureau of Economic Analysis, Economics and Statistics Administration (2006) "Current Dollar and Real Gross Domestic Product" Accessed online at http://www.bea.gov/bea/dn/gdplev.xls.

U.S. Census Bureau, Economics and Statistics Administration, U.S. Department of Commerce (1988) Value of Product Shipments. 1986 Annual Survey of Manufactures, M86(AS)-2.

U.S. Census Bureau, Economics and Statistics Administration, U.S. Department of Commerce (1996) 1992 Census of Manufactures. Subject Series, MC92-S-1.

U.S. Census Bureau, Economics and Statistics Administration, U.S. Department of Commerce (1998) Value of Product Shipments. 1996 Annual Survey of Manufactures, M96(AS)-2, Accessed online at http://www.census.gov/prod/3/98pubs/m96-as2.pdf.

U.S. Census Bureau, Economics and Statistics Administration, U.S. Department of Commerce (2003) Value of Product Shipments: 2001. Annual Survey of Manufactures, M01(AS)-2, Accessed online at http://www.census.gov/prod/2003pubs/m01as-2.pdf.

U.S. Census Bureau, Economics and Statistics Administration, U.S. Department of Commerce (2004a) "Correspondence Tables: 2002 NAICS Matched to 1987 SIC" Accessed online at http://www.census.gov/epcd/naics02/N02TOS87.HTM.

U.S. Census Bureau, Economics and Statistics Administration, U.S. Department of Commerce (2004b) "Historical Poverty Tables – Periods of Recession" Accessed online at http://www.census.gov/hhes/poverty/histpov/recessn.html.

U.S. Census Bureau, Economics and Statistics Administration, U.S. Department of Commerce (2005a) Statistics for Industry Groups and Industries: 2004. Annual Survey of Manufactures, M04(AS)-1, Accessed online at http://www.census.gov/prod/2005pubs/am0431gs1.pdf.

U.S. Census Bureau, Economics and Statistics Administration, U.S. Department of Commerce (2005b) Value of Product Shipments: 2004. Annual Survey of Manufactures, M04(AS)-2, Accessed online at http://www.census.gov/prod/2005pubs/am0431vs1.pdf.

U.S. Department of Justice (1997) "The Herfindahl-Hirschman Index" Accessed online at http://www.usdoj.gov/atr/public/testimony/hhi.htm.

U.S. Department of Labor, Bureau of Labor Statistics (1991) CPI Detailed Report: Data for January 1991, Table 25, page 76.

U.S. Department of Labor, Bureau of Labor Statistics (2001) CPI Detailed Report: Data for December 2000 , Table 25, Accessed online at http://www.bls.gov/cpi/cpid0012.pdf.

U.S. Food and Drug Administration (2005) "FDA Organization" Accessed online at http://www.fda.gov/opacom/7org.html.

U.S. International Trade Administration, U.S. Department of Commerce (2005) "Industry, Trade, and the Economy: Data and Analysis" Accessed online at http://ita.doc.gov/td/industry/otea/industry_sector/tables_naics.htm.

U.S. Library of Congress (1983) Thomas Legislative Information System "Bill Summary & Status for the 98th U.S. Congress" Accessed online at http://thomas.loc.gov/cgi-bin/bdquery/z?d098:HR01900:|TOM:/bss/d098query.html|.

U.S. Office of Management and Budget (1997) "1997 North American Industry Classification System—1987 Standard Industrial Classification Replacement" Federal Register. Vol. 62, No. 68, April 9, pp. 17287-17337.

U.S. Patent and Trademark Office, U.S. Department of Commerce, Patent Full Text and Image Database. Accessed online at http://patft.uspto.gov/netahtml/search-adv.htm.

U.S. Patent and Trademark Office, U.S. Department of Commerce (2005) "General Information Concerning Patents" Accessed online at http://www.uspto.gov/go/pac/doc/general/index.html.

U.S. Securities and Exchange Commission (1994) Ballard Medical Products Form 10-K Report Filing for the Period Ending September 30, 1994.

U.S. Securities and Exchange Commission (1995) Nellcor Puritan Bennett Incorporated, Form 10-K405 Filing for the Period Ending July 2, 1995.

U.S. Securities and Exchange Commission (1995) Stryker Corporation Form 10-K Filing for the Period Ending December 31, 1994.

U.S. Securities and Exchange Commission (1995) United States Surgical Corporation Form 10-K Filing for the Period Ending December 31, 1994.

U.S. Securities and Exchange Commission (1996) Form S-4 filing for the purchase of Daig Corporation by St. Jude Medical, Inc.

U.S. Securities and Exchange Commission (1996) Medtronic, Inc., Form 10-K Filing for the Period Ending April 30, 1996.

U.S. Securities and Exchange Commission (1997) Form S-4 filing for the purchase of Target Therapeutics, Inc. by Boston Scientific Corporation.

