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The Determinants of Hospital Adoption and Expansion of Bariatric Procedures: A Resource Dependence Perspective

Wenquiang Tian
Virginia Commonwealth University

The Determinants of Hospital Adoption and Expansion of Bariatric Procedures: A Resource Dependence Perspective

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University

By

Wenqiang Tian,
B.S.M., Zhengzhou University, 1998
M.S., Chinese Center for Disease Control and Prevention, 2001

Dissertation Director: Robert E. Hurley, Ph.D.
Associate Professor, Department of Health Administration

Virginia Commonwealth University
Richmond, Virginia
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ABSTRACT

The Determinants of Hospital Adoption and Expansion of Bariatric Procedures: A Resource Dependence Perspective.

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New medical technologies have been viewed as the primary cause of rising health care expenditures by health policy researchers in the United States. Since the mid 1990s, with the prevalence of obesity among Americans, the utilization of bariatric surgery, a medical innovation, has increased rapidly among U.S. hospitals. Generally, current literature only states that the volume of bariatric procedures is increasing dramatically. Very limited studies have been conducted to investigate the growth of bariatric procedures. The objective of this study is (1) to provide a detailed description about the adoption and utilization of bariatric procedure in hospitals in 11 states, and (2) to identify the factors significantly enhancing hospitals to adopt or expand the service of surgical treatment for obesity.

A panel design from 1995 to 2000 was employed in this study. Several databases are merged together for the final analysis.

The descriptive analyses show that the increase in bariatric procedures is coming from two contributors: the entry of hospitals into the market of bariatric surgery, and the

continuous expansion of capacity of offering the surgery by antecedent adopters. The panel analyses provided mixed support to the factors influencing hospitals' decision on adoption or expansion of bariatric surgery. The fixed-effects logit model suggests that hospital size, competition and cumulative adoption rate in a local market are strong predictors of hospitals' adoption of the surgery. The fixed effects model shows that ownership status, payment mix improvement, and cumulative adoption rate in a local market are strongly impact the expansion rate of bariatric procedures in hospitals.

These findings suggest determinants enhancing hospitals to adopt or expand the bariatric service program. As the provision of bariatric procedures continues to increase among U.S. hospitals, health plans and policy makers will face greater challenges to balance the demand of patients with morbid obesity and the rapid increasing healthcare expenditures related to the surgery.

CHAPTER 1 – INTRODUCTION

Advances in medical technology have attracted widespread attention in recent decades both for the substantial benefits produced for patients and for the rapidly rising costs incurred. Health policy researchers have pointed out the technological changes as the primary cause of rising health care expenditures (Chernew et al., 1998; Newhouse, 1993). Traditional, fee-for-service insurance is thought to bias the innovation adoption towards higher quality, but higher cost (Weisbrod, 1991). The early and duplicative adoption of these innovations by hospitals, as described by the literature, led to the increases in health care costs. With the introduction of the Prospective Payment System (PPS) based on DRGs and managed care, the hospital industry in the United States has been experiencing a profound change over the last two decades. Increasing market competition, changing payment system, newly-emerged needs, and various policy requirements have put the health care market in a situation of turmoil. Hospitals, which account for 60 percent of U.S. medical cost, pay continuous attention to respond to the changing environment from researchers, policy makers, and health insurers.

As the health care environment moves toward managed care and PPS, hospitals no longer receive full reimbursement through traditional fee-for-service payment or cost-based reimbursement system, which were widely used before the payment changes in the 1980s. Given the concern held by most of policy makers and researchers that these payment methods fueled the adoption and utilization of medical innovations, it is quite unclear why and how hospitals continue to adopt and utilize new medical technologies under such situations. By using the case of bariatric surgery, the surgical treatment for obesity, this study intends to

explain what factors and how these factors influence hospitals to adopt and use the medical innovations under the current environment of the health care market.

Background

After the world entered the 20th century, many remarkable and unprecedented improvements had been achieved in the lives of people. However, complex new health challenges also continue to emerge and confront us despite these successes. Obesity and overweight are among the most important of these new challenges. Although the World Health Organization (WHO) has recognized obesity as illness for quite a long while, the concept of obesity as illness was not accepted by Medicare until July, 2004 (CMS, 2004; WHO, 1998).

The Prevalence and Impacts of Obesity

The US is facing a rapid increase in the prevalence of population who are overweight and obese, which are defined as body mass index (BMI) 25-29.9 and greater than 30, according to the National Institute of Health (Fitch et al, 2004). Between the 1960s and 1988-1994, the National Health and Nutrition Examination Survey (NHANES) showed that the prevalence of obesity had only increased by approximately 8 percent in the United States after a relatively stable period from 1960 to 1980. Since these data were published, additional reports suggested that this trend is still continuing and is growing faster. As shown by the latest NHANES survey, in 1999-2000, the prevalence of overweight American adults is 64.5%, and the prevalence of obesity is 30.5%. Also, extreme obesity, defined as BMI greater than 40, increased to 4.7% (Flegal, et al, 2002). According to the CDC National Health Interview 2003 findings, approximately one quarter of Americans are considered obese during the period of 1997-2003, which is a similar conclusion as NHANES 1999-2000 (DHHS, 2001).

The dramatic prevalence of obesity raises growing concern in the United States. Many public health institutions and organizations have tried to warn the public about the negative

effects of being overweight or obese. Evidence was found that obesity raises health risks such as an increase in mortality and morbidity, and consequently, related healthcare expenditures. First, epidemiological studies showed that an increase in mortality in the United States is associated with being overweight and obese. It is estimated that 300,000 deaths a year may be attributable to obesity (Allison, et al. 1999). Further, it is estimated that white men aged 23 to 25 with a severe level of obesity (BMI>45) are expected to lose 13 expected life years, which represent a 22% reduction in expected remaining life span (Fontaine, et al. 2003).

Second, overweight and obesity are also increasing the morbidity of Americans, which may be as a great influence as poverty, smoking, or problem drinking (Sturm and Wells, 2001). As the NIH pointed out (NIH, 1998), obesity is associated with an increased risk for coronary heart disease; type II diabetes; hypertension; psychological disorders; endometrial, colon, postmenopausal breast, and other cancers; and certain musculoskeletal disorders. Results of surveys and data analysis demonstrate the negative effect of obesity on maintaining and improving health and quality of life. As a result, obesity and overweight have substantial economic consequences for the U.S. health care system and business costs.

The prevalence of overweight and obesity results in both direct and indirect costs. In 2000, the total costs (direct and indirect) attributable to obesity were estimated to be $99 billion in 1995 (Wolf and Colditz, 1998), and $117 billion in 2000 (Wolf, 2001). Obesity has been estimated to account for 9.1% of annual US medical expenditures and 5% of medical costs for US business (Thompson, et al. 1998). Thorpe and colleagues (2004) estimated that the rising prevalence of obesity accounted for 27 percent of the growth in real per capita spending between 1987 and 2001.

Treatments for Obesity

With the growing prevalence of obesity and overweight, the need for treatment increases. For individuals, research has shown that as body mass increases, so do healthcare utilization and costs (Heirhoff, et al, 1997). Sturm's (2002) study suggested that obesity increases health costs 36% for inpatient and ambulatory care and medication costs 77% compared to people in a normal weight range. Given that many public health organizations and media continuously warn the public about the dangers of obesity, the opinion of maintaining appropriate weight has been accepted among Americans. People who are overweight or obese are increasingly interested in weight loss or seeking treatment.

According to a NIH expert panel, three major treatments for weight loss or weight maintenance are believed to be most successful and recommended: dietary therapy, increased physical activity, and behavior therapy. However, both experience and research reveal that lost weight usually is regained easily by using these therapies. Therefore, there has been an increased interest in the treatment of obesity with prescription drugs, and, especially surgery. Published reports suggested that adults with severe obesity do not often achieve long-term weight loss with non-operative methods alone. The NIH recommendation states that surgical intervention is an option for patients with severe obesity who are at high-risk for obesity-associated morbidity and mortality. Previous studies proved that surgery for obesity has produced the longest period of sustained weight loss in severely obese individuals (NIH, 2003).

Bariatric Surgery: Type and Market

Surgery for severe obesity, referring to bariatric surgery, began in the early 1950s. It has continually evolved through the last 50 years. The aim of bariatric surgery is to modify the gastrointestinal tract to reduce net food intake. Generally, bariatric surgery falls into two major

designs: malabsorptive procedures and restrictive procedures. Roux-en-Y gastric bypass (RYGB) and bilio-pancreatic diversion with duodenal switch (BPD-DS), the most commonly performed procedures, account separately for about 75% and 10% of bariatric surgical procedures. Both procedures are classified as malabsorptive procedures. Vertical banded castroplasty (VBG), the most common restrictive operation, accounts for approximately 15% of bariatric surgical procedures performed. The techniques and clinical outcomes have improved dramatically over the years. The most common types of such procedures were developed during the period from 1985 to 1996.

Bariatric surgery is a lucrative service, which is believed by researchers, physicians, and hospital executives to raise hospitals' profit margins. There is no well-accepted estimation of cost for the procedure. New York Health Plan Association estimates that the average cost of this procedure ranges from $20,000 to $35,000 across the US. In Pennsylvania, the average hospital charge for bariatric surgery was $35,643 in 2003. Fitch and associates (2004) believed that a typical case of bariatric surgery can easily cost a health plan $60,000. Also making the procedure lucrative is the willingness of patients to pay cash even if they do not have insurance or they have been denied coverage for this procedure. As the result, "this is the highest-paying general surgical procedure there is," said Edward H. Livingston who has performed about 1500 bariatric procedures, "and a lot of patients will pay." (Mitka, 2003).

Facing the dramatically increased demand for treatment of obesity, the coverage denial for bariatric procedures has gradually become a thing of the past. More and more health plans have covered the surgical procedures, provided that a physician determines it to be medically necessary (Alt, 2003). Several states have mandated coverage of treatments for morbid obesity, which include bariatric surgery, and the increasing prominence of the issue suggests more states will follow (Fitch, 2004). The biggest payer for bariatric surgery is the commercial

health insurance company, which provides more than 80 percent of cost for such procedures to hospitals (Alt, 2003).

Additionally, a new policy handed down by the Department of Health and Human Services removed the phrase "obesity itself cannot be considered an illness" from the Medicare Coverage Issues Manual, allowing scientists, clinicians and companies to submit proposals recommending that certain treatments be covered (Glassman, 2004). Those interventions could come in the form of surgical procedures, dietary counseling or cognitive behavioral therapies. This implies that Medicare will enter the market of bariatric surgery and become another major important payer for this procedure in the future along with commercial insurers. As the result, hospitals could admit more patients demanding bariatric surgery under the coverage of Medicare, and expand the capacity of offering the service to more people with obesity.

Several factors, such as the increasing demand, high profitability, and expanded insurance coverage, are believed to drive the volume of bariatric procedures which has been increasing rapidly in hospitals. The volume of bariatric surgeries performed in the US expands exponentially in the last decade. According to the American Society for Bariatric Surgery (ASBS), the 144,000 bariatric procedures expected to be performed in 2004 in the US represent more than twice the number in 2002 and more than five times the 25,800 surgeries performed in 1998. The demand for the surgery is so great that many hospitals have year-long waiting list of hundreds of patients (Mitka, 2003). With an estimated more than ten millions people with morbid obesity in the United States, the trend of rapid increasing bariatric procedures is expected to carry forward into the future.

Purposes of Study

Although the phenomenon of increasing bariatric procedures has been recognized, the factors influencing its rapid expansion are still unclear. Therefore, the first purpose of this

study is to make clear whether the growth of bariatric procedures is the consequence of increasing adoption of the medical technology, or of the expanding volume that happened in some hospitals where the technology had been adopted, or of the combination of above two situations. This explanation would provide a relatively clear description of the procedure growth and its sources. Further, the description of growth is expected to confirm the assumption that the diffusion of bariatric procedures resulted from both new adopters and past adopters expanding their capacity to offer this service.

Based on the assumption that the growth is the mix of the two components, the main purpose of this study is to develop and examine a conceptual framework to identify the effects of environmental and organizational factors on the adoption and expansion of bariatric surgery in U.S. hospitals. By examining the direct relationship among these constructs, the hospital response to the internal organizational constraints and external environmental changes can be determined. Related policy implications can also be drawn.

This study employs resource dependence theory to examine the expanding trend of bariatric procedures among U.S. hospitals. By using resource dependence theory, this study will explore the relationship between the volume of the procedures performed in a hospital and organizational, environmental, and other factors. Through this perspective, the adoption and expansion of bariatric surgery are considered as a response by a hospital to environmental conditions that threaten its core function.

Research Questions

Given the nature of bariatric surgery, it is defined as a medical innovation in this study. However, it does not mean that the growth of bariatric procedures simply results from the diffusion of this medical innovation. As argued by Grossman and Banks (1995), the successful diffusion of medical innovation is composed of two components: it is adopted by an increasing

portion of physicians or hospitals, and its rate of utilization by these adopters also increases at the same time. Therefore, three possibilities are considered in this study to explain the rapid growth of bariatric procedures. First, it is possible that bariatric surgery was adopted in several hospitals originally and then it was diffused to other hospitals during the 1990s, and the increased cases of adoption resulted in the rapid growth of number of the procedures performed by hospitals. Second, because bariatric surgery was developed in the mid-1950s, it is possible that it has been adopted by most hospitals in the United States over the last four decades. Because of the change of payment system and high profitability of performing bariatric procedures, the volume of bariatric procedures performed in these hospitals generally increased with the rapid increase in demand for treatments of obesity in recent years. Thus, the total number of procedures performed jumped as a response to the market need. Third, the growth is the mixed result of the two above possibilities. This indicates that bariatric surgery is being diffused across hospitals, and most of the adopters performed more bariatric procedures for some certain purpose. Both perspectives interact and result in the rapid growth of the procedures in the hospitals. Up to now, there is no previous research describing what is behind the curve of rapid increased volume of bariatric procedures. Thus, it is inappropriate to exclude one of the three assumptions without evidence.

To shed light on the natural growth described in the previous reports, the study expects to give a clear picture of the expansion of procedures across hospitals. The following research questions are based on which assumption is primarily responsible for the growth of baritric procedures. Therefore, in order to clarify the real story behind the expanding of bariatric surgery, the first research question (RQ1) is proposed as: Is the growth of bariatric procedures the consequence of the entry of more new hospitals into this market of the surgery, or increased volume of the surgery among most adopters, or both?

Based on the assumption proposed in research question 1, two related research questions emphasize what influences a hospital's decision to adopt or expand the bariatric procedures. Both adoption and expansion of bariatric procedures are seen as a hospital's response to environmental changes such as reimbursement variation, policy requirements, initiation of managed care, and so on. How hospitals respond to the changes in environment will be affected by their internal constraints and external constraints. The literature reviewed in Chapter 2 suggest that organizational characteristics, environmental constraints, and financial situations affect a hospital's decision of adopting or expanding the utilization of new technologies. In order to understand the reason for the dramatic increase in the volume of bariatric procedures in recent years, it should be answered what makes the hospitals offering such procedure or operating more procedures than before. By examining the differences between adopters and non-adopters of bariatric surgery, one can expect to determine the environmental factors, organizational factors, and other factors that are associated with the hospital adoption of bariatric surgery. Similarly, by identifying relevant factors, it may be understood why some hospitals are interested in increasing bariatric procedures faster than other hospitals. Thus, the following two questions are proposed to examine the possible relationships among hospital characteristics, environmental factors and hospital's decision of offering or expanding bariatric procedures.

RQ2: What factors influence the adoption of bariatric surgery in hospitals?

RQ3: What factors are associated with the expansion of bariatric surgery in the hospitals that have adopted the procedure?

Overview of Conceptual Framework

The conceptual framework of this study is drawn from the literature related to organizational adaptation. There is a significant body of theoretical literature that is focused on

the response of organizations to the environment (Child and Kieser, 1981; DiMaggio and Powell, 1991; Meyer and Rowan, 1991; Pfeffer and Salancik, 1978; Pfeffer, 1982; Scotter, 1987; Thompson, 1967). In this investigation, resource dependence theory will be applied in order to answer the research questions proposed.

Resource dependence theory argues that the organizational survival depends on acquiring slack resources from the external environment. An organization, therefore, deliberately attempts to reduce its dependence on other organizations in the environment that control the critical resources they need for survival (Pfeffer and Salancik, 1978). On the other hand, the theory also suggests that organizations do not passively comply with demands from external environments, but attempt to maintain their autonomy. Therefore, organizations would balance the acquisition of necessary sources against the maintenance of their autonomy depending on the source situation. Organizations maintain their independence when sources in external environments are quite certain, or they owned plentiful resources, or they have more ability to acquire resources. However, faced with the uncertainty of critical resources, organizations would give up autonomy to exchange the necessary resources that are key to organizational survival. Whichever response will be selected by an organization facing environmental changes depends on an individual organization's characteristics, environmental resource certainty, and the likelihood that the response will successfully reduce the resource uncertainty. Based on resource dependence theory, a conceptual model is constructed to explain the hospitals' responses to the utilization of bariatric procedures (Figure 1). Because both adoption and expansion of bariatric procedures are seen as the same kind of response of hospitals to environmental change, this model will be applied to answer research question two and question three.

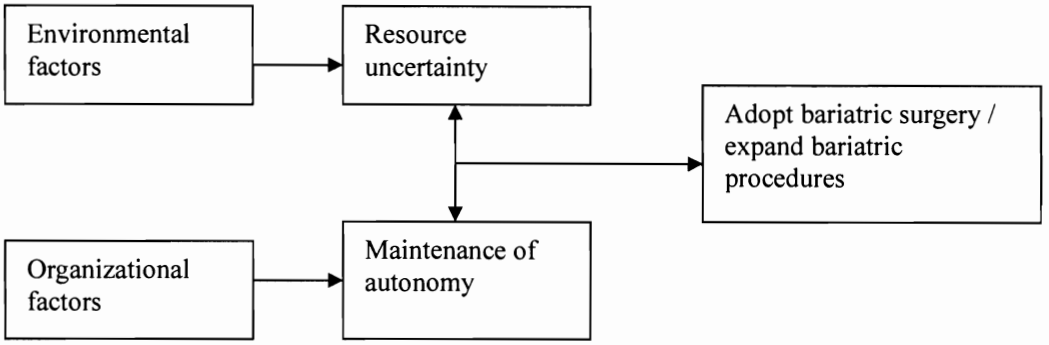

Figure 1. Conceptual Model of Hospital Adoption/Expansion of Bariatric Procedure.

According to this model, the adoption and expansion of bariatric procedures in hospitals are the function of the resource uncertainty faced by hospitals and the ability of hospitals to maintain their autonomy. Environmental factors affect the level of resource uncertainty, while, organizational characteristics determine the hospital's ability to maintain autonomy as well as the ability to respond through adoption and expansion. The interplay between the environment, the organization, and the innovation itself constructs a basic framework for analysis.

Scope and Approach

This study uses two major retrospective data sets, the American Hospital Association (AHA) annual survey and Healthcare Cost and Utilization Project (HCUP) state inpatient databases (SID). Several other datasets, the Area Resource File (ARF), the CDC Behavioral Risk Factor Surveillance System Files (BRFFS), the Health Policy Tracking Service files, the Interstudy file, and Centers for Medicare & Medicaid Services (CMS) data, will provide complementary information for this study. All data used in study range from 1995 to 2000, a period of six years. The community hospital is the unit of analysis in this study.

The sample frame in this study is all community hospitals in 11 selected states, which include Arizona, California, Colorado, Florida, Iowa, Maryland, Massachusetts, New Jersey,

New York, Washington, and Wisconsin. Through excluding the specialty hospitals, closed hospitals, and non-responders, a panel ranging from 1995 to 2000 will be created for final analysis. Given that HCUP SID provides universal information on all hospitals in states, research question one will be answered with a description of all the hospitals adoption and expansion of bariatric procedures in the 11 selected states.

The hospital status of adoption of bariatric surgery is the focus of research question two. For research question three, expansion of the procedure is measured by the number of increase in the annual volume of bariatric procedures performed in the hospitals that had the procedure. The study examines the relationships of hospitals adoption status and expansion rate with environmental factors and organizational characteristics.

Several analytical approaches will be used for this research. First, an accurate estimation will be made on a base of the population, rather than sample, to obtain the description of adoption and utilization of bariatric surgery in hospitals. Then a conditional logistic regression will be used to examine the relationship between hospital adoption and environmental and organizational factors. After this, a panel data analysis with fixed effect model will be utilized to analyze the influence of environmental and organizational factors on the expansion of bariatric procedures in the hospitals that had adopted this technology.

Rational and Significance

Although researchers and organizations have noted the phenomenon that the volume of bariatric procedures has expanded dramatically in recent years (Alt, 2001; ASBS, 2004; Fitch, 2004), limited analysis has been available to date. There is a dearth of research in this field. First, despite knowledge of the fact of rapid growth of bariatric procedures, there is no research telling us what the trend has been in the hospital adoption and expansion of the procedures. Generally, current literature only states that the volume of bariatric procedures is increasing

dramatically (Alt, 2001; ASBS, 2004; Fitch, 2004). The information of hospital adoption and utilization of bariatric procedure, that is critical to future research, remains unanswered in the current literature. Second, according to the relevant literature searching, most research related to bariatric surgery comes from the clinical perspective and focuses on the outcome of this procedure. Very few studies have been conducted within specific organizational fields and in local market areas. Third, there is still no literature investigating the reason that pushes the hospitals to begin to perform bariatric surgery, or for those who already adopted it how they expand their capacity to do more procedures. In general, very limited studies have been conducted to investigate the growth of bariatric procedures. Given the serious prevalence of obesity among Americans and the exponential increase in the volume of bariatric surgeries, the rapid increase of bariatric procedures is anticipated to contribute greatly to the healthcare expenditure growth in the United States. With more and more health plans beginning to cover bariatric surgery and Medicare's new change in coverage of this procedure, it is expected that the rapid growth of the procedures will increase for a long future. As the major provider of this procedure, hospitals are drawing increasing attention from health plans, policy makers, and, certainly, patients with obesity. There is considerate need for this study and future studies in this field.

There are several important contributions that will be realized through this research. First, this study will provide a detailed description about the adoption and utilization of bariatric procedure in hospitals in 11 states. Although it is not a nationwide estimation, this study can offer the basic information about the utilization of the procedure in hospitals in these states, which may be helpful for future research on this technology. Second, this study will contribute to the current body of literature by initiating an empirical study for the utilization of bariatric procedures from an organizational perspective. Very little literature focusing on this technology

comes from the organizational perspective, which emphasizes the hospital's decision of adoption, utilization, and management of medical innovation. This study is expected to provide an explanation for the increase in utilization of bariatric procedures different from a clinical perspective. Finally, through examining the relationship between the adoption/expansion of the technology and environmental and organizational factors, it is expected to identify the factors significantly enhancing hospitals to adopt or expand the service of surgical treatment for obesity. Given the concern about increasing healthcare expenditures, the results will have implications for policy and regulator agencies. Also, the study is expected to identify those most possible adopters and the biggest adopters, who contribute most to health costs. These high volume hospitals should be paid attention by health plan and, particularly, Medicare, which has decided to cover bariatric procedures for the enrollees. It is critical for health plans to identify these hospitals in order to control reimbursement of the costs due to the medical innovation. In summary, this study is expected to contribute to the current literature body by providing implications to not only researchers but also health plans and policy makers.

Conclusion and Outline of Remaining Chapters

This chapter introduced the study that is conducted in this dissertation. The current situation of prevalence of obesity and utility of bariatric surgery is addressed. A theoretical framework based on resource dependence perspective is introduced. Three research questions are proposed in exploring the growth of bariatric procedures in hospitals.

Chapter two provides an overview of the literature on bariatric procedure, the use of the procedure, and the outcome of this surgery. The literature on the adoption and utilization of new medical innovations is also reviewed in the second chapter. In chapter three, the description of resource dependence theory will be presented, as well as the conceptual model. Rationale and hypotheses are proposed. In chapter four, the research design, description and

sources of data are presented. This chapter provides measurements for variables used in this study, as well as the statistical analysis plan. Results in narrative and tabular form are presented in chapter five. Chapter six provides the conclusion and policy implications of this study.

CHAPTER 2 - LITERATURE REVIEW

This chapter reviews the current situation of the prevalence of obesity among Americans and the history and evolution of bariatric surgery since the early 1950s. The growth of bariatric procedures and its possible reasons are then discussed. Because the bariatric surgery is viewed as a medical innovation in this study, the chapter discusses innovation and explores an operational definition for this study. Then the chapter reviews the current literature about the studies on hospitals adoption of innovations regarding the time dimension, which addresses the question of how earlier adopters differ from later adopters of an innovation. In addition, studies on the factors associated hospitals increasing their services.

Bariatric Surgery: Context, Introduction, Demands, and Outcomes

Context

The prevalence of overweight and obesity in Americans has reached alarming levels. By using the CDC standard for obesity (overweight defined as BMI ≥25 and obesity defined as BMI ≥30), approximately two thirds of individuals in the United States are overweight, and of them, almost half are obese, which is the highest percentage among the world (Buchward et al, 2004; CDC, 2003; NCHS, 2002). Among the obese people, those with severe or morbid obesity are seen as the population suffering the most danger from obesity, and most likely to seek treatment, especially bariatric surgery (Buchward et al, 2004). Morbid or severe obesity is defined as a BMI of 40 or more, or a BMI of 35 or more in the presence of comorbidities. According to the US1999-2000 population data, the prevalence of severe obesity was

estimated to be 3.1% in males and 6.7% in females (Flegal et al, 2002). Figure 2 shows the escalating prevalence of overweight and obesity in the United States from 1988 to 2004.

Figure 2. Escalating Prevalence of Overweight and Obesity in the United States, 1988-2004. Source: NCHS (National Center for Health Statistics), 2006.

The increase in the prevalence of obesity is associated with the rise in the prevalence of obesity comorbidities, such as type II diabetes, hyperlipidemia, hypertension, obstructive sleep apnea, heart disease, stroke, asthma, several forms of cancers, and depression (Fitch et al, 2004; US DHHS, 2001). These comorbidities account for approximately 30,000 deaths per year in the U.S. (Allison et al, 1999; Mokdad et al, 2001) As reported, in patients with morbid obesity, mortality was 12 times higher in men aged 25 to 34 years and 6 times higher in men aged 35 to 44 years versus men with healthy weight of the same age (Drenick, et al. 1980).

Despite the high danger related to obesity, clinical research indicates that even modest weight loss (10%-15% of initial weight) could result in improvement or resolution of multiple medical comorbidities (Dietel, 2001). The dramatic prevalence of obesity among U.S. citizens

leads to a high demand for treatments. As reported, various treatments such as dietary therapy, excise, behavior therapy, prescription drug therapy, and surgery for obesity, are available in the United States (Fitch, 2004; DHHS, 2001; Serdula, Khan, and Dietz, 2003). Based on the clinical research, however, the non-operative kinds of therapies are relatively ineffective in treating obesity over the long term. Most of patients with non-operative treatments regain all the weight lost over the subsequent five years (Serdula, Khan, and Dietz, 2003). In 1991, the National Institute of Health established guidelines for the surgical therapy of morbid obesity, which is now referred to as bariatric surgery, and opened the stage for an explosive increase in its utilization (Fitch, 2004).

Introduction of Bariatric Surgery

Bariatric surgery, introduced in the early 1950s, has been continually improved during the last four decades. The first bariatric procedure to be preceded by animal studies was presented and published by Kreman and associates in 1954 (Kremen et al, 1954). With continuous evolution, the surgery has improved to be a systematic treatment for obesity. Bariatric surgery has now developed along three generic lines: malabsorptive, malabsoptive/restrictive, and purely restrictive (Buchwald, 2002). In general, four types of bariatric procedures and their variations are being performed as shown in Figure 3.

The jejuno-ileal bypass, the prototype of malabsorptive procedures, was the first-generation bariatric surgery. Originated in 1953 and 1954, this procedure dominated bariatric surgery for more than 20 years. However, multiple complications are associated with JIB, which include mineral and electrolyte imbalance, protein calorie malnutrition, cholelithiasis, enteric complications, extra-intestinal manifestations, and other miscellaneous.

Given the significant complications, this procedure was developed to bilio-pancreatic division with duodenal switch (BPD-DS), the second-generation malabsorptive procedure in

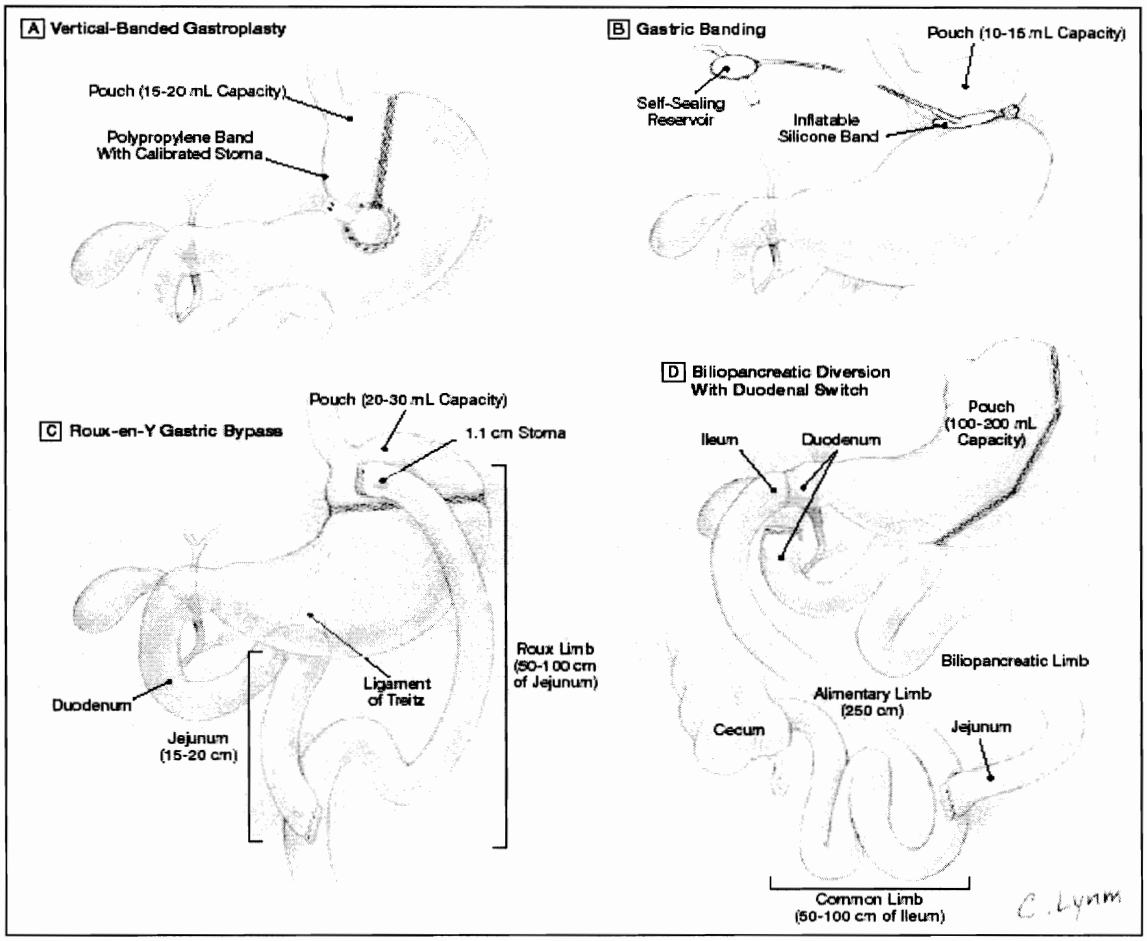

Figure 3. Bariatric Surgery Techniques (source: Brolin, 2002)

the 1990s. In BPD-DS, as shown in Figure 3-D, the entire jejunum is excluded from the digestive continuity and is anastomosed end-to-side to a common channel of ileum between 50 and 100 cm proximal to the ileocecal junction. Weight loss results with BPD-DS have been good, which were reported to equate to a mean loss of 75% to 80% of the excess weight with excellent weight maintenance after stabilization (Hess and Hess, 1998). Currently this surgery accounts for approximately 10% of bariatric procedures performed (Fitch et al, 2004).

Purely restrictive operations were performed first in 1971. Generally, two types of procedures in this method, gastroplasty and gastric binding, are performed in hospitals now. As shown in Figure 3-A, in stapled gastroplasty, a small stomach pouch is formed through surgical

stapling, reducing the capacity of the stomach to approximately one ounce. A small calibrated outlet leading from the upper pouch to the remainder of the digestive tract is also formed. The vertical banded gastroplasty (VBG) was ever the most common restrictive operation for weight loss. As reported, early weight loss results after banded gastroplasty is in the range of 30% of initial preoperative weight lost (MacLean, Rhode, and Forse, 1990). However, many patients regain a substantial portion of their lost weight within five years post this surgery (Howard et al, 1996). Thus, stapled gastroplasty has recently fallen into disfavor due to the poor loss maintenance and a 15% to 20% rate of reoperation (Brolin, 2002). Currently, stapled gastroplasty accounts for about 15% of bariatric procedures performed (Fitch et al, 2004).

Gastric binding, as shown in Figure 3-B, used a premeasured prosthetic device to restrict oral intake. Originally, the circumference of the band is generally in the range of 5 cm, which is similar to the measurement used in gastroplasty. In 1989, an inflatable band in which the diameter of the band can be adjusted was introduced by Kuzmak (Kuzmak, 1989). By using the inflatable band, the outcomes of such procedures were improved. Despite the improvement, weight loss results of gastric binding have been less consistent than weight loss reported after banded gastroplasty and gastric bypass (DeMaria et al, 2001).

Roux-en-Y gastric bypass (RYGB), the most common of bariatric surgeries now, is the typical procedure of malabsorptive/restrictive surgery. Gastric bypass was introduced by Mason and Ito in 1966, and was developed to RYGB by Buchwald and associates in 1985 (Buchwald, 2002). As shown in the Figure 3-C, in this procedure, the upper stomach is completely closed off, which excludes more than 95% of the stomach, all of duodenum, and 15 to 20 cm of proximal jejunum from digestive continuity. Weight loss results with RGBY technique have been superior to those observed after other bariatric procedures in multiple comparisons. Reported mean percentage excess weight loss after RYGB typically ranges from

65% to 75% (Sugerman et al, 1992; Brolin et al, 1992). Median percentage excess weight loss after this surgery is 56% after four years (Oh, Kim, and Oh, 1997). Given that, the Roux-en-Y gastric bypass is currently preferred type of gastric bypass, and accounts for 75% of bariatric procedures performed.

In 1991, a consensus statement by the NIH established the criteria for eligibility for surgical treatment of morbid obesity (NIH, 1991). The criteria for patients selection is: 1) body weight $\geq$ 45 kg or 100% above ideal weight, or BMI $\geq$ 40, or BMI$\geq$35 with medical comorbidities; 2) failure of nonsurgical attempts at weight reduction; 3) absence of endocrine disorders that cause morbid obesity; 4) psychological stability, which includes absence of alcohol and drug use, understanding how surgery causes weight loss, realization that surgery itself does not guarantee good results, and preoperatative psychological evaluation for selected patients. With the continuous improvement of the technology and the establishment of these criteria, bariatric surgery entered the door for insurance coverage and began the stage of an explosive increase in its volume performed in hospitals.

Growth of Bariatric Procedures in Hospitals

Demand for bariatric surgery has been rocketing since the mid-1990s. In their research, Pope, Birkmeyer, and Finlayson (2002) used the National Inpatient Sample to evaluate that the national annual rate of bariatric surgery from 1990 to 1997 increased from 2.7 to 6.3 per 100,000 adults. According to the American Society for Bariatric Surgery (ASBS), 144,000 bariatric procedures were expected to be performed in the U.S. in 2004, while, the number was 63,000 in 2002, and was only 39,000 in 2000 (Becker, 2004). As Figure 4 shows, after a stable growth period from 1994 to 2000, the volume of bariatric procedures performed jumped significantly each year since 2000. As a result, the volume of bariatric surgery performed has increased almost 10 times during from 1994 to 2004. Using the Nationwide Inpatient Sample

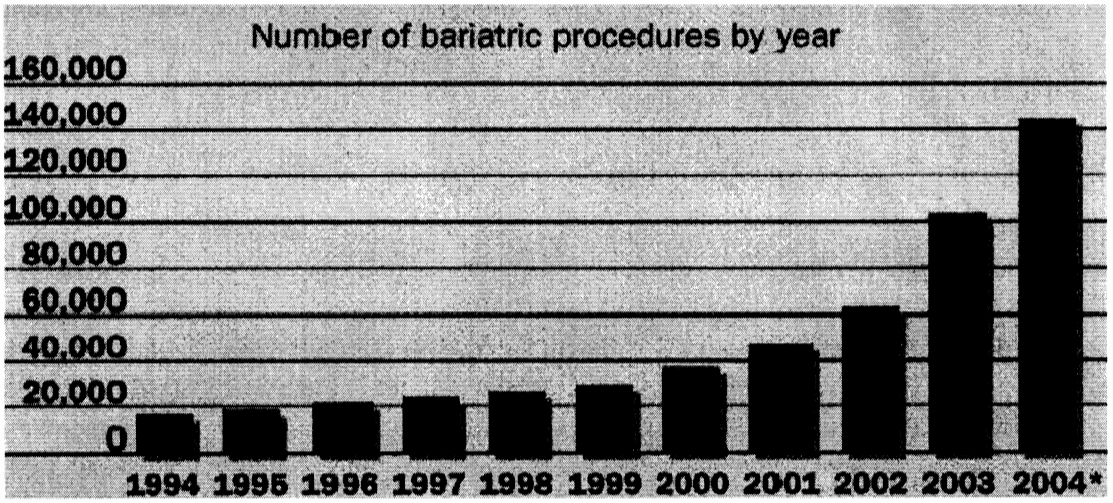

Figure 4. Number of Bariatric Procedures Performed, 1994-2004 (Source: Becker, 2004. *Estimated by American Society for Bariatric surgery).

of Healthcare Cost and Utilization Project (HCUP), Encinosa, et al. (2005) estimate that the total number of surgeries increased from an estimated 13,386 to 71,733 in 2002. Despite the difference in the volume estimated between different organizations and researchers (Alt, 2004; ASBS, 2004; Bercker, 2004), they are consistent with this trend that the number of bariatric procedures performed in hospitals is increasing dramatically.

There is no official statistic of how many hospitals are performing bariatric surgeries. A useful article addressing the issue comes from Susan Alt (2001). According to the estimation of Alt (Alt, 2001), in 2001, approximately 300 hospitals and medical centers are now thought to be in the bariatric surgery business, which is estimated that as many as 700 surgeons are performing the procedure. She suggested that many of these hospitals are middle or small community hospitals. And another 150 to 200 hospitals collaborate with a local surgeon but have only parts of a full-blown program in place in this year. In her article, Alt summarized that these hospitals that launched bariatric surgery programs are located nation-wide. A point suggested by Alt is that the size of a hospital makes little difference in operating the bariatric surgery. As she stated, "Small and large institutions alike – from just 125 beds to the nation's

largest university health systems and tertiary care centers – have established well-regarded programs and are attracting droves of patients. " (Alt, 2001. p. 6).

In her article, Alt provided much valuable information about the growth and operation of bariatric procedures in hospitals. However, the major weakness of this article is that it did not provide the sources of information, and is based on experiences rather than on scientific research. Despite the weakness, this article began the step of investigating the rapid growth of the surgery in hospitals. Lucido, Joshi, and Reinius (2004) surveyed 584 directors of surgical services and directors of materials management at VHA organizations to explore whether and why hospitals offer a bariatric surgery program. It was found that 25 percent of hospitals have offered the service or planed to develop bariatric surgery. Responses showed that business, huge bariatric population are determinants of offering such program, and, no bariatric on staff or no interest from surgeons, associated risks, and no malpractice fees are suggested to delay hospital's step to develop such program. Generally, the report by Lucido, Joshi, and Reinius (2004) provides the baseline information of adoption of bariatric procedures in hospitals. However, a very low response rate (18%), a small sample size (n=82), and a non-random sample undermined the reliability of the report. Also, there is only the simple descriptive analysis, which provides very limited information.

Despite the dramatic growth of volume of bariatric procedures performed, the number of the operations performed still can't represent the demand for the surgical procedure from patients with morbid obesity. As Mitka said, "the demand for the surgery is so great that many hospitals have year-long waiting list of hundreds of patients" (Mitka, 2003). Alt stated that "even young surgeons who have entered the field in the last year or two have waiting lists of six to 18 months" in some places (Alt, 2001). With such a large number of people with morbid

obesity in the U.S., which is continuing to increase, the market for bariatric surgery is huge, and the trend of it rapidly growing is expected to remain for a relatively long period.

Several factors are thought to be contributing to the remarkable growth of bariatric procedures performed (Alt, 2001; Becker, 2004; Lucido, Joshi, and Reinius, 2004; Mitka, 2003). First, most researchers believe that the huge demand from patients with morbid obesity is an important factor. Second, the high profit margin is attracting hospitals to add this service in their delivery list or increase the volume of the procedure. Third, more and more health plans have or, are considering to cover the procedure, which induces individuals with morbid obesity to enter the waiting list of bariatric procedures.

As mentioned earlier, there are a huge number of individuals with morbid obesity in the United States. According to Alt (2001) estimated, some 13 million to 16 million people in the U.S. are considered morbidly obese and are potential candidates for bariatric surgery. Flegal and colleagues (2002) estimated the prevalence of extreme obesity (BMI of 40 or greater) is 4.7% in the United States by 1999-2000. The ASBS (2004) estimates that another 10 million people have BMIs between 35 and 40 with comorbidities, which make them eligible for bariatric surgery. Using the clinical guidelines of NIH, it is estimated that there were at least 11.5 million adults eligible for bariatric in 2002, and only 0.6 percent received the surgery (Encinosa, et al., 2005). Compared with the estimation of bariatric procedures performed, the demand for surgery far exceeds current capacity of hospitals. In addition to the large number of individuals eligible for the surgery, the increased popularity of the technique among potential candidates is also attracting them to hospitals. With the continuous improvement and advertisements by hospitals, the public is increasingly aware of the high level of success among morbidly obese patients with bariatric surgery. Particularly, since Carnie Wilson went

public in 2000 about the difference bariatric surgery has made in her life, the number of procedures performed has jumped greatly (Alt, 2001).

Bariatric surgery is seen as a lucrative service through which hospitals are able to raise their profit margins. Current literature is not consistent in the case cost of bariatric procedures. Alt (2001) estimated that the total charges for a bariatric procedure range between $14,000 and $35,000, absent serious complications. Becker (2004) believed that it costs between $20,000 to 35,000 with usually two or three days in the hospital. Fitch and colleagues (2004) found that in typical PPO plans, a bariatric procedure costs about $ 25,000 if it is classified as DRG 288 and costs about twice the amount if it is classified as DRG 154-155. Encinosa, et al. (2005) estimated that the average price for a surgical procedure was $ 19,346 in 2002. In Pennsylvania, while, the average hospitals charge for the surgery is $35,643 in 2003 (The Pennsylvania Health Care Cost Containment Council, 2004). Despite the variation in estimation of the cost of surgery, researchers and organizations pointed out that the bariatric procedure is a highly profitable service for hospitals. Alt (2001) estimated that the hospital costs of providing care for a bariatric surgery patient are less than half of reimbursed charges. Through adding the surgery into their service list, or performing more bariatric procedures based on current volume, hospitals are able to increase their profit margins and obtain more revenues.

In addition to the huge demand for the bariatric procedures, the fact that more and more health plans cover the surgery enhances the growth of the number of procedures performed in hospitals. Given the high costs of the surgery, it is important for morbidly obese individuals needing bariatric procedures to be covered by health plans. Also, for hospitals, coverage of bariatric surgery guarantees that they can obtain the profit through reimbursement from health plans. As Alt (2004) pointed out, some hospitals delayed their plans to expand or add programs of bariatric surgery because the health insurance companies are slowing obesity surgery

approvals or tightening the rules regarding coverage of the procedures. Several states such as Louisiana, Maryland, Indiana, West Virginia, Virginia and Georgia, have laws requiring health plans to cover bariatric surgery for morbid obesity, using NIH guidelines (Fitch, 2004). Given the prominence of the issue, more states, for example, Illinois and Ohio, are expected to follow the early adopted states' lead. According to the estimation of Alt (2001), the vast majority of hospital bariatric surgery costs are covered by private health plans and HMOs, with 1% to 5% paid by Medicare, 3% to 10% covered by Medicaid, and a small portion of self-pay. As The Pennsylvania Health Care Cost Containment Council (PHC4, 2004) reported, of the bariatric surgeries performed between 1999 and 2003 in Pennsylvania, 85.5 percents were paid by commercial insurers, 6.4 percent were billed to Medicaid, 6.5 percent were billed to Medicare, and less one percent was directly billed to patients.

An important decision regarding the coverage of bariatric surgery was made by Medicare in 2004. In July 2004, a new policy handed down by the Department of Health and Human Services removes the phrase "obesity itself cannot be considered an illness" from the Medicare Coverage Issues Manual, allowing scientists, clinicians and companies to submit proposals recommending that certain treatments be covered (Glassman, 2004). According to the American Obesity Association (2004), 18 percent of the Medicare population is obese, and the prevalence of obesity among people ages 60 to 69 increased 45 percent from 1991 to 1998. Before this change, Medicare does pay the bill of bariatric surgery only for those patients with coexisting conditions such as diabetes (CMS, 2004). Given the increasing belief that obesity is public health problem, the new policy of Medicare allows the coverage of bariatric surgery for all Medicare enrollees. Based on the estimation of the estimation of Hedley and colleagues that 3.9 percent adults age sixty or older are morbidly obese, approximate 395,000 elderly people will be clinically eligible for bariatric surgery in 2005 (Encinosa, et al., 2005). With the

coverage by Medicare in a higher level than before, it is expected that hospitals will face greater demands from more patients who are paid by their plans.

In general, the healthcare industry in the United States is facing the rapid expansion of bariatric surgery over the last decade. As reviewed above, it is suggested that the growing trend stemmed from several sources: 1) high prevalence of obesity among Americans resulting in the great demand for bariatric surgery, 2) continuous improvement of bariatric surgery techniques making this procedure safer and more effective, 3) high profitability of bariatric procedures enabling hospitals to increase their profit margin, and 4) coverage by more and more health plans, which enabled hospitals obtain a stable reimbursement for the procedures.

Medical Innovation, Definition and Previous Studies

In this study, bariatric surgery is seen as a medical innovation. Given the lack of literature regarding the process of diffusion of bariatric surgery, it is still unclear if the expansion of the surgery matches the ideal model of diffusion of innovation described by Rogers (Rogers, 2003). Grossman and Banks (1995) argue that as a successful medical innovation evolves over time, the growth of utilization is composed of two components: it is adopted by an increasing portion of physicians or hospitals, and its rate of use by those adopters also increases during the period. Based on this argument, the growth of bariatric procedures performed are thought to include two components: increasing number of hospitals adopting the procedure and early adopters increasing their capacity of performing the procedures. Therefore, the remain of the chapter will reviews the literature about the definition of medical innovation, studies on determinations of innovation adoption, as well as studies on the increase in the utilization of medical innovation in hospitals.

Health care organizations are often involved in various types of changes and innovation ranging from the introduction of new pieces of equipment and programs. Innovation is

generally considered as one of the key drivers of organizational success (Cardozo et al., 1993). The research on medical innovation has occupied an important position in both innovation field and health services research (Rogers, 2003; Walston, Kimberly, and Burns, 2001). Extensive research has been conducted on hospitals' adoption of medical innovations. However, innovation has been conceptualized in many ways and studied from different perspectives.

In general, distinctions are made between various studies of (1) adoption and diffusion of innovation (Kimberly, 1981), (2) innovating and innovativeness (Van de Ven and Rogers, 1988), and innovations at different level of analysis (e.g. individual, organization, and population of organizations). This study focuses on the adoption and utilization of innovations by hospitals and explores how environmental and organizational factors affect organizational innovativeness.

In his series of classic books exploring the diffusion of innovation, Rogers (2003, p.12) proposed a definition of innovation as "any idea, practice or material artifact perceived to be new by the relevant unit of adoption – organization, work group, or individuals". This definition has been well accepted in the studies on innovation diffusion and utilization in health services research. The definition of innovation by Rogers is inclusive and broad-based concept, which includes individual, team, and organization levels. Given the unit of this study, the definition is applied at organizational level. Therefore, the definition of innovation in this study is "any idea, or behavior, whether a system, policy, program, device, process, product or service, that is new to the adopting organization" (Daft, 1982; Damanpour and Evan, 1984). This definition was developed on the basis of Rogers's definition of innovation.

Newness is a basic concept in the definition of innovation. Rogers's definition of innovation matters little whether or not an idea, practice, or object is "objectively" new as measured by the lapse of time since its first use or emergence (Rogers, 2003). This indicates

that if an idea, practice or object seems new to the individual or organization, it is an innovation regardless how long it has emerged or proposed. In this study, although bariatric surgery first emerged in the 1950s, it has evolved during the four decades. Until the 1990s, it was adopted and used widely among hospitals. Based on the definition employed in this study, bariatric surgery is a kind of technological innovation or service innovation.

As Rogers (2003) suggested, the rate of an innovation adoption is influenced by the five perceived attributes of an innovation, which include relative advantage, compatibility, complexity, trialability, and observability. Relative advantage refers the degree to which the innovation is perceived as better than the object it supersedes. Compatibility is the degree to which the innovation is perceived as being consistent with the existing value, past experiences, and needs of potential adopters. Complexity means the degree to which the innovation is perceived as difficult to understand and use. Trialablity is the degree to which the innovation can be experimented with on a limited basis. And observability refers to the degree to which the result of innovation is visible to others.

Studies on the Adoption of Technical Innovations

Studies on innovation hold an important position in health services research since the late 1960s. For years, scholars in innovation research have tried to answer a most fundamental question: What determines innovation in an organizational setting? Despite extensive studies on the determinants of innovation, results have often been confusing and inconclusive (Kimberly & Evanisko, 1981). Earlier studies in this area focused on investigating the economic and organizational factors that stimulated and hindered innovation adoption by organizations and individuals (Westphal, Gulati, and Shortell, 1997). Researchers investigated the relationship between the decision of adoption and variables such as firm size, performance, functional differentiation, slack and leader characteristics (Kimberly and Evanisko, 1981;

Moch and Morse, 1977; Rosner, 1968). These studies examined the factors influencing innovation adoption at a micro-level, which is generally limited within individual organizations.

More recent empirical studies have begun to explore the role of macro-social factors in influencing the spread of innovation in the healthcare industry. In addition to economic or efficiency factors in previous research, some studies emphasize the effects of social factors such as regulatory pressure, as well as more traditional intraorganizational factors, on the likelihood of adopting organizational innovations (Baron, Dobbin, and Jennings, 1986; Davis, 1991; Palmer, Jennings, and Zhou, 1993; Westphal, Gulati, and Shortell, 1997). More and more researchers sought to identify institutional factors influencing an innovation adoption in organizations. Also, the factors of timing and interorganizational links began to receive the attention from the researchers on innovation adoption (Goes and Park, 1997; Walston, Kimberly, and Burns, 2001; Westphal, Gulati, and Shortell, 1997). In general, most studies have focused on economic, political, and institutional rationales to explain why organizations adopt innovations. Recent research has also attempted to introduce more determinant factors into the area of investigation.

Several comprehensive literature reviews have been done regarding the determinants and moderators of innovation adoption within organizations (Glazer and Montgomery, 1980; Tornatzky and Klein, 1982; Gooding and Wagner, 1985; Damanpour, 1991). However, these reviews tend to produce an overview of the phenomenon of innovation adoption in overall industries and inevitably omit the difference in adoption of innovations among different industries. Also, these reviews include studies from the level of individual, organizational, and organization populations. This study intends to address the factors influencing innovation adoption from the level of organization.

In this section, only the empirical studies that focus on adoption of technological innovation in hospitals, specialized services, and nursing homes, that are conducted after 1980 and that are from the organizational level, are reviewed. Classic research on adoption of managerial innovation will also be included. And then some conclusions and weaknesses will be drawn regarding these studies.

Technology Adoption in Hospitals

Compared with other healthcare facilities, hospitals are quite active in adopting new medical or therapy technologies. In the last two decades, a large number of medical innovations have been adopted and utilized in hospitals. The adoption of new technologies in hospitals received wide attention from researchers. Correspondingly, the literature about technology adoption is plentiful.

In their comparative analysis, Kimberly and Evanisko (1981) examined the influence of individual, organizational, and contextual factors on hospital adoption of technological and administrative innovations. Twelve technological innovations and eight administrative innovations were chosen to test. The results suggest that (1) individual, organizational, and contextual variables were much better predictors of hospital adoption of technological innovations than of administrative innovations; (2) the two different types of innovation adoption were influenced by different variables; and (3) organizational level variables, size in particular, were clearly the best predictors of both types of innovation.

Damanpour (1992) offered a meta-analysis reviewing the relationship between organizational size and innovation. Using 36 correlations derived from 20 published studies, he found that there is a positive correlation between size and innovation adoption. In addition, several moderating factors were examined in this study: (1) size is more positively related to innovation adoption in for-profit organizations than in nonprofit organizations; (2) the

association of size and innovation adoption is stronger when a non-personnel or a log transformation measure of size is used; (3) types of innovation do not have a significant moderating effect on the relationship between size and innovation adoption; and (4) size is more strongly related to the implementation than to the initiation of innovations in organizations.

Luft et al. (1986) analyzed the impact of competition on the availability of specialized clinical services, with special focus on mammography, emergency services, cobalt therapy, heart surgery, and cardiac catheterization by using a sample of 3,584 community hospitals surveyed in 1972. They found that for certain technologies, hospitals may compete on nonprice dimensions leading to the existence and early adoption or duplication of specialized clinical services. The results are mixed and depend on the service or technology in question. For example, for mammography, 24 hour emergency service and cardiac catheterization, hospitals tended to be duplicative, i.e., if a competing hospital in the local market offered the service, then the other hospitals were also more likely to adopt and offer this service. However, for cobalt therapy and heart surgery, this was not the case.

Using data on the diffusion of radioisotope facilities between 1952 and 1972 in hospitals in the U.S., Rapoport (1978) also found the evidence of non-price competition among hospitals. In addition, he explored the effects of some other factors on hospital adoption of this new technology. He found that: (1) hospitals in more competitive environments tended to adopt the innovation earlier, (2) hospitals in more competitive markets tended to adopt more expensive services, (3) larger hospitals spent more in the initial phase of adoption than smaller hospitals, (4) if the technology was adopted using funds from specific donations, they tended to adopt early but spent less on the initial adoption and, (5) hospitals where physician incomes were tied

to the use of technology tended to adopt early and spend more on the adoption compared to hospitals where physicians earned straight salaries.

Dranove and colleagues (1992) used 1983 data on providers of specialized services in California to estimate market effects on the number of hospitals adopting a service in a market. The results showed that the size of the market, measured by the population, was a significant predicator of the number of hospitals adopting specialized service for all the eleven study technologies. They also found that increased hospital competition leads to more hospitals providing specialized services although the coefficient was not significant for all the services.

Cutler and McClellan (1996) estimated the impact of various factors on the share of patients in a hospital receiving angioplasty by using a data set consisted of hospitals from 1984 and 1991 with a bed size larger than 100. The results showed that the percent of population in a state enrolled in HMOs was negatively associated with the hospitals' adoption of angioplasty. In addition, by assuming a proportional hazard for adoption, they semi-parametrically estimated the base line hazard and found that hospitals in areas with high HMO enrollment or with rate regulation are less likely to adopt angioplasty.

By using AHA data from 1983 through 1993, Backer and Spetz (1999) constructed three indices for technology in hospitals, which have high values representing the presence of either more services/technologies in a hospital or the presence of rarer technologies adopted. They found that until 1986, the mean value of technology index was higher for hospitals located in markets with high HMO penetration, while that beyond 1986 the mean index value was higher for hospitals in markets with low HMO presence. Although statistically insignificant, their results are indicative of a negative correlation between HMO penetration and adoption of technologies.

Bokhari (2001) examined the effect of HMO penetration and the effect of HMO competition on a hospitals' probability to adopt cardiac catheterization, as well as the time to the first and follow-on adoption in a given hospital market. Data from 1985 to 1995 on cardiac catheterization laboratories from all short term general hospitals, and data on HMO penetration and competition was used in this study. Inconsistent with previous studies, the results showed that HMO penetration does not affect the probability of hospital adoption of cardiac catheterization. However, it was found that a hospital is more likely to adopt this medical innovation as the competition within HMOs increases. Further, the results indicate that the probability of follow-on adoption in a local hospital market initially increases as the HMO market becomes increasingly competitive, but eventually starts decreasing. This study implies that as HMO competition increases, so does duplication of technology.

By using 1983-1993 AHA data, MRI census data, and HMO market share data, Baker (2001) examined the relationship between HMO market share and the diffusion of magnetic resonance imaging (MRI) equipment into hospitals. He found that across markets, increases in HMO market share are associated with slower diffusion of MRI into hospitals between 1983 and 1993, and with substantially lower overall MRI availability in the mid- and later 1990s. The results also showed high managed care areas also had markedly lower rates of MRI procedure use. These results suggest that technology adoption in health care can respond to changes in financial and other incentives associated with managed care.

Burke, Wang, and Wan (2002) explored the adoption of information technology (IT) and its association with organizational and market factors in hospitals. Data used in their study comes from 1999 Dorenfest IHDS+ database including 4000 hospitals, and 1998 AHA data. Three categories, administrative IT, clinical IT, and strategic IT, were investigated. The results showed that hospital size is positively associated with all three components of the IT profile.

Hospital ownership, or profit status is not associated with the adoption of administrative or clinical IT. However, for-profit status is positively associated with the adoption of strategic IT. Membership in a multihospital system is positively associated with the adoption of clinical IT and strategic IT, but not with the adoption of administrative IT. Finally hospitals in urban markets and in highly competitive markets are associated with higher adoption of administrative IT, clinical IT, and strategic IT.

Teplensky, et al (1995) examined hospital motivations to acquire new medical technologies by using the case of magnetic resonance imaging equipment (MRI). The sample of the study included 507 hospitals owned or leased an MRI unit as of 31 December 1988. Three common explanations, profit maximization, technological preeminence, and clinical excellence are examined. It was concluded that a hospital attempting to being a technological leader, adjusted its clinical requirements, and the change in revenues associated with the adoption of MRI were the major determinants of adoption behavior.

Lavizzo-Mourey, et al. (1993) described hospital adoption of Geriatric Evaluation Management Units (GEMs), and explored factors underlying hospitals' adoption of an inpatient GEM. 1, 639 hospitals responded the nationwide mail survey and composed the sample used in this study. The authors found that adopters were more likely to be large, urban, teaching hospitals. Among adopters, space and nonphysician staffing were the most critical barriers to establishing a GEM unit. Also, reimbursement sources and physician staffing were also viewed as the barriers. It was concluded that the reasons underlying hospital decisions to adopt this new technology are often related to financial, rather than clinical concerns.

Different from other studies on urban hospitals, Hartley, Moscovice, and Christianson (1996) evaluated the relationship between hospitals and regional characteristics and the adoption of mobile computed tomography (CT) in rural hospitals by using a data including all

471 rural hospitals in eight northwestern states in 1991. Key hospital characteristics include patient volume, distance to the nearest referral center, distance to nearest hospital, financial performance, and medical staff size. Results showed that hospitals closely spaced are more likely to choose mobile CT; hospitals with more physician staff are more likely to adopt fixed CT than mobile CT; hospitals that are closer to a mobile CT base are more likely to adopt mobile CT; Hospitals may realize economies of scales and scope in their decisions about CT adoption. There is no support that rural hospitals compete with referral centers for patients by purchasing CT.

By investigating the diffusion of six surgical endoscopic procedures performed by 138 laparoscopic surgeons, Dirksen, Ament and Go (1996) explored the simulating and restraining factors that influence the diffusion of new surgical technologies in hospitals. Data were collected by interviewing 138 general surgeons working in 138 surgical clinics in Netherlands in 1994. Surgeons were asked which of the following six endoscopic procedures has been adopted in their hospitals: cholecystectomy, appendicectomy, Nissen fundoplication, inguinal hernia repair, large bowel resection and thoracospic procedures. Furthermore, they were asked to indicate the influence of 13 pre-defined factors, which included budget, competition, conference, extra benefit, media, nature of the technology, patient demand, planning/logistics, reimbursement, service industry, support industry, surgical technique, and training/course. Results showed that the factors "conference," "extra benefit," "support by the industry" and "training" simulated the introduction of most procedures. The factor of "reimbursement" tends to be a restraining factor, whereas "competition," "patient demand," and "media" tend to be stimulating. "Nature of technology" and "surgical technique" have neutral influence with both restraining and stimulating influences. The factors "budget" and "planning" were assessed as restraining factors for all procedures.

Technology Adoption in Specialized Services

Cutler and Sheiner (1997) used state level data to estimate the relationship between HMO enrollment and diffusion of 19 technologies. Generally, they found that HMO enrollment was negatively associated with the diffusion of technology and offered preliminary evidence that managed care has reduced the diffusion of medical technologies.

Baker and Wheeler (1998) examined the relationship between HMO activity and the market-level availability and use and adoption of magnetic resonance imaging (MRI) in 1994 and 1995. The data came from a nationwide census of 3,705 MRI sites in late 1994 and early 1995. The results showed that managed care activity may lead to providers refusing adoption of MRI or providers reducing the utilization of MRI or even shutting it down. They also found that a large HMO market share was weakly associated with fewer procedures per site. This suggested that managed care may be able to reduce health care costs by influencing the adoption and use of new medical equipment and technologies.

By using AHA data from 1980 through 1996, Backer and Phibbs (2002) empirically examined the relationship between HMO market share and the adoption of neonatal intensive care units (NICU). They found that higher HMO market share was associated with slower adoption of mid-level units, and that the time to adoption of a NICU was longer in high-managed-care relative to lower-managed-care markets between 1980 and 1996. However, the results showed that the level of HMO market share was not associated with adoption of the most advanced high-level units. The study indicated that managed care can influence the adoption of technology, which also depends on the level of technology.

Technology Adoption in Nursing Facilities

Banaszak-Holl, Zinn, and Mor (1996) examined the impact of market and organizational characteristics on nursing care facility service innovation. By using the Medicare/Medicaid

Automated Certification Survey data and ARF file, they examined the likelihood of providing Alzheimer's disease care in nursing homes. Results suggested first from the market perspective that HMO penetration, market competition, and hospital supply are positively related to adoption of the service in nursing home. Second, greater regulatory stringency constrains the adoption of the service innovation adoption and organizational characteristics (e.g., size and proprietary status) are important enabling factors influencing nursing homes to provide the specialty care.

Adoption of Managerial Innovation in Hospitals

Since the mid 1980s, with the emergence of more and more managerial innovations, such as TQM/CQI, restructuring, matrix management programs and reengineering, in hospital industry, health service researchers began to study the adoption of management innovations within hospitals. Despite the difference between the managerial innovations and technological innovations in adoption of hospitals, similar diffusion models were applied by researchers focusing on adoption of innovation in organizations. Therefore, it is expected that the literature on the studies on the adoption of management innovations in hospitals can provide suggestions to this study. Typical studies on managerial innovation focused on TQM/CQI and reengineering and are reviewed in the following section.

Westphal, Gulati, and Shortell (1997) examined institutional and network effects of innovation adoption in the context of total quality management (TQM) programs introduced by general hospitals over the period 1985 to 1993, a period of widespread diffusion of TQM among hospitals. A sample of over 2,700 general hospitals in the U.S. was used in this study. The findings suggest that early adopters gain efficiency, while later adopters gain legitimacy from adopting the normative TQM programs. The results also show that institutional factors

moderate the role of network membership in affecting the form of administrative innovation adopted.

In their study on the adoption of reengineering, Walston, Kimberly, and Burns (2001) examined the influence of institutional and economic factors on the adoption of the managerial innovation in hospitals. The study sample consisted of 678 general medical/surgical hospitals larger than 100 beds located in metropolitan statistical areas in 1996. The results regarding the perspective of economic factors suggest that contrary to some previous studies, the percentage of the hospital market penetration by HMOs was negatively associated with the adoption of reengineering; hospitals with higher cost structures relative to their competitors are more likely to adopt the innovation, as are hospitals with more patients at risk for managed care contracting. Concerning the perspective of institutional pressures, results indicated that the uncertainty generated by volatility of admissions did not significantly affect the likelihood of adopting reengineering, and the cumulative number of past adoptions in market area increases the likelihood of reengineering adoption. The perspective of timing was consistent with previous research. Institutional pressures influenced late adopters of reengineering, while economic factors appear to motivate earlier adopters. The perspective of organizational characteristics results showed that membership in a hospital system and a greater market share of admissions increases the likelihood of adopting reengineering.

Goes and Park (1997) examined the growth of interorganizational links in a population of hospitals and the influence of these strategies on organization-level innovation by using a sample of over 400 California hospitals over ten years (1981- 1990). Four types of interorganizational links were examined in this study, which included structural links (MHS membership), administrative links (contract management), institutional links (institutional affiliations), and resource links (transaction between a hospital and other organization). Results

showed that hospitals that were linked into multihospital systems, regularly exchanged resources with related hospitals and aggressively built institutional affiliations were more likely to adopt innovative services and technologies. However, the administrative links did not show the significant association with the adoption of service innovation.

Arndt and Bigelow (1995) investigated the individual, organizational, and institutional factors associated with the adoption of corporate restructuring by hospitals in Massachusetts by using a sample including all general, short-term, non-profit hospitals in Massachusetts during the period of 1982-1991. The findings, which conflicted with the conclusions of other studies, showed no differences between early and later adopters but do show that after an intense period of restructuring, hospitals became less likely to adopt an innovation. Hospital size was suggested to be associated with adoption of corporate restructuring, which supports previous findings that large organizations are more likely to adopt innovation. Occupancy rate, however, was not significantly related to the adoption of restructuring. Also, this study showed that cumulative rate of adoption, the institutional variable, was significantly associated with adoption of the innovation, but in a negative way, which conflicted with some other studies.

In their research, Burns and Wholey (1993) examined the effects of organizational characteristics and interorganizational networks on the adoption of matrix management programs in U.S. hospitals from the perspective of information-process theory and network theory. A panel including all nonfederal general hospitals that were either large size (300 or more beds) or had teaching programs in any specific year of 1961, 1966, 1972, and 1978 was used in this study. The results showed that task diversity, central sociometric position, and prior transmission of information were positively associated with adoption of matrix management. Also, the local and regional cumulative number of adoptions was suggested to positively influence the adoption. However, the findings suggested that hospital size and slack had no

effect on the decision of adopting such a program. The results suggested that the diffusion of matrix management at a local level proceeds primarily from higher- to low-prestige hospitals.

As shown in Table 1, the determinants and moderators of adoption of innovations are summarized into two categories: contextual factors and organizational characteristics. In general, most factors showed a different influence on the adoption of innovations in different studies.

Literature Related to Supply of Innovations

Compared to the number of studies focusing on adoption of innovation, the literature focusing on supply or provision of innovations appears limited. Most studies have focused on the extensiveness of innovation as the number of innovations adopted within a given period or the percentage of innovations (Damanpour, 1991). Although there are a large volume of studies describing the expansion of therapy services from the clinical perspective, very few studies have been conducted to investigate the factors influencing expansion of innovation utilization after adoption from the perspective of organization theory.

Based on a survey of 1,779 U.S. hospitals in 1993, nearly 50 percent intended to expand their oncology programs in the next two years (Lamkin and Rice, 1993). In their study, Lamkin and Rice (1993) depicted the process and prerequisites of a hospital to develop an oncology programs. They found three factors that encouraged hospitals to develop an organized cancer program: (1) The community recognizes that there is a need for cancer services; (2) Hospitals wish to distinguish services from those of competitors via a cancer program and thereby improve their overall image; and (3) Hospitals desire to positively affect their financial picture by increasing inpatient oncology admissions and outpatient use.

Grossman and Banks (1998) conducted a panel study which included a total of 774 observations, spanning the period 1983 to 1990 using California data and AHA data. In their

Table 1: Summary of Determinants and Moderators of Innovation Adoption.

Determinants	Effect	Literature
Organizational characteristics		
Size	Positive	Kimberly and Evanisko, 1981; Damanpour, 1992; Rapoport, 1978; Banaszak-Holl, Zinn, and Mor, 1996; Burke, Wang, and Wan, 2002; Lavizzo-Mourey et al, 1993; Arndt and Bigelow, 1995
	Neutral	Burns and Wholey, 1993
For-profit status	Positive	Damanpour, 1992; Banaszak-Holl, Zinn, and Mor, 1996; Burke, Wang, and Wan, 2002
	Neutral	Burke, Wang, and Wan, 2002
Types of innovation	Moderating	Kimberly and Evanisko, 1981; Luft et al, 1986; Becker and Phibbs, 2002; Burke, Wang, and Wan, 2002; Teplensky et al, 1995
	Neutral	Damanpour, 1992; Dirkson, Ament and Go, 1996
System alliance	Positive	Burke, Wang, and Wan, 2002; Walston, Kimberly and Burns, 2001; Goes and Park, 1997;
	Neutral	Burke, Wang, and Wan, 2002
Urban	Positive	Burke, Wang, and Wan, 2002; Lavizzo-Mourey et al, 1993;
Reimbursement	Positive	Teplensky et al, 1995;
	Negative	Lavizzo-Mourey et al, 1993; Dirkson, Ament and Go, 1996
Teaching status	Positive	Lavizzo-Mourey et al, 1993;
Medical staff size	Positive	Lavizzo-Mourey et al, 1993; Hartley, Moscovice, and Christianson, 1996;
Market share	Positive	Walston, Kimberly and Burns, 2001;
Contextual factors		
competition	Positive	Luft et al, 1986; Rapoport, 1978; Dranove et al, 1992; Banaszak-Holl, Zinn, and Mor, 1996; Bokhari, 2001; Burke, Wang, and Wan, 2002; Dirkson, Ament and Go, 1996;
	Negative	Luft et al, 1986
Cumulative number of adopters	Positive	Walston, Kimberly and Burns, 2001; Burns and Wholey, 1993
	Negative	Arndt and Bigelow, 1995;
Size of market / demands	Positive	Dranove et al, 1992; Banaszak-Holl, Zinn, and Mor, 1996; Dirkson, Ament and Go, 1996
HMO penetration	Positive	Culter and McClellan, 1996; Banaszak-Holl, Zinn, and Mor, 1996
	Neutral	Becker and Phibbs, 2002; Bokhari, 2001
	Negative	Culter and Sheiner, 1997; Backer and Spetz, 1999; Becker and Wheeler, 1998; Becker and Phibbs, 2002; Becker, 2001; Walston, Kimberly and Burns, 2001;
Regulation	Negative	Culter and McClellan, 1996; Banaszak-Holl, Zinn, and Mor, 1996;
Time	Moderating	Backer and Spetz, 1999; Westphal, Gulati and Shortell, 1997; Walston, Kimberly and Burns, 2001;

study, the effect of hospital entry in the market for cardiovascular surgical services on the number of procedures performed at both the market and hospital levels was studied. The

results showed that a 10% increase in primary and secondary market demands results in a 1% in the supply of coronary artery bypass graft (CABG), the most common of cardiovascular procedures. Hospital payer mix is significantly associated with the number of procedures offered by hospitals. Relative to privately insured patients, a 10% increase in uninsured and Medi-Cal patients is associated with 1% and 2% reduction in CABG procedures, respectively. Hospital size is negatively associated with the supply of procedures. Public hospitals significantly performed more procedures than invest-owned and non-profit hospitals. Hospitals with later-opened heart surgery units performed significantly fewer CABG procedures than those units established longer than six years. And the hospital's supply of CABG surgeries decreases with the proximity of competitors.

Hirth, Chernew, and Orzol (2000) examined the relationship between ownership, competition and other organizational characteristics and utilization of technological innovations in a managed care environment. The authors conducted a cross-sectional study by using 1989 and 1993 dialysis technology using HCFA and ARF files to test the adoption of the innovation. The findings suggest that (1) under the fixed-price environment of services firms are unlikely to invest in developing services that are not anticipated to pass the fixed-price; (2) hospital-based and free-standing nonprofit facilities were more likely than free-standing for-profit to use new technologies; and (3) size and chain membership were positively related to utilization of the new technologies. Older facilities were less likely to use the technologies and use of new technologies was lower in less competitive markets.

By using two years of AHA data (1988 and 1991), LeBlanc and Hurley (1995) examined the formal adoption of HIV-related services among urban US hospitals. The results suggest that the public ownership is a key determinant of greater investment on HIV-related services, for-profit status is negatively associated with the provision of the services in hospitals, and size,

medical school affiliation, and reliance on Medicaid funding positively affect the likelihood of hospitals investing in a comprehensive set of HIV-related services.

White, Roggenkamp, and LeBlanc (2002) assessed how hospital characteristics and market demand for HIV/AIDS services are related to the likelihood of hospital provision of HIV/AIDS services. The authors conducted a cross-sectional study by using 1988 and 1997 AHA survey data. The findings showed that teaching status and system affiliation were positively associated with hospital provision of HIV/AIDS services, increasing hospital size increases the likelihood of a hospital adding the service, and hospitals in markets with increasing number of persons living with AIDS are more likely to offer such services.

Although there is limited literature to examine the factors influencing provision of innovation in hospitals, a comprehensive set of variables were investigated in these studies and the findings are mixed or even conflicting. The demand for services, favorable payment mix (e.g., a high portion of private insurance), chain affiliation, and profitability of the service are positively associated with the hospital utilization of medical innovations. Time is negatively related to the number of hospitals providing a new service. For the factors of market competition, size and profit-status, the findings from the reviewed studies showed mixed directions. Regarding the nature of services that are profitable or under-compensated, the effects of these variables may interact with the type of innovation.

Implications for Current Research

In general, previous studies on hospital adoption of innovation included many factors influencing the decision of adopting an innovation. Various perspectives were used in explaining hospitals adoption of innovations in the body of current literature, which includes individual forces, organizational characteristics, economic forces, external environment, regulatory force, payment method and institutional forces. However, as mentioned earlier,

these studies are inconclusive, or even mutually conflicting on the effect of these factors. It is easily seen in the research reviewed above that almost each factor, such as HMO penetration, showed a mixed influence on the adoption of innovation in hospitals in different studies. From the perspective of expansion of utilization of innovations, there is little literature that explores the factors impacting organizations to increase utilization in the innovations they adopted from the perspective of organizations.

Regarding the adoption of bariatric surgery in hospitals, there remains quietly unclear on the procedure from the perspective of organizational level. The current literature only provides a brief description of the increase in the procedures performed. First, it is still not clear what the reason for growth consisted of behind the increase in the number of procedures performed annually in hospitals. Although the estimation by Alt (2001) mentioned the increase of procedures, the source of statistics and information was not specified. Other estimations done by ASBS (2004) and Pope, Birkmeyer, and Finlayson (2002) evaluated the trend of increase in the volume of bariatric procedures performed. In general, extremely little attention has been paid to the factors consisting of the increase in volume. Is the growth a result of more hospitals adopting bariatric procedure, or from hospitals who had adopted the surgery doing more procedures, or from the mixed situation of both possibilities? No study addressed the primary question that is the base for future studies on this phenomenon.

The second weakness in current body of literature on bariatric surgery is that very few empirical studies have been conducted. Most of studies are descriptive research, or even a brief introduction. Compared with the studies on some other procedures such as heart surgery, which have examined intensively the adoption of these procedures in hospitals, studies on bariatric surgery from health services research perspective are more simple and superficial.

Based on the literature reviewed in this chapter, researchers have begun to pay attention to the phenomenon — rapid increase in the utilization of bariatric surgery. However, most of related studies were limited to the perspective of clinical technology in a single hospital or by a single surgeon. There is no literature found to explain what factors enhance hospitals to adopt the technical innovation. In addition, explanation of the growth of bariatric procedures performed has not been made from the perspective of organizations.

The literature review as detailed here is a step in framing the current study examine the determinants of hospitals adoption or expansion of bariatric surgery. In the next chapter, further framing of this research is provided through the development of theoretical framework.

CHAPTER 3 - THEORETICAL FRAMEWORK AND CONCEPTUAL MODEL

Today's health care environment is in turmoil, characteristic of rapid and uncertain change. In order to survive in the dynamic environment, organizations must be able to respond to these changes appropriately. Various organizational theories provide us tools to understand the motivation for certain decisions made by organizations and subsequent influences on the entire industry.

This chapter develops a conceptual model using resource dependence theory to study the current issue of adoption of bariatric surgery in hospitals. Resource dependence theory emphasizes on individual organizations, such as hospitals, and their response to environmental uncertainty from the perspective of resource acquisition and survival.

In Chapter 3, the theoretical framework, conceptual model, and hypotheses of study will be presented. This chapter begins with a discussion of resource dependence theory. Then, the conceptual model of this study is presented, followed by discussion of factors and hypotheses. The chapter will conclude with a summary and discussion of the model.

Resource Dependence Theory

The resource dependence perspective was formally introduced by Pfeffer and Salancik in the 1970s. Resource dependence theory is an open system theory that characterizes organizations as open systems and capable of self-maintenance on the basis of throughput of resources from the environment (Scott, 2003). The underlying premise of open systems theory is, according to Pfeffer and Salancik (2003), "... organizational activities and outcomes are accounted for and by the context in which the organization is embedded." The interdependence

of an organization and its environment receives primary attention in the open systems perspective. The environment is perceived to be the ultimate source of materials, energy, and information, all of which are critical to the survival of organizations.

Within the resource dependence perspective, organizations are viewed as coalitions, altering their structure or patterns of behavior to acquire and maintain external resources necessary for survival. Acquiring the necessary resources needed for the organization comes by increasing or decreasing the organization's dependence on environment. The resource dependence theory rests on a number of assumptions that explain how organizations work to obtain and maintain resources.

First, this open-systems organizational model posited that no organization is entirely self-sufficient or can control all of the resources necessary to survive, and the exchange of resources with other organizations is a condition for survival. As Buckley (1967, p. 50) stated, "That a system is open means, not simply that it engages in interchanges with the environment, but that this interchange is an essential factor underlying the system's viability." Resource dependence theory proposed that all organizations, as open systems, are characterized by an assemblage or combination of parts whose relations make them interdependent. It also suggests that all organizations are embedded in a context combined by related organizations and individuals and no organization is able to be independent and self-sufficient. Scarce resources, which are in the form of monetary, material, information, regulation, and so on, are necessary to any organization for survival. Therefore, it is inevitable for organizations to rely on and interact with external environments.

Second, the environment is assumed to contain scarce and valued resources essential to organizational survival (Pfeffer and Salancik, 1978). From the open systems perspective, the environment is the set of all objects whose attributes affect the organization and those objects

whose attributes are changed by the behavior of the organization (Hall and Fagen, 1956). The environment in the resource dependence perspective is seen as the pool of resources for organizations, which provides materials, technologies, personnel, information, and so on. Specht (1993) summarized environmental resources into five categories: social, economic, political, infrastructure development, and market emergence. It is believed that these five types of resources are critical to the formation, survival and development of organizations (Specht, 1993). In addition to a simple stock of resources, environments also consist of different stakeholders, who control the resources and exert pressures on organizations (Oliver, 1991). Resource dependence theory argues that those stakeholders who control scarce resources have power, and organizations are constrained by pressures from external stakeholders to whom they must respond to survive. The dependence of an organization on its environment can create problems of uncertainty or unpredictability for the organization.

The resource dependence perspective also suggests that organizations intend to maintain their autonomy (Pfeffer and Salancik, 1978). Despite the inevitable interaction with external environment, organizations still desire to remain autonomous and are reluctant to enter into the interaction with environments. Organizations' interactions with environments to acquire resources increase their possibility of survival, but reduce their freedom to make autonomous decisions. These interactions with environments also make organizations subject to external scrutiny and evaluation. The environment may place demands or requirement on the organization in exchange for providing necessary resources to the organization. The more important the resources are to an organization's mission and the greater their scarcity, the more likely the organization is to sacrifice autonomy to obtain resources (Alexander and Morrisey, 1989; Cook et al., 1983). Therefore, organizations must carefully balance the maintenance of autonomy against acquisition of resources from the environment. An organization's attempt to

satisfy the demands of the environment is the function of organizational dependence on the environment and the extent to which the organization is expected to give up autonomy.

According to resource dependence theory, organizational dependence on the environment does not necessarily cause problems for the organization (Pfeffer and Salancik, 1978). However, when the environment becomes undependable or unpredictable, resources may be scarce, demands of external stakeholders may change or become more rigorous, and multiple demands may arise. The variation of the environment can cause survival uncertainty for the organization. Several perspectives are suggested to reflect the extent of environmental uncertainty: resource munificence, resource stability, and resource complexity (Pfeffer and Salancik, 1978).

Resource munificence is the magnitude of available resources or resource substitutes. When there is a large amount of resources relative to the demands of the organization, resource uncertainty for the organization is low. Low resource munificence leads to increased resource uncertainty because resources become relatively scarce to each organization.

Resource stability refers to the consistency of the availability of resources in the environment. For organizations, environmental uncertainty is low when there are resources available consistently. However, resource instability increases the resource uncertainty because of the inconsistency of the availability of resources.

Resource complexity is the level of complexity of relationships which an organization must encounter in order to acquire the resources. For organizations, a high degree of resource complexity increases the resource uncertainty of organizations. While, low resource complexity leads to a decreased resource uncertainty for organizations.

Resource uncertainty in external environments influences an organization's response to the environments. Two ways are supposed to be applied by organizations to respond to

environmental uncertainty for obtaining scarce resources: (1) adapt themselves to the environments, or (2) change the environments to fit the organization's capability (Pfeffer and Salancik, 1978). However, organizational and environmental constraints always limit an individual organization's ability to change the environment and make the organization choose to adapt to the environment within its constraints. Several strategies are suggested for use by organizations to respond to environmental uncertainty.

Organizational responses to environmental uncertainty would include adaptation, growth, avoidance, or alteration of the environment (Pfeffer and Salancik, 1978). The response form depends on the level of environmental uncertainty and the ability of the organization to maintain its autonomy.

Adaptation is the response of trying to make minimal changes to the technical core, and reduces environmental uncertainty by modifying the organization to meet the demands from external stakeholders. Organizations will always try this way as the first choice to respond to the external environmental uncertainty because it is the way to minimally reduce the organizations' autonomy, and make their resources more stable and munificent. Organizations engage in adaptation, through internal or external adjustments, such as intentional, rational, and adaptive response to reduce dependence on external organizations and to maintain their own autonomy, in the face of changing economics or technological circumstances that threaten organizations' survival. Through adaptation, organizations buffer themselves from influences of uncertainty or change of environments.

Organizations can also respond to their external environment through growth (Pfeffer and Salancik, 1978). Organizations may grow by joining a system, cooperation, merger, expansion, or diversification. Through these means, an organization may become larger in order to attract

more coalitional support to take advantage of acquiring limited resources from the external environment.

Another way in which organizations can respond to environmental uncertainty is through avoidance (Pfeffer and Salancik, 1978). Instead of simply satisfying the demands of the external environment, organizations can also reduce the uncertainty by not complying with external demands. The organization can change its operating domain to avoid competition and reduce dependence on the uncertain part of the environment. By altering the purpose or structure of an organization, the organization no longer requires a limited range of resources that were previously critical to its survival. Resource dependence perspective believes that within each of these broad categories of altering the organization or the environment, there are many subsets of possible organizational responses. Therefore, organizations can reduce their dependence on scarce resources induced by environmental uncertainty by changing their domain from a current situation to the range that is less influenced by environmental uncertainty.

Rather than adapting or changing themselves to fit environment requirements, alternatively, organizations can also adapt by operating on the environments (Pfeffer and Salancik, 2003). Organizations can lobby to have the government control the environment in their interest or can persuade established regulators to create favorable environmental contexts. Not only are organizations constrained by the political, legal, and economic environment, but, in fact, law, legitimacy, political outcomes, and the economic climate reflect, in part, actions taken by organizations to modify these environmental components for their interests of survival and growth.

In summary, resource dependence theory suggests that organizations' activities and outcomes are affected by the context in which they are embedded. It argues that organizational

survival depends on obtaining necessary resources from the external environment, and therefore, organizations respond to the demands of groups and organizations in their environment that control the valued and scarce resource (e.g., technology, funds, personnel) (Pfeffer and Salancik 1978). The theory, however, also suggests that organizations do not just passively comply with demands from their environments, but attempt to maintain their own autonomy which allows adaptation to new contingencies. Therefore, organizations should manage their relationship to environments by balancing acquisition of necessary resources against maintenance of autonomy. When resources in external environments are plentiful and stable, organizations would keep more independence. However, faced with a shortage of critical resources or uncertain environments, organizations would give up more autonomy to exchange the necessary resources that are the key to organizational survival. Resource scarcity, resource instability, and resource complexity reflect the level of resource uncertainty within external environments which an organization encounters. The organization is likely to respond to the environmental uncertainty by adaptation, growth, avoidance, or alteration of the environment. Whichever responses will be selected by the organization are the function of its constraints that generally refer to individual organization's characteristics, environmental resources and the likelihood that the response will successfully reduce the resource uncertainty. The focal concepts of resource dependence theory and their relationships are depicted in Figure 5.

Development of Conceptual Model

With the introduction of the prospective payment system based on DRGs and managed care, the health care sector in the United States has experienced a profound change in the last two decades. As a result, hospitals face an environment with higher uncertainty than before,

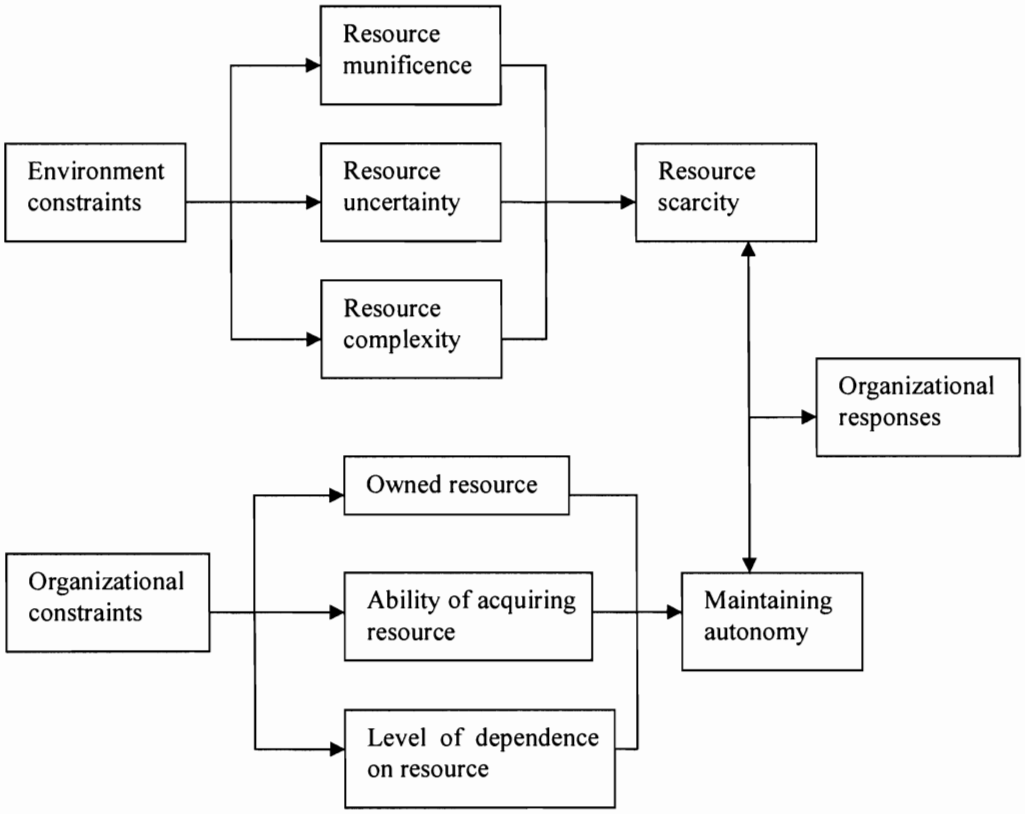

Figure 5: Theoretical Model of Resource Dependence Theory.

and they must respond to the changes in the external environment to obtain the necessary resources for their survival and success.

For hospitals, patients should be the most important resource because patients are the core of customers and they bring the revenue that ensures hospital survival. However, there are differences between patients who have various payment methods. Before the initiation of PPS and managed care, fee-for-service was generally used as the major means of reimbursement that provided favorite payment rate to hospitals. The rise of managed care organizations (MCOs) is seen as one of major trends or changes in the health care industry over the last twenty years (Burns, Bazzoli, Dynan, and Wholey 1997, Gaynor and Haas-Wilson, 1999).

MCOs encompass three various mechanisms that include health maintenance organizations (HMO), preferred provider organizations (PPO), and point-of-service organizations (POS). The emergence of MCOs has transformed the traditional health care insurance plans greatly (Fuchs 1997, Dranove, Simon, and White 2002). Under traditional reimbursement insurance, plans do not restrict the provider or treatment choices of patients. Thus, there is little incentive for an insured consumer to consider price in choosing among providers. However, MCOs, which were encouraged by federal legislation as alternative, lower-cost providers in the health industry, contract with only a subset of hospitals offering the best prices (adjusting for quality differences) in the area they serve. As a result, the growth of managed care led to increased competition, especially price competition among hospitals in the American health care market, and at the same time, it also caused a shift from "patient-driven" competition to "payer-driven" competition (Dranove, Shanley, and White, 1993).

In this study, adoption of the surgical technology and expansion of this service are two components of the growth of bariatric procedures performed in hospitals. A similar point for the two actions is that both of them are the investment of hospital in this innovation. From the resource dependence perspective, both adoption of and expansion of bariatric surgery are seen as the hospitals' response to the changed environment, which has provided less revenue for the same volume of patients than before. Under the stricter payment methods, hospitals have to choose to maintain or increase monetary revenue by attracting more patients, or operating more services with higher reimbursement. Based on the resource dependence theory, the response decision is influenced by both internal and external constraints, which refer to the hospitals' organizational characteristics and environmental factors. The hospitals' features decide the dependence of hospitals on the unstable resource due to environmental change and the ability of hospitals to maintain their autonomy. Also, hospitals' characteristics are related to the

hospitals' ability of adopting or expanding the bariatric procedures, and the ability of hospitals to suffer the outcome of responding to the environment change. The environmental factors decide the degree of uncertainty being faced by hospitals, and the importance of resources towards hospitals.

The resource dependence perspective suggests that the likelihood that the hospital response will successfully reduce the resource uncertainty may influence the hospital's decision to invest in the bariatric procedures. For hospitals, if the investment in bariatric procedures does not enable them to increase their resource acquisition, hospitals would not respond to the environment uncertainty in this way. However, strong evidence supports that investment in bariatric surgery can lead to attracting more patents and more favorable reimbursement for the procedure (Alt, 2001). As the literature reviewed in chapter 2 showed, a large volume of patients with obesity that include almost one third Americans are seeking the surgical treatment. In addition, hospitals can obtain more favorable reimbursement from performing bariatric procedures. Up to now, private insurance companies had been the major payer for the bariatric procedures. Compared to Medicare and Medicaid, private insurance companies are more generous in reimbursement rate for services delivered by hospitals. Therefore, hospitals can expect to attract patients for a higher reimbursement rate by adopting or expanding bariatric procedures.

In sum, the continuously changing environment in the health care industry makes hospitals change their position in the balance between acquisition of resources and maintenance of autonomy in order to survive and develop. From the view of resource dependence, the collective function between environmental factors and organizational features affect hospitals' decisions to adopt or expand bariatric procedures. Given the above discussion and related literature reviewed, the conceptual model is shown as Figure 6.

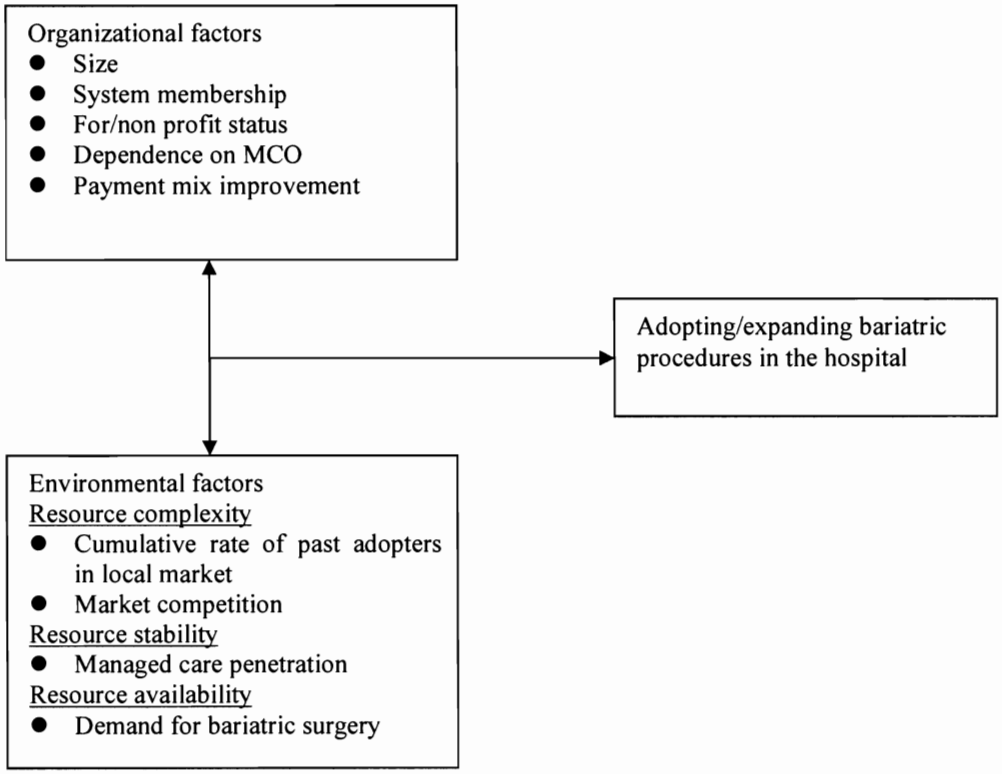

Figure 6: Conceptual Model – The Adoption or Expansion of Bariatric Procedure in Hospitals Using a Resource Dependence Perspective.

Hypotheses

Hospital Characteristics

Despite being faced with the same environmental pressures, some hospitals adopt or expand their services in bariatric procedures while others do not. According to Scott (1995), although all organizations in a given industry are subject to the environmental forces, they do not respond in the same way to these pressures. Hospitals differ from others in their organizational characteristics such as size, aim, and technical core. Resource dependence perspective suggests that the organizational characteristics of a hospital decide its ability to acquire necessary resources from the external environment and the ability to maintain its autonomy when facing the requirements from external stakeholders. Therefore, different

positions of hospitals in the balance of acquisition of resources against maintenance of autonomy result in the different decisions of hospital to invest in bariatric surgery and the level of the investment.

Size

Size is an important organizational characteristic that influences organizational responses to the environments. Many researchers argued that organizational size facilitates innovation (Aiken and Hage, 1971; Kimberly and Evanisko, 1981). Large organizations have more complex and diverse facilities that aid the adoption or the utilization of innovations (Nord and Tucker, 1987). Resource dependence perspective suggests that large organizations have greater internal resources, which may include the availability of additional staff, facilities, and monetary resources able to be used in responding to environmental change, and which may also be more capable of accommodating environmental demands than small organizations. In the case of bariatric surgery, a unit for performing such procedures is constructed on the basis of resources including the surgeons who received the professional training of bariatric surgery, related equipment, spaces, auxiliary personnel, and so on. Large hospitals command greater resources and can afford the huge expenditure of initial investment and maintenance for operating a bariatric surgery unit. In addition, greater internal resources give large hospitals the leeway to tolerate the potential loss due to unexpected errors when adopting or expanding such service. Thus, the advantage of having internal resources enables large hospitals to be more likely to invest in the innovation, which means adoption or expansion of bariatric services.

Increased size and visibility make organizations a more likely target for groups, ranging from consumer rights' organizations to government agencies (Pfeffer and Salancik 1978). Also, larger hospitals experience more media exposure and interest group pressure than smaller hospitals, and get singled out for attention and demands by external stakeholders (Greening

and Gray 1994). Because large organizations are more visible to external constituencies, are more vulnerable to public pressure, and make more prominent targets for political activists, regulators, and other institutional actors, they will conform to a greater extent with external pressures to ensure their legitimacy (Dobbin, Edelman, Meyer, et al. 1988; Dobbin et al. 1993; Edelman 1992; Mintzberg 1983; Scott 1992). For larger hospitals, it is a response to these pressures from stakeholders to adopt or expand their services in bariatric surgery. Also, the action of investing in the procedure can make hospitals gain the legitimacy and reputation, which are necessary resources for their survival, from communities and authorities.

Above arguments suggest that larger hospitals are more likely than smaller ones to conform to external pressures and adopt or expand bariatric procedures. They are also more likely to possess the initial resources needed for the investment. Based on the discussion,

Hypothesis 1a: Hospital size will be positively related to the likelihood of adopting bariatric surgery.

Hypothesis 1b: Hospital size will be positively related to the rate of expanding bariatric surgery.

For-profit Status

In addition to the level of environmental pressures, the content of environmental pressures also determines the degree of organizational responsiveness. According to Oliver (1991), organizations are more likely to conform to external expectations that are consistent and compatible with their own goals and objectives. While, they tend to resist external demands that conflict with their interests or that interfere with the implementation of their goals (Covaleski and Dirsmith, 1988). Incongruence between organizational interests and environmental expectations would provoke organizational hesitation about the validity of their responses. A high degree of conformity of organizations to environmental demands is more

likely to be achieved when external expectations are congruent with organizational values and benefits.

In general, expectations regarding social welfare are more likely to be consistent with interests in organizations that are not held exclusively to economic standards of performance (Oliver, 1991). However, if the social welfare can bring economic chances for organizations, those organizations that hold economic interests would also be more likely to conform to these expectations. Facing the prevalence of obesity in the U.S., provision of treatment of obesity has become a kind of social welfare, which was emphasized in the change of policies related to obesity of the Department of Health and Human Services (CMS, 2004).

Hospitals that are characterized as for-profit organizations place a strong emphasis on profitable services (Greenlick, 1988). These hospitals have strict profitability and return on investment criteria and are more likely to permit the allocation of resources to the adoption, expansion and utilization of profitable services. As reviewed in chapter two, bariatric procedures can bring generous revenue to hospitals. For-profit hospitals would achieve more revenue, the interests of these hospitals, through operating bariatric procedures, which is expected by environmental stakeholders. Compared with for-profit hospitals, non-profit hospitals are expected to serve broad societal interests in return for the tax advantages that are granted to them (Guggenheimer, 1988). They are not accountable to investors who seek a financial return (Seay and Vladeck, 1988). Rather than revenue obtained, they tend to be driven by religious, educational, and charitable interests. Despite that treatment of obesity has been accepted as the solution to a public problem, bariatric surgery is still seen as a means to make profit by many researchers, physicians, and organizations due to the high reimbursement portion from private insurers for the procedure. Stakeholder expectation of bariatric procedures will be more congruent with the value and objectives of for-profit hospitals. Thus,

Hypothesis 2a: For-profit status is positively associated with the adoption of bariatric procedures.

Hypothesis 2b: For-profit status is positively associated with the expansion rate of bariatric procedures.

System or Alliance Membership

Resource dependence theory suggests that organizations are embedded in a context (Pfeffer and Salancik, 1978). The extent of organizational responses depends on the environmental context, especially the degree of interconnectedness with environmental institutions (Oliver, 1991). Interconnectedness refers to the presence of interorganizational relationships in an organizational context. Interconnectedness enhances sharing of information, values and practices and influences organizational responses (Pfeffer and Salancik, 1978).

In addition to organizational and environmental influences, the likelihood that responses successfully reduce resource uncertainty also suggests an influence on organizational decision (Pfeffer and Salancik, 1978). While, networks, systems or alliances provide a forum that hospitals can understand the expectations and demands expressed by environmental stakeholders, and the benefits of responding through adopting or expanding bariatric procedures. Ingram and Simons (1995) suggest that interconnectedness is related to how much attention an organization pays to the policies and practices of other organizations. Membership structures, such as hospital alliances and multi-hospital systems, can provide relational density and serve as facilities for diffusing expectations and practices (Westphal, Gulati, and Shortell, 1997). Hospitals that belong to systems or alliances are more likely to be able to recognize the benefit of operating bariatric surgery as a response to environmental uncertainty that face the hospital industry (Daft and Weick, 1984). Also, hospitals that are members of these systems or alliances can learn valuable experiences and information regarding operating bariatric surgery

services from their peers in the networks, which reduces the uncertainty in initiating or increasing the bariatric procedures.

On the other hand, hospitals are more likely to become aware of community health needs, to be exposed to environmental expectations, and to be willing to adopt or expand their services in bariatric procedures (Lumsdon, 1993). In addition to hospitals, multi-hospital networks, alliances or systems may also include advocacy groups, public health agencies, religious and educational institutions, civic groups, and professional associations, which are often used by communities to organize for better health care outcomes (Minkler, 1990). Within these networks, hospitals likely understand what these stakeholders expect them to do and are more likely to conform to the demands. In general, hospitals that belong to systems, alliances or networks are more likely to expose the pressures from environmental stakeholders, and to obtain useful information and recognize the benefits of invest in the bariatric surgery. Therefore,

Hypothesis 3a: System membership is positively associated with adoption oft bariatric procedures.

Hypothesis 3b: System membership is positively associated with the expansion rate of bariatric procedures.

Payment Mix

The likelihood that the response will successfully reduce the resource uncertainty is considered as the factor influencing organizations response to environmental change (Pfeffer and Salancik, 1978). Organizations hold some expectations of reducing uncertainty when they decide to respond to environmental uncertainty through some actions. If the organization realizes that it is less likely to reduce the resource uncertainty by responding to the environment in the special way, it would not adopt the response action. While, if the response

is proved to be effective to reduce resource uncertainty, organizations will be more likely to respond in this way.

For hospitals, Medicare and Medicaid occupied a major position in the payers for services hospitals delivered. Traditionally, Medicare and Medicaid pay a lower rate compared with other payers, especially private insurers. From 1998 to 2000, the period when the volume of bariatric procedures jumped up, the Medicare profit margin declined from 2.5 percent to -0.5 percent, compared to the total profit margin from 5.5 percent to 2.6 percent in 2000 (Ernst & Young, 2000). It is argued by Banaszak-Holl, Zinn and Mor (1996) that in markets where Medicare and Medicaid is a major presence, reimbursement that does not cover the actual costs of care may discourage innovation.

The bariatric procedure is supposed to bring large volumes of patients in waiting lists and higher rates of reimbursement from health insurers (Alt, 2004; Fitch et al, 2004). In general, bariatric surgery is mainly paid by commercial health plans rather than Medicare and Medicaid. However, the proportion of Medicare and Medicaid in cost payers varies from hospital to hospital. In fact, the surgery can be almost as profitable as cardiac surgery (Alt, 2004), but it still depends on hospitals contracts with payers. If a hospital is mainly, or highly, compensated by Medicare and Medicaid, the profit acquired from operating bariatric surgery is low, or even negative (Alt, 2004). Therefore, a high proportion of Medicare and Medicaid in the payment for bariatric surgery does not achieve the expectations of hospitals for operating the procedure, which include increasing profit margin, attracting more patients, and so on. However, a relatively low proportion of Medicare and Medicaid payment enables hospitals to obtain more profit and be more likely to enroll patients with severe obesity. The hospitals that have not adopted such procedure would be willing to operate it if they are located in a market with low level of Medicare and Medicaid paying for the procedure. Similarly, the hospitals that have

operated the surgery are also more likely to expand their volume of procedures if the prior procedures performed were reimbursed in low portion of Medicare and Medicaid reimbursement. Therefore,

Hypothesis 4a: The payment mix improvement is positively associated with the likelihood of hospital adoption of bariatric procedures.

Hypothesis 4b: The payment mix improvement is positively associated with a hospital's expansion rate of bariatric procedures.

Level of Dependence on Managed Care Organizations

For hospitals, managed care organizations (MCOs) have become the key stakeholders since the introduction of managed care. MCOs influence which hospitals their members will use, how many services they will utilize, and what price will be paid for these services. They control critical resources that hospitals need for survival. Therefore, MCOs are considered as a significant source of dependence for hospitals. Resource dependence perspective suggests that compliance with stakeholder demands is likely to be higher among firms that depend on these stakeholders for scarce resources (Pfeffer and Salancik, 1978). However, rather than simply comply with demands of stakeholders, organizations can seek alternative source of resources to eliminate or reduce the dependence on one or relative few significant stakeholder in order to maintain their autonomy at the largest scale (Pfeffer and Salancik, 1978). It is argued by resource dependence theory that the dependence of organization on one constituent who controls resources is influenced by the availability of an additional source of resources. When there are additional suppliers of resources in the environment, the organization will seek the diversification of resources and then reduce its dependence on a unique source of resource. For an organization, the resource importance is positively related to the concentration of resource control, but negatively related to the maintenance of its autonomy. By using diverse sources of

scarce resources, the organization can reduce its dependence on few suppliers and obtain more autonomy. Therefore, those organizations highly dependent on one or a relative few significant suppliers of resources are more likely to seek additional sources of needed resources to reduce the dependence and maintain more autonomy in exchange for resources needed for survival.

Up to now, bariatric procedures mainly have been reimbursed by commercial insurers rather than MCOs. As shown in chapter two, nearly 90 percent of hospital bariatric surgery costs are paid by private health plans (Alt, 2004; PHC4, 2004). One solution for hospitals to obtain or increase the function of additional suppliers is by investing in bariatric surgery. This provides an alternative source of patients and monetary resources for hospitals. Those hospitals that highly depend on managed care give up more autonomy in order to exchange the resources needed for survival than the hospitals with fewer patients contracted with MCOs. By operating or expanding bariatric procedures, hospitals can reduce their level of dependence on managed care organizations, the major stakeholders that control the resources needed for a hospital's survival. Based on the above discussion,

Hypothesis 5a: The hospitals' dependence on managed care organizations is positively associated with adoption of bariatric procedures.

Hypothesis 5b: The hospitals' dependence on managed care organizations is positively associated with expansion rate of bariatric procedures.

Environmental Factors

According to resource dependence theory, when resources are stable and sufficient, dependence on external constituencies is not in itself problematic. However, environments vary with respect to the abundance of resources and uncertainty, meaning the variability and complexity of acquiring resources. The decision to comply with the demands of key constituents in environments will depend on how abundant, stable, and accessible resources are

in an organization's market environment. Under favorable resource conditions, organizations may not be greatly constrained to comply with the need of external constituents and hence can maintain a higher autonomy. However, under less favorable market conditions, organizations would be more compliant with external constituents in order to acquire necessary resources.

Market Demand for Bariatric Surgery

Resource dependence perspective would agree that organizations respond to constituents that control resources needed for organizational survival. Constituents impose expectation on the organizations in the environments. The level of resources available to organizations from environments depends on the degree of the organizations' compliance with constituents, especially key constituents' expectations. However, from the opposite perspective, the level of the organization's compliance with constituents' expectations also depends on the amount of necessary resources controlled by the constituents.

For hospitals, the patient is a key resource and is vital for hospital survival. If there are plenty of patients with obesity for the hospitals in an area, these patients will become an important constituent for hospitals. Also, given the great prevalence of obesity among the community, obesity, especially morbid obesity, becomes a great threat to public health rather than a kind of disease limited within a small population. Therefore, the provision of bariatric surgery is expected by communities and other stakeholders such as public health agencies, insurance companies, government authorities, and so on. These environmental stakeholders impose expectations on hospitals through exerting pressures such as regulations and reimbursement rates. The expectation that hospitals adopt or expand bariatric procedures is heightened when hospitals face such great pressures. On the contrary, if there is not sufficient population with obesity, the demand for bariatric surgery is lessened. And thus, strategy of

adopting or expanding bariatric procedures can not help hospitals acquire the necessary resources for survival.

On the other hand, a higher volume of obese people in the market makes it impossible for hospitals to obtain incremental revenue from the reimbursement as well as prestige and legitimacy, which are also key resources to hospitals (Proenca, Rosko and Zinn, 2000). By investing in bariatric surgery in markets with large volumes of obese people, hospitals may realize more profit due to the favorable payment for the procedure, which in turn, attracts more patients. Also, adopting or expanding bariatric procedures in such area may be viewed as a contribution to reduce prevalence of obesity, a serious public health problem. Thus, the action may obtain legitimacy from not only the community but also the public health agencies, regulatory authorities, and other stakeholders. Based on the above arguments,

Hypothesis 6a: Prevalence of obesity in the area where the hospital is located is positively associated with the likelihood of hospital adoption of bariatric procedures.

Hypothesis 6b: Prevalence of obesity in the area where the hospital is located is positively associated with expansion rate of bariatric procedures.

Competition

According to resource dependence theory, dependence on external stakeholders is not itself problematic if resources are stable and sufficient. However, environments would vary due to resource munificence and resource uncertainty. The level of competition in the local market can influence how stable and accessible resources are. It is one environmental factor mitigating organizational compliance with external constituents. Given a fixed total resource available, in highly competitive market, organizations would share a limited resource pool and survival depends more on how resources are allocated across competitors. In addition, organizations will spend more in exchanging slack resources from environments in the highly

competitive market. On the other hand, organizations also try to strengthen their ability of acquiring resources in order to reduce their dependence on external constituents. According to the resource dependence arguments, hospitals will experience more difficulties in acquiring resources in a highly competitive market. On the one hand, hospitals have to face the possibility of available resources reduction, for example, hard to attract nursing staffs, losing patients, or getting low reimbursement rates. On the other hand, hospitals also have to pay more cost to acquire resources than they do in less competitive market. However, if new resources emerge and develop, the resource munificence increases in the environment. Hence, organizations can reduce the degree of resource uncertainty by acquiring the newly developed resources. Therefore, facing the competitive markets, in addition to a stricter compliance with demands of external constituents, finding and acquiring additional resources also enables organizations to obtain resources needed for survival and to reduce dependence on one or few significant constituents.

For hospitals, a large population with obesity provides a new source of scarce resources, such as patients and corresponding profits, to them. The continuously increasing prevalence of obesity makes the pool of resources rapidly expanding and guarantees the plentiful stock of resources in the short term. For hospitals, one major and highly profitable method of acquiring these resources is to begin operating or to operate more bariatric procedures. If the hospital is located in a less competitive market, it possesses relatively more resources and faces less resource uncertainty. The less competitive market would produce less incentive for hospitals to adopt or actively increase the utilization of bariatric surgery. However, the hospitals in a highly competitive market would be more aggressive in adopting or expanding the procedure in order to acquire the scarce resources for survival because operating the procedure will lead to the increase in resource availability and the decrease in resource uncertainty. Although

hospitals in less-competitive markets are also able to benefit from the procedure, hospitals encountering high competition will gain more in terms of resource certainty and the ability to obtain more resources from operating bariatric surgery. So these hospitals have more incentives to respond to environments in this manner. Given above augments,

Hypothesis 7a: The degree of competition is positively associated with adoption of bariatric procedures.

Hypothesis 7b: The degree of competition is positively associated with expansion rate of bariatric procedures.

Cumulative Adoption within Local Market

Legitimacy is a generalized perception that actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions (Suchman, 1995: p 574). The concept widely appears in the institutional theory. Legitimacy is seen as one kind of resources needed for organizational survival by more and more researchers (Oliver, 1991; Proenca, Rosko, and Zinn, 2000). Organizations must obtain legitimacy, or as Sharma (1991) concluded, without legitimacy the environment will not be willing to supply resources. Tolbert and Zucker (1983) argued that the experiences of early adopters of a practice or service serve as cues for other organizations to imitate.

With the cumulative level of adoption, environmental pressures will be greater, which legitimize the practice and require other organizations to follow. However, resource dependence theory also addresses the economic incentive to organizations rather than simply emphasizing normative resources. If the price of obtaining legitimacy is too high, organizations would give up adoption of the practice because it is not the only way to acquire legitimacy. In the case of bariatric procedures, the cumulative number of adopters gives rise to normative pressure, legitimizing adoption or expansion of the procedure and increasing the pressure on

other hospitals to follow. When the cumulative level of adoption reaches a point discussed in next section, hospitals will pay too much for acquisition of the legitimacy. By balancing the legitimacy and the economic loss, hospitals will be reluctant to adopt or expand the procedure any more.

On the other hand, for hospitals, before the procedure has diffused to a certain point, which means the local market of bariatric surgery is saturated, hospitals can still obtain revenues in terms of patients and funding by entering the bariatric surgery market or expansion of their capacity for bariatric procedures. Before this point, the outcome of adopters and expanders of bariatric surgery would be positive in terms of obtaining scarce resources. Given the influence of experiences of these adopters, hospitals are more likely to adopt the procedure or expand their capacity of the surgery. However, when the local market for bariatric surgery has been saturated, hospitals face more competition and difficulties to obtain the resource they expect. After the saturated point, adoption or expansion of the procedure may result in economic loss rather than gain compared to their investment. Therefore, there is an inverted-U, rather than a linear relationship between the accumulative level of adopters and the hospitals' adoption or expansion of bariatric procedures. Before the saturated point, hospitals are more likely to adopt or expand bariatric procedures. But after the point, hospitals may be reluctant to adopt or expand the procedures. Given the above discussion,

Hypothesis 8a: The cumulative level of adoption is inverted-U associated with the likelihood of hospital adoption of bariatric procedures.

Hypothesis 8b: The cumulative level of adoption is inverted-U associated with the expansion rate of bariatric procedures.

Penetration of Managed Care

Resource dependence theory argues that the responses of organizations vary depending upon the stability of resources provided by the environments in which they operate. Organizations operating in unstable environments are faced with a high degree of risk and uncertainty in terms of resources compared to those organizations whose domains are more predictable. In order to counter the instability, organizations are likely to be defensive in their response to secure themselves from the possible loss in resource acquisition (Aldrich and Pfeffer, 1976; Pfeffer and Salancik, 1978; Scott, 2003).

Managed care, from its introduction in health care industry, is regarded as an important source of environmental uncertainty by researchers (Aaron, 1991; Weisbrod, 1991; Fuchs, 1996). By steering the direction of patients, selective contracting with hospitals, and capitation payments, managed care organizations control and allocate the resources that are critical for hospital survival. Hospitals have to face the risk that the resources are deprived when their operations mismatch the requirements of managed care organizations. Therefore, high level of managed care penetration within the local market makes the resources for hospitals to be more unstable. Hospitals operating in highly managed care-penetrated markets will be more willing to adopt or expand a new service to gain control over a vital resource necessary for survival – patients. Through acquiring the additional and new resources, hospitals have greater capacity to counter the unstable resource availability due to managed care. Therefore,

Hypothesis 9a: The penetration of managed care in local markets is positively associated with the likelihood of hospital adoption of bariatric procedure.

Hypothesis 9b: The penetration of managed care in local markets is positively associated with the expansion rate of bariatric procedure.

Summary

Resource dependence theory is based on the premise that individual organizations must respond to environmental uncertainty to acquire the critical resources needed for ongoing operations as well as survival. The theory emphasizes the influence of the environment in terms of three perspectives: resource munificence (availability of resources), resource stability (managed care penetration), and resource complexity (cumulative adoption and market competition). From another perspective, the theory addresses the function of organizations in the response to environmental change. Rather than passively complying with the demands of environments, organizations also intend to maintain their autonomy. The organizational characteristics decide the organizational degree of dependence on resources, ability of acquiring resources, and the ability of responding in a certain way. Both environmental factors and organizational characteristics influence organizations in how they respond to environmental uncertainty in a special manner and the degree of response.

Based on the resource dependence theory, a conceptual model was developed of the hospital decision to adopt or expand bariatric surgical services. This model depicts two major categories of determinants – hospital characteristics and environmental factors. Deriving from the model, various hypotheses were developed for testing. Table 2 presents these hypotheses aligned by determinants of adoption or expansion of bariatric procedures. The expected results (sign) related to each hypothesis are also summarized in this table.

The combination of the literature review from Chapter 2 and the conceptual framework presented in Chapter 3 not only lays the groundwork for the study examining the determinants of hospitals adoption or expansion bariatric procedures, but also defines the applicable boundaries. In the following Chapter 4, the methodologies employed to carry out the study are described.

Table 2. Summary of hypotheses and the expected results.

Hypothesis	Determinants of adoption or expansion	Expected sign	
		Adoption	Expansion
Hospital characteristics			
H1	Size	+	+
H2	For-profit status	+	+
H3	System or alliance affiliation	+	+
H4	Payment mix improvement	+	+
H5	Level of dependence on managed care	+	+
Environmental factors			
Resource munificence			
H6	Available patient with obesity	+	+
Resource complexity			
H7	Competition	+	+
H8	Cumulative number of adopters	Inverted-U	Inverted-U
Resource stability			
H9	Penetration of Managed care	+	+

CHAPTER 4 - METHODOLOGY

Based on the literature review and theoretical framework as previously shown, this chapter will outline the methodologies used to examine the determinants influencing hospital adoption or expansion of bariatric surgery. The methods used to frame, acquire, model, and examine the study's data are discussed regarding the individual hospital as the unit of analysis.

The chapter first discusses the research design, which provides a frame to guide the statistical analysis and defines the boundaries of the time period of examination. Then, the data and data sources used in this study are described. Next, the sample selection process is discussed, which further delineates the studies boundaries. Variable selection and measurements are then addressed. Finally, the statistical methods used to analyze the data are depicted.

Research Design

The purpose of this study is to explore the association of adoption or expansion of bariatric surgery with hospitals' features in two dimensions: organizational characteristics and environmental factors. The study design, with a variety of constraints, aims to explore the relationship between the independent and endogenous variables.

In this study, the research design is characterized as being a retrospective panel design. Given the nature of a retrospective study, there is no intervention implemented to the research unit – an individual hospital in this study. Therefore, this study is a non-experimental study using the secondary data. The unit of analysis, as stated above, is the individual hospital.

The retrospective design denotes the historical focus of the research as the event being studied, hospital adoption and the expansion of bariatric surgical services has previously occurred. As shown in Figure 7, a nonequivalent, panel design is employed in this study. The period included in the study ranges from 1995 through 2000. In each year from 1995 to 2000, a portion of hospitals adopted bariatric surgery or expanded their service in the procedure. Simultaneously, some hospitals may have cut or removed the service due to hospital merger or closure. In order to obtain the growth rate of numbers of bariatric procedures performed in hospital, only the hospitals operating in all 6 years are included in the analysis of the study, which constitute the panel. The group of hospitals that did not adopt bariatric surgery in each year served as the control group. During the period of 1995 to 2000, the size of adoption group and control group are dynamic due to the new adopters, which results in the nonequivalence between the two groups. Data from the six years, 1995-2000, are pooled together to provide the basis for the statistical model.

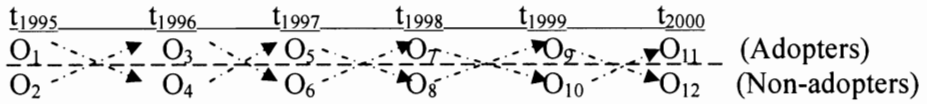

Figure 7. Research Design.

Where, t_{1995} refers to the year of 1995, so does other years.

O_1 — O_{12} refers to the observation in each year.

- - - - - ► means the flow of "control group" (non-adopters) to adopters or the adopters drop the service.

A panel study allows us to observe a set of individual hospitals sampled repeatedly at different points in time. Therefore, such design offers a certain number of advantages over a pure cross section or a pure time series study. The most obvious advantage is that the size of

sample is much larger in panel data by multiplying years of observations. This situation is likely to produce more reliable parameter estimates, and enable researchers to specify and test more sophisticated models. Second, a panel data set may alleviate the problem of multicollinearity (Hsiao, 2003). When the explanatory variables vary in two dimensions, they are less likely to be highly correlated. A third advantage is that a panel design makes it possible to identify and measure effects that are not detectable in a cross-sectional design or a pure time series design. Finally, it is argued that the use of panel data eliminates or reduces the estimation bias. In a panel context, through introducing a fixed effect into the equation, the latent variable can be controlled, and thus eliminates the bias in the elasticity estimates. Specifically for this study, multiple years of data are needed to trend the hospitals action in providing bariatric procedures. The panel data across six years are able to show how and which organizational and environmental factors most influence the hospital provision of the bariatric service.

Despite the advantages discussed above, because the panel design in this study is a kind of non-experimental design, the internal validity of this study is threatened by several effects as shown in Table 3.

Table 3. The Existence of Threats to Internal Validity of Study.

Threats	Existence
History effect	-
Maturation effect	+
Testing effect	?
Statistical regression effect	?
Instrumentation effect	+
Selection bias	++
Mortality	-
Cross-over effect	+

Given the nature of this panel study, the largest threats to this study are selection bias and a possible cross-over effect. An instrumentation effect and a maturation effect may also impact

the validity of this research. Through using the panel, the effect of mortality is eliminated from the study. With the control group used, the effect of history should be eliminated because both groups experienced the same historical events during the study period.

Selection bias refers to the bias resulting from preexisting differences between groups, which mean the sample used and the hospitals omitted in this study. In the process of sampling and data merger, some hospitals are eliminated because these hospitals did not respond to all six years of surveys collecting data used in this study, or were acquired by other hospitals, or were closed. Only those hospitals that retain their identity during the period of 1995 to 2000 and respond to all these surveys are included in this study sample. It may be argued that the dropped hospitals have significantly different features from the sample, and these features interact with the factors influencing hospital adoption or expansion of bariatric surgery. Selection bias may threaten the internal validity of this study because researchers are faced with the possibility that any group difference is the result of initial difference rather than the effect of independent variables. This bias may lead to the argument that only those hospitals with certain characteristics, which also influence their survival or response to surveys, invested in the innovative therapy. In addition, if the hospitals with some special features were dropped from the sample, the influences of these factors on the hospital investment in bariatric procedures would be over- or under-estimated in this study.

Cross-over effect is also suggested to exist in this design. Some hospitals that did not adopt or expand the service of bariatric surgery at the beginning of the each year in study period also invested in the procedure. This resulted in the decrease in the number of cases in the control group and increased the number of "exposed" group cases. Generally, cross-over effect may lead to the change in the portion of control group to "test" group, and hence affect the statistical validity.

An instrumental effect may also exist, which is that the differences across time are due to the change of instrumentation rather than factors being studied. Secondary data are used in this study, which range from 1995 to 2000. Changes in instrumentation or data collection methods of these data over the time period of the study may result in the instrumental effect. Given possible confounding, a complex analysis will be used in this research to reduce or eliminate such threats.

Data and Data Sources

Data are drawn from a variety of sources for this study. Several data sources are merged together for the final analysis. The primary data source is the State Inpatient Databases (SID, 1995-2000), a component of the Healthcare Cost and Utilization Project (HCUP) data from Agency for Healthcare Research and Quality (AHRQ), which provides the study's sampling frame, dependent variables, and part of independent variables such as payment mix. A second source is the American Hospital Association data (AHA, 1995-2000), which provide the information on hospital size, profit status, chain affiliation, and other hospital characteristics. The Area Resource File (ARF, 2001) which provides information on some environmental variables. The HMO Interstudy file supplies the HMO penetration in market. The CDC Behavioral Risk Factor Surveillance System Files (BRFFS) provide the information on prevalence of obesity among adults in the level of state.

The State Inpatient Data of AHRQ's HCUP data from 1995 to 2000 include 11 states participating in the program. The latest version of the SID covers inpatient care in community hospitals in 33 states, but only 13 states have complete records back to 1995. Given the data availability, 11 states are selected in the study, which include: Arizona, California, Colorado, Florida, Iowa, Maryland, Massachusetts, New Jersey, New York, Washington, and Wisconsin. These states are geographically dispersed and cover about 1,500 hospitals, which represent

about 30% of community hospitals nationwide. HCUP State Inpatient Data (SID) contains the universe of hospital inpatient discharge records in each state participating in the program. The SID contains a core set of clinical and nonclinical information on all patients' hospital discharge, regardless of payer. The data identify state-specific trends in inpatient care utilization, access, charges, and outcomes, such as principle and secondary procedures, admission and discharge status, patient demographics (e.g., gender, age, and race), payment source (e.g. Medicare, Medicaid, private insurance, self-pay, and additional discrete payer categories in some states), total charges, and length of stay. In addition to the sample frame, SID provides the information for the general increase in the utilization of bariatric surgery, two dependent variables — adoption of the surgery and growth of procedures performed. It also is used to obtain the information of payment mix.

The American Hospital Association (AHA) annual survey is a data source widely used in health services research. The vast majority of hospitals surveyed are members of the AHA, while, surveys are also sent to some nonmember hospitals. Although it is a voluntary survey for hospitals, the response rate normally reaches 85 percent or even higher each year. It should be noticed that the response rate is also related to the hospital size, ownership and the region hospitals are located (AHA, 2000). 1995-2000 AHA data are used in this study to provide the information on hospital characteristics including hospital size, for-profit status, system membership and some control variables, such as case mix and occupancy rate.

The Area Resource File (ARF) is a national county-level health resources dataset designed to be used by planners, policymakers, researchers, and other analysts interested in the nation's health care delivery system and factors that may impact health status and health care in the United States. More than 50 data source files are used, including National Center for Health Statistics (mortality and quality records), American Hospital Association (facilities

statistics), and American Medical Association (physician specialty data). The 2001 ARF is used to provide comprehensive information on market factors, population characteristics, and other health resources across the six years. Through hospital identification, the SID can be linked to hospital-level data from AHA and county level data from the ARF.

Finally, the Center for Disease Control (CDC BRFFS) census data provides the information on the rate of adults with obesity at the level of state across the six years. HMO Interstudy files and Health Policy Tracking Service files are used to provide HMO penetration rate and state mandate status on the coverage of treatment for obesity for health plans.

Sample

The sample used in this study is composed of the community hospitals with 1995-2000 data available in HCUP SID, AHA, ARF, and Interstudy. The study target population includes all the U.S. community hospitals being operated in the 50 states. However, a complete data only available for 11 states is included in the sample. Community hospitals, according to the definition of American Hospital Association, refer to all nonfederal, short-term, general and other specialty hospitals, excluding hospital units of institutions. Research question 1 proposed the growth of trend is consisted of two components: hospital adoption of bariatric procedures and hospital expansion of the procedure. Therefore, for research question 1, all hospitals located in the 11 selected states are included in the sample pool because it is expected to provide an overall description of the growth trend of bariatric procedures. By including all these hospitals, the study can explore the detailed nature of growth of bariatric procedures.

For research question 2 and research question 3, specialty hospitals will be excluded from the sample because the specialty hospitals have specific service fields and until 2000, there were not any specialty hospital focusing on the surgical treatment for obesity. Given the panel study design, only the hospitals that responded to each AHA survey and had complete records

in HCUP SID during 1995-2000 are included in the panel. The sample selection process is shown as Figure 8. For research question 2, all the short term, nonfederal hospitals in the final sample through the selection process will be used to depict the components of trend of growth in the bariatric procedures performed, and to examine the determinants influencing hospitals adoption of the surgery. For research question 3, only those community hospitals that have ever adopted bariatric procedures during the 1995-2000 are included in the final sample to examine the factors influencing the hospitals expansion of the procedures.

Measurement of Variables

These measures are discussed in groups (e.g., dependent variables, independent variables, and control variables) as follows. All variables are based on the time unit of year, which means the variable value is from the statistics of one year.

Dependent Variables

Research question 2 and research question 3 explore the factors influencing the hospital adoption of bariatric procedure and expansion of the procedure after adoption. Two dependent variables are used in this study: adoption of bariatric procedure and growth of bariatric procedure performed per year in the dimension of both absolute change and percentage change. Three measurements are provided in HCUP SID to identify procedures, which include ICD-9-CM, Clinical Classification Software (CCS), and Diagnosis Related Group (DRG). In this study, a bariatric procedure is identified as DRG 288, which is the operating room procedure for obesity. In their report, Fitch and colleagues (2004) mentioned that bariatric procedures are sometimes assigned to DRG 154-155, which refer to stomach, esophageal and duodenal procedures age >17 with or without complications, comorbidities. However, three reasons are used to support the use of DRG 288 in this study instead of DRG 154-155: (1) DRG 154-155 encompasses a wide range of procedures including various biopsies, excisions, and repairs of

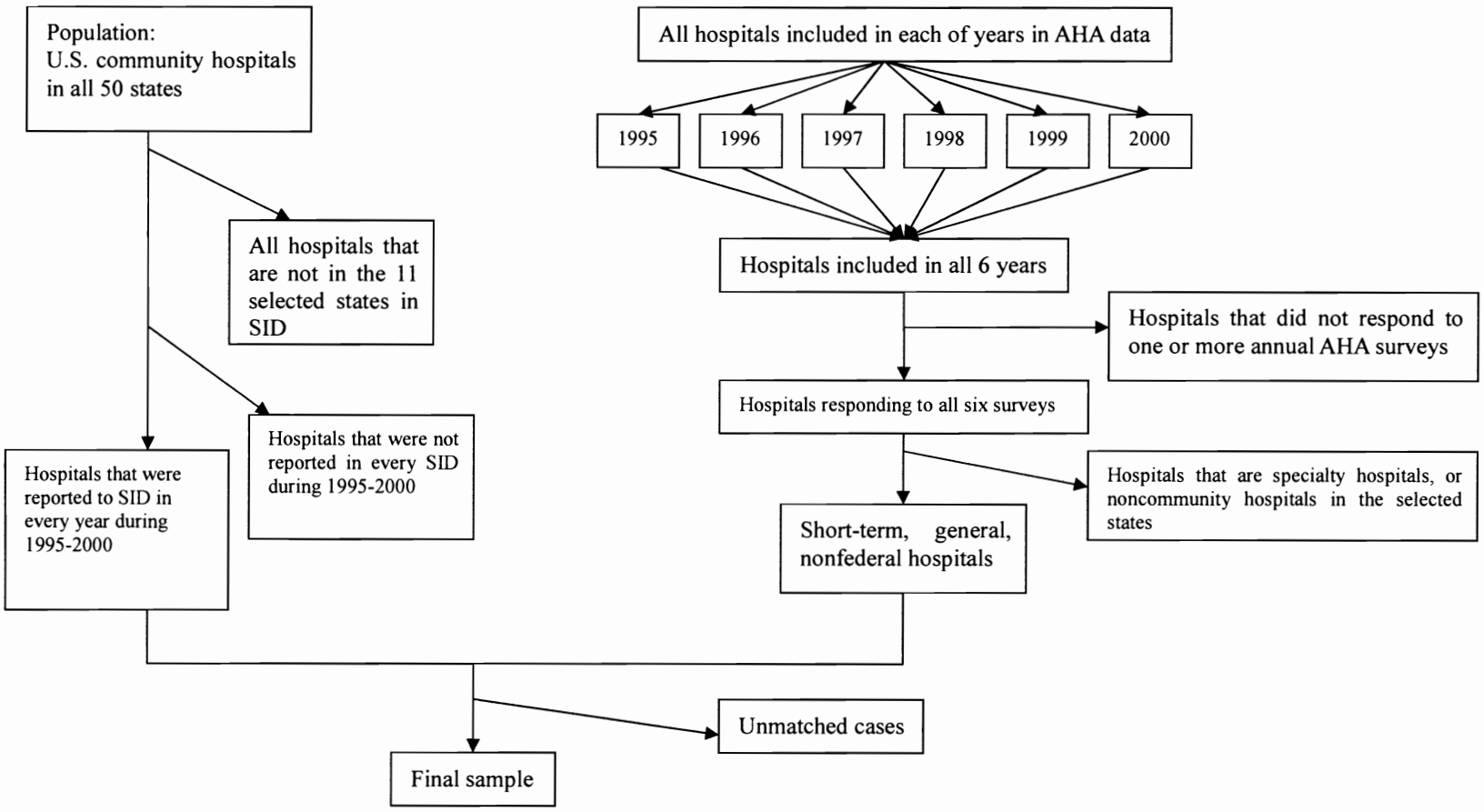

Figure 8: Sampling procedure.

the upper gastrointestinal system. By using this DRG, the volume of bariatric procedures will be overestimated greatly. However, DRG 288 in the category of endocrine, nutritional and metabolism more strictly narrows in the surgical treatment for obesity. (2) DRG 288 has been widely used in clinical studies by researchers to refer to the bariatric surgery (Angus, et al, 2003; Cooney, et al, 2000; Livingston and Ko, 2004; Nguyen, et al, 2004). And (3) by comparing the procedure volume estimated by ASBS and the estimation of HCUP net by using DRG 288 during 1994 to 2002, the two estimations of number of procedures performed each year are generally same, and the trends are consistent. However, the annual estimation of volume of bariatric procedures by using DRG 154-155 is much higher than the ASBS estimation, and the two trends through 1994 to 2002 are quite different. Given the above rationale, DRG 288 is a better fit to identify the bariatric procedure than DRG 154-155. Therefore, DRG 288 is used in this study to refer to the bariatric procedure in the HCUP SID.

Adoption of bariatric procedure (ADOPTION) is a dichotomous (yes/no) variable in this study. Generally, there are a number of hospitals performing a very few procedures just as "emergency" cases. These hospitals, actually, did not provide the routine or continuous services for patients with morbid obesity. These hospitals that occasionally perform bariatric procedures are not seen as adopters in this study. Through analyzing the frequency of procedures performed in hospitals, it is shown that hospitals are clustered into two groups approximately at a point of 24 procedures performed in one year. Therefore, the number of 24 procedures annually performed, which means 2 cases per month, is selected as the split point. Accordingly, those hospitals whose annual records of DRG 288 performed are greater than 24 are assigned a dependent variable code of 1. In contrast, hospitals that annually performed 24 or less bariatric procedures are assigned a dependent variable code of 0. Growth of bariatric procedures performed (GROWTHBS) is the continuous variable that represents the annual

change, e.g. operating more or less procedures than a prior year, of hospitals who have adopted the service in one or more year during 1995-2000. The growth of bariatric procedure is measured by the annual number of bariatric procedures performed subtracting the number of prior year ($Number_t$ - $Number_{t-1}$) divided by the $Number_{t-1}$. In the panel analysis, a log transformation is used as $\ln(Number_t)$ - $\ln(Number_{t-1})$.

Independent Variables

In developing the statistical model describing hospitals' adoption and expansion of bariatric procedures, various determinants are expected to influence the hospitals' decisions. These variables are derived from both the literature review as discussed in Chapter 2 and the theory as outlined in Chapter 3.

Hospital Characteristics

Organizational characteristics of a hospital will be constructed from the 1995-2000 AHA Annual Survey data and HCUP SID. The group of variables will include hospital number of staffed beds (BEDSIZE), system membership (SYSID), tax exempt status (PROFIT, e.g., for-profit, defined as invest-owned hospitals, or nonprofit hospitals), the portion of patients who contract with managed care organizations (PERMCO), and payment mix (PAYMIXDF, e.g. the difference of overall portion of Medicare + Medicaid payment and the portion of Medicare + Medicaid payment for bariatric procedures) for hypothesis 4a and hypothesis 4b. According to the findings of Damanpour (1992), the association of size and innovation adoption is stronger when a non-personnel or a log transformation measure of size is used. Therefore, a natural log transformation of size will be used in this study. From hypothesis 1 to hypothesis 10, the measurements for these determinants are same for every pair of sub-hypotheses, e.g., Ha and Hb, except for hypothesis 4. The dependent variable used in

hypothesis 4a and 4b is specifically discussed as follows because the variable is measured differently in the two hypotheses.

Hypothesis 4a and Hypothesis 4b proposed that the portion of Medicare and Medicaid payment for bariatric procedures is associated with the hospitals' decision of adopting and expanding the service. In order to evaluate the influence of Medicare and Medicaid portion in payment, the portion is compared with the level of overall Medicare and Medicaid payment in all procedures. The overall portion of Medicare and Medicaid payment is defined as the inpatient revenue paid by Medicare or Medicaid divided by the total inpatient revenue in the hospital in one year. The portion of Medicare and Medicaid payment for bariatric procedure is defined as the revenue of the procedure paid by Medicare or Medicaid divided by the total revenue of the procedure in one year.

For the hospitals that have performed the bariatric procedures, payment mix difference is obtained through subtracting the overall portion of the Medicare and Medicaid payment in the hospital by the portion of Medicare and Medicaid payment for bariatric procedure in this hospital. For hospitals that have not adopted this procedure, while, the difference of payment mix is actually the expected value based on the market level rather than hospital level. The portion of Medicare and Medicaid payment for bariatric procedure is an expected portion in the market that derived from their peer hospitals that are in the same market and have adopted bariatric procedures. It is defined as the mean level of Medicaid and Medicare payment for the procedure in the hospitals performing bariatric procedures in this market. The overall portion of Medicare and Medicaid payment, while, is still derived from the hospital that has not adopted bariatric procedure. Thus, the difference of payment mix for hospitals that have not adopted the surgery is obtained by subtracting the overall portion of Medicare and Medicaid payment in this hospital by the portion of Medicare and Medicaid for bariatric procedures in

the market where the hospital is located. It is possible that some hospitals are located in the market where there is no any existed adopter. For these hospitals, the portion of Medicare and Medicaid payment for the procedures is measured by the average level of the portion of Medicare and Medicaid payment for bariatric procedures at the state level. Generally, hospitals located in the market without any early adopters are supposed to use three sources of the relevant information to evaluate the "expected payment mix for bariatric procedures": a nationwide average level, a statewide average portion, and the average portion of Medicare and Medicaid in a nearby market. It is not reliable for hospitals to use the nationwide average level because the portion of Medicare and Medicaid payment for the procedure varies greatly across the states. An optional way for hospitals is to look around the nearby markets for collecting the information of "expected payment mix". The logic for hospitals is that it is a better way to see several or all markets around them rather than only one market. Therefore, an estimation based on the level of states is more reliable to represent the overall level of portion of Medicare and Medicaid for bariatric procedures in nearby markets.

Environmental Factors

Environmental factors define the competitiveness of market, the demand for hospital provision of bariatric services, and financial and regulatory pressures on hospitals. They are classified into three categories: resource complexity, stability, and availability as outlined in conceptual model. These variables are derived from AHA 1995-2000, ARF 2001, Interstudy 1995-2000, and CDC Behavioral Risk Factor Surveillance System (BRFSS) files 1995-2000.

This group of variables includes the accumulative rate of adopters in the market (ACCUADPT, defined as the number of hospitals that performed bariatric procedures in the market divided by the total number of hospitals), market competition (HHI, measured by Herfindahl index, which is the sum of squared market shares of inpatient days), HMO

penetration (HMOPT) and the prevalence rate of obesity (RATEOBST). The accumulative rate of past adopters and market competition are based on the market level, which is the county for rural hospitals and MSA for urban hospitals. Given the data availability, HMO penetration is at the MSA level because it can't be obtained at the county level. Similarly, the rate of obesity is at the level of state because there are no data available at the level of MSA or county.

As shown in Table 4, the independent variables are detailed in terms of theoretical construct, variable type measurement, and data sources.

Analytical Approach

To gain some initial insight into the growth of bariatric procedures performed, a preliminary analysis trending the phenomenon is performed. This analysis is useful to know the increase of bariatric procedures performed in hospitals over time and what factors influence the trend. According to the research questions proposed in chapter 1, the analysis of this study will be processed in three stages: primary analysis, correlation and comparison analysis, and multivariate analysis. First, the trend of hospital adoption and expansion of bariatric procedures and their contributions to the total increase of the procedures are addressed to answer research question 1. The data are descriptively examined by comparing the hospitals adopting the procedure and non-adopters by independent variables. Second, correlation and comparison analysis are used to build the final statistical models. Third, a conditional logistic regression analysis is used to examine the influence of selected determinants on the hospital adoption of bariatric procedures. A fixed effect model is used to examine the influence of these determinants on the rate of hospital expansion of the procedure.

Descriptive Analysis

Various descriptive analyses are compiled from the data. Primary analysis includes a descriptive statistical summary of all indicators and a check for normality in distribution. The

Table 4: Independent Variables, Definitions, and Sources

Variable	Definition	Source of Data
Organization characteristics		
Size (BEDSIZE)	Continuous: Natural log of number of staffed bed	AHA: 1995-2000
System membership (SYSID)	Dichotomous: 1=yes, 0=no	AHA: 1995-2000
Profit status (PROFIT)	Dichotomous: 1=for-profit, 0=nonprofit	AHA: 1995-2000
Percentage of the patients contracted with MCO (PERMCO)	Continuous: The number of inpatient discharges paid by managed care organizations divided by the total inpatient discharges	HCUP SID: 1995 -2000
Payment mix difference (PAYMIXDF)	Continuous: Overall portion of Medicare +Medicaid payment subtracts the portion of Medicare + Medicaid payment for bariatric procedures	HCUP SID: 1995 -2000
Environmental factors		
Resource complexity		
Accumulative rate of past adopters (ACCUADPT)	Continuous: The number of hospitals that have bariatric procedures in the market divided by the total number of hospitals	HCUP SID: 1995 -2000
Market competition (HHI)	Continuous: Sum of squared market shares of inpatient days in the market	AHA: 1995-2000
Resource stability		
HMO penetration (HMOPT)	Continuous: Percentage of population covered by HMOs in MSA	Interstudy: 1995-2000
Resource availability		
Rate of obesity (RATEOBST)	Continuous: Percentage of population with obesity by body mass index in the state	CDC BRFSS: 1995-2000

Note: AHA — American Hospital Association Annual Survey
HCUP SID —HUP State Inpatient Data
ARF — Area Resource Files
Interstudy — Interstudy and Wholey Data
CDC BRFSS — CDC Behavioral Risk Factor Surveillance System Files
HPTS — Health Policy Tracking Service files

analysis will describe the mean, standard deviation of all continuous variables. In order to obtain an initial insight on the trend of growth, the number of hospitals that already have performed the procedures is calculated for each year from 1995 to 2000. The number of procedures performed by new adopters and the number of procedures increased by past adopters are also calculated to examine the contributions of two components to the yearly

growth of bariatric procedures performed. Also, the distribution of adopters by different types of hospitals will be described.

Bivariate Analysis

The second stage of data analysis will include the correlation analysis and comparison analysis. Bivariate analysis is conducted on the independent variables to assess the degree of correlation between pairs of independent variables, and between independent variables and dependent variables. Significant correlations between independent and dependent variables are expected.

The z-test will be performed to compare the portion of hospitals adopting bariatric procedures across different types of hospitals in terms of hospital characteristics. The t-test and ANOVA will be used to test for significant differences between hospitals that have operated bariatric procedures and those that have not. Comparisons are made on hospital characteristics as well as environmental factors in the statistical models. Also, the hospitals included in the panel sample are compared with those dropped in terms of the determinants in order to decide the existence and level of selection bias in this study. Additionally, the difference of growth of the procedures performed across hospital characteristics will also be evaluated to provide the primary information about the impact of independent variables on the dependent variable of procedure expansion.

Multivariate Analysis on the Panel Data

Two techniques, conditional logistic regression and panel analysis will be used in this study. For research question 2, the dependent variable in the model is a dichotomous variable (1=adopter and 0=non-adopter). Therefore, a logistic regression will be used to answer research question 2. For research question 3, panel analysis will be used to estimate the effect

of explanatory variables on the dependent variable while controlling for unobserved attributes from those unmeasured factors.

Logistic regression is a form of regression which is used when the dependent variable is dichotomous and the independents are continuous variables, categorical variables, or both. Logistic regression applies maximum likelihood estimation after transforming the dependent variable into a logit variable (the natural log of the odds of the event occurring or not). In this study, the logit variable is derived from the natural log of the odds of hospital as an adopter or a non-adopter. Because the data in this study is a panel data, a conditional logit model or fixed-effects Logistic regression (clogit or xtlogit) will be used to do the analysis. The fixed-effects Logistic regression performs conditional maximum likelihood estimation of models with dichotomous dependent variable code as 0/1 for the panel data. In this way, the conditional logistic regression estimates the probability of a hospital adopting bariatric surgery. Specifically, the following model will be estimated in this study:

$$P(y_{it} = 1|\alpha_i, \beta) = \frac{\exp(\alpha_i + \beta X_{it})}{1 + \exp(\alpha_i + \beta X_{it})}, \text{ i=1... N, t=1... 6. (1)}$$

Where

P is the probability of a positive out come (e.g., adoption of bariatric procedures) within group conditional on there one positive outcome;

α_i is the unit-specified parameter for each hospital;

β is the vector of parameters to be estimated;

X_{it} is a vector of explanatory variables including hospital characteristics and environmental factors.

Research question 3 examines the impact of organizational and environmental factors on the hospital expansion rate of bariatric procedures. However, hospitals have different traditions

and other unobserved features that may affect hospital expansion rate. These unobserved or omitted factors may correlate with the key variables in this study. Therefore, the exclusion of these unmeasured factors may result in omitted variable bias. The panel analysis in this study is able to control for such factors by incorporating hospital fixed effects, which assigns a separate intercept to each hospital. The specific model to estimate the relationship is shown as equation 2.

$$GROWTHBS_{it} = \alpha + \beta_1 ORG_{it} + \beta_2 ENV_{it} + \beta_3 Time_t + \gamma_i + \varepsilon_{it}, \text{ i=1... ,N, t=1... ,6. (2)}$$

Where, $GROWTHBS_{it}$ is the growth of bariatric procedures in a hospital;

$Time_t$ is a vector of dummy variables indicating the year when the dependent variable was observed;

γ_i a hospital specific error component;

Equation 2 could be estimated using both first difference and within transformation under the situation of correct model and strict exogeneity assumption. A test will be applied to decide which method is used in this study from the perspective of efficiency (Wooldridge, 2002). If within transformation is appropriate, the first difference transformation should induce serial correlation, and can not estimate the model efficiently. The regression is estimated as:

$$\hat{e}_{it} = \hat{\rho}_1 \hat{e}_{i,t-1} + error_{it} \qquad \text{t=3,4,.....T; i=1,2,....,N}$$

Then, the parameter $\hat{\rho}_1$ is tested for $\rho_1 =$to -0.5. If the null hypothesis that $\rho_1 =$-0.5 is accepted, the within transformation method is supported to be efficient. However, if the null hypothesis that $\rho_1 = 0$ is accepted, the first-difference transformation is supported.

Summary

This chapter described the research design, data sources, sample, variable measurements, and analytical approaches used in this study. For research question 1, a general descriptive

analysis including all hospitals in the 11 selected states is made to provide the insight into the trend of bariatric procedures over the period of 1995-2000. A panel design is employed to examine the influence of organizational and environmental factors on hospital adoption of the procedure as well as hospital expansion of the procedure.

Data from seven sources are merged together to provide the final sample for analysis. The databases include a variety of information on hospital structure, market characteristics, payment for bariatric procedures, hospital adoption of the procedure, and expansion rate of the procedure. The data range from 1995 to 2000, which are used to investigate the trend of increase in bariatric procedures and to create the dynamic model to answer the research questions.

In this study, market is defined as metropolitan statistical area (MSA) for urban hospitals and county for rural hospitals. Two dependent variables, including one dichotomous variable, represent two components of growth of bariatric procedures performed in hospitals. Independent variables are structured as organizational characteristics and environmental factors based on the conceptual model.

Two statistical techniques, fixed-effects logistic regression and panel analysis, are employed to examine the relationship between explanatory variables and hospital adoption, the dichotomous variable, and hospital expansion rate of bariatric procedures. In order to address the possible heterogeneity problems, a fixed effect model is analyzed. A first difference transformation or a within transformation is used to estimate the panel model.

In Chapter 5, the results of this study are presented. These include trending information of hospital adoption and expansion of bariatric procedures during 1995-2000. The correlation and comparison results are also presented. For each of the two research questions, the findings

from the descriptive analysis, bivariate analysis, and multivariate logistic regression analysis and fixed effect model are provided.

CHAPTER 5 - RESULTS

This chapter presents the results of the empirical analysis. The descriptive statistics, bivariate statistics, and panel analysis model are reported sequentially. The first section, descriptive statistics, reports the sample composition, hospital characteristics, trend of bariatric procedures, and the contribution of different types of adopters to the increase of bariatric procedures. The second section provides the results of the bivariate analyses, which include the comparison of hospital characteristics between the sample in the study and nationwide hospitals, and a correlation matrix between independent variables and dependent variables. The third section reports the panel analysis model to estimate the influence of hospital characteristics and market features on the hospital decision of adopting bariatric surgery and expanding the volume of bariatric procedures. Additionally, it was found that the expansion rates of bariatric procedures in three states, California, Massachusetts, and New Jersey, are much higher than other states. Therefore, a sample including the hospitals in the three states is drawn to do supplemental analysis. The results are reported in the final section.

Sample

The descriptive analysis of the trend of bariatric procedures within the 11 states is based on the all hospitals reported in the HCUP SID data. By deleting the duplicate hospitals, the annual numbers of hospitals in HCUP SID from 1995 to 2000 are shown in Table 5, which also contains the number of hospitals nationwide. Generally, the hospitals located in the 11 selected states represent about 20 percent of all hospitals in the U.S. during this period. The descriptive analysis for examining the effects of hospitals characteristics and market factors

Table 5. The Number of Hospitals in 11 States and Nationwide, 1995-2000.

	Year					
	1995	1996	1997	1998	1999	2000
Hospitals in SID	1492	1531	1541	1529	1418	1414
U.S. hospitals*	7445	7228	6985	6960	6969	7087
Percentage (%)	20.04	21.18	22.06	21.97	20.35	19.95

* Source: CBP United States Economic Profiles, the U.S. Census Bureau.

on the adoption and expansion of bariatric procedures is based on the panel sample. As described in the section regarding sampling method in Chapter 4, only community hospitals are qualified to be sampled. Through sampling procedures, the panel is composed of 1310 community hospitals. Table 6 shows the number of community hospital in the U.S. during 1995-2000 and the percent of sample of all of the whole community hospitals nationwide. Nearly one quarter of total community hospitals are included in this panel.

Table 6. The Number of Hospitals in the Panel and SID, 1995-2000.

	Year					
	1995	1996	1997	1998	1999	2000
Sampled hospitals	1310	1310	1310	1310	1310	1310
Total community hospitals	5194	5134	5057	5015	4956	4915
Percent	25.22	25.52	25.90	26.12	26.43	26.65

Descriptive Analysis

The results of the descriptive analysis mainly describe the trend of bariatric procedures performed in the 11 selected states during the period of 1995-2000. This section answers the research question one regarding the composition of rapid increase of bariatric procedures in the six years. In addition, the descriptive analysis shows the characteristics of hospitals selected in the panel over the six years. The means and standard deviation of independent variables are also provided in this section.

Trend of Bariatric Procedures during 1995-2000

The number of bariatric procedures performed in the 11 states and the aggregate increase during 1995- 2000 are shown as Table 7, which also shows the nationwide trend. From 1995 to 2000, the number of bariatric procedures increased 333 percent over the six years. According to the statistics of HCUPnet, bariatric procedures performed in the whole nation increases 328 percent. The trend of bariatric procedures in the selected states is highly consistent with the trend nationwide. The volume of bariatric procedures performed in the 11 states represents on average approximately 40 percent of overall bariatric procedures in the United States. Within the 11 selected states, the number of performed bariatric procedures began to significantly increase after 1997, and remained a relatively steady increase except the year of 1999. However, the number of bariatric procedures nationwide soared since 1999 and before then, the volume was increasing steadily.

Table 7. Number of Bariatric Procedures Performed in 11 States and Nationwide, 1995-2000.

Year	1995	1996	1997	1998	1999	2000	Changes (%)
BS in 11 states	4,273	4,590	6,309	8,712	10,270	14,246	333.39
BS in the U.S.*	10,964	12,472	16,042	18,395	27,431	36,024	328.57
Rate of increase in 11 states (%)		7.42	37.45	38.09	17.88	38.71	
Rate of increase in the U.S. (%)		13.75	28.62	14.67	49.12	31.33	

* Source: HCUPnet statistics

For each selected state, Table 8 shows the number of bariatric procedures in the state from 1995 to 2000. California is the state where higher number of bariatric procedures was performed annually among the 11 states over the six years. Four states, California, Florida, New York and New Jersey, contributed approximate 70 percent of the volume of bariatric procedures done within the 11 states. Three states, California, Massachusetts, and New Jersey,

Table 8. The Number of Bariatric Procedures Performed in Each State, 1995-2000.

State	Year						change (%)
	1995	1996	1997	1998	1999	2000	
Arizona	267	247	318	293	378	673	252.06
California	1213	1486	2258	3665	4457	5939	489.61
Colorado	53	67	116	186	241	143	269.81
Florida	765	684	674	974	1130	2056	268.76
Iowa	347	278	250	273	154	174	-50.14
Massachusetts	210	221	439	603	740	1088	518.10
Maryland	216	177	225	212	211	288	133.33
New Jersey	296	285	499	630	753	1257	424.66
New York	639	893	1099	1312	1491	1885	294.99
Washington	138	147	274	365	506	394	285.51
Wisconsin	129	105	157	199	209	349	270.54

have the highest rates of increase, which are each more than 400 percent. A supplemental analysis, therefore, is conducted to compare the three states with the overall eleven states. Compared to other states where the volumes of bariatric procedures increased greatly, the state of Iowa, however, has a trend that the annual volume of bariatric procedures performed decreased gradually.

Distribution of Adopters

Only those hospitals that performed 25 or more procedures per year are defined as adopters in this study. Based on the definition, there are 39 adopters of bariatric procedures in 1995. As shown as Figure 9, the number becomes 111 in 2000, which increased by 2.8 times. Generally, the increase in the rate of adopters is smaller than the increase of bariatric procedures. This suggests that the number of procedures per hospitals is increasing gradually. From 1997 to 1998, the rates of increase of adopters reach 30 percent and higher (31.6% in 1998 and 42.8% in 1997). For other years, the rates of increase are less than 25 percent.

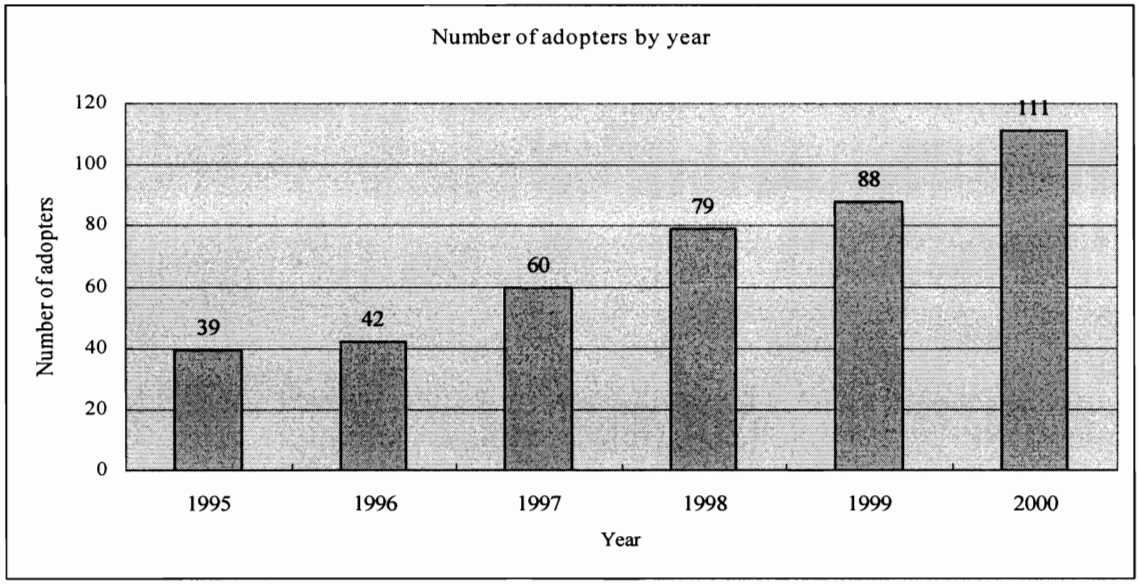

Figure 9. The Number of Hospitals that Adopted Bariatric Surgery, 1995-2000.

The distribution of adopters in 11 states varies greatly. Table 9 shows the number of adopters in every selected state during the period of 1995-2000. Among the 11 states, California has the most adopters, followed by New York and Florida. Some states, such as Colorado, have very few adopters within the state. In the state of Iowa, the numbers of adopters range from 2 to 4 in the six years. Combined with the fact that the number of bariatric procedures in Iowa decreases over the years, it is suggested that the number of procedures per hospital within Iowa declined over the six years.

Based on the definition of adopter applied in this study, some hospitals, which performed more than 24 cases in one year and are treated as adopters, may fall below this threshold of bariatric procedures in the following year. These hospitals are labeled as droppers