U.S. Securities and Exchange Commission (1997) Boston Scientific Corporation Form 10-K Filing for the Period Ending December 31, 1996.

U.S. Securities and Exchange Commission (1997) Guidant Corporation Form 10-K Filing for the Period Ending December 31, 1996.

U.S. Securities and Exchange Commission (1997) United States Surgical Corporation Form 10-K Filing for the Period Ending December 31, 1996.

U.S. Securities and Exchange Commission (1998) Abiomed, Inc. Form 10-K Filing for the Period Ending March 31, 1998.

U.S. Securities and Exchange Commission (1999) C. R. Bard, Inc. Form 10-K Filing for the Period Ending December 31, 1998.

U.S. Securities and Exchange Commission (1999) Fischer Imaging Corporation Form 10-K Filing for the Period Ending December 31, 1998.

U.S. Securities and Exchange Commission (2002) Medtronic, Inc., Form 10-K Filing for the Period Ending April 26, 2002.

U.S. Securities and Exchange Commission (2004) Boston Scientific Corporation, Form 10-K Filing for the Period Ending December 31, 2003.

U.S. Securities and Exchange Commission (2005) Advanced Neuromodulation Systems, Inc., Form 10-K Filing for the Period Ending December 31, 2004.

U.S. Securities and Exchange Commission (2005) Zimmer Holdings, Inc. Form 10-K Filing for the Period Ending December 31, 2004.

van Hout, B.A., P.W. Serruys, P.A. Lemos, M.L.B.M. van den Brand, G.A. van Es, W.K. Lindeboom, and M.C. Morice (2005) "One Year Cost Effectiveness of Sirolimus Eluting Stents Compared with Bare Metal Stents in the Treatment of Single Native De Novo Coronary Lesions: An Analysis from the RAVEL Trial" Heart. Vol. 91, No. 4, pp. 507-512.

Very, Philippe, Michael Lubatkin, Roland Calori, and John Veiga (1997) "Relative Standing and the Performance of Recently Acquired European Firms" Strategic Management Journal. Vol. 18, No. 8, pp. 593-614.

Vistnes, Gregory, (1995) "Hospital Mergers and Antitrust Enforcement" Journal of Health Politics, Policy, and Law. Vol. 20, No. 1, pp. 175-190.

Wagner, Mary (1993) "Life in the Slow Lane at the FDA: Device Makers Say Slow Process Hurts Them and Product Users" Modern Healthcare. February 1st issue.

Wang, Bill B., Yasar A. Ozcan, and Thomas T.H. Wan, and Jeff Harrison (1999) "Trends in Hospital Efficiency Among Metropolitan Markets" Journal of Medical Systems. Vol. 23, No. 2, pp. 83-97.

Warner, K.E. (1978) "Effects of Hospital Cost Containment on Development and Use of Medical Technology" Milbank Memorial Fund Quarterly. Vol. 56, No. 2, pp. 187-211.

Wernerfelt, Birger (1995) "The Resource-Based View of the Firm: 10 Years After" Strategic Management Journal. Vol. 16, No. 3, pp. 171-174.

Wilcoxon, Frank (1945) "Individual Comparisons by Ranking Methods" Biometrics. Vol. 1, No. 6, pp. 80-83.

World Research Group (2006) Conference titled "Managing and Controlling Physician Preference Items" January 17-19, 2006, in Scottsdale, Arizona. https://www.worldrg.com/HW609/agenda_dayone.asp.

Wright, Peter, Mark Kroll, and Detelin Elenkov (2002) "Acquisition Returns, Increase in Firm Size, and Chief Executive Officer Compensation: The Moderating Role of Monitoring" Academy of Management Journal. Vol. 45, No. 3, pp. 599-608.

Yeh, Quey-Jen (1996) "The Application of Data Envelopment Analysis in Conjunction with Financial Ratios for Bank Performance Evaluation" Journal of the Operational Research Society. Vol. 47, No. 8, pp. 980-988.

Yeheskel O, O Shenkar, A Fiegenbaum, and E Cohen (2001) "Cooperative Wealth Creation: Strategic Alliances in Israeli Medical Technology Ventures" Academy of Management Executive. Vol. 15, No. 1, pp. 16-24.

Young, Gary J., Kamal R. Desal, and Fred J. Hellinger (2000) "Community Control and Pricing Patterns of Nonprofit Hospitals: An Antitrust Analysis" Journal of Health Politics, Policy, and Law. Vol. 25, No. 6, pp. 1051-1081.

Zollo, Maurizio and Harbir Singh (2004) "Deliberate Learning in Corporate Acquisitions: Post-Acquisition Strategies and Integration Capability in U.S. Bank Mergers" Strategic Management Journal. Vol. 25, No. 13, pp. 1233-1256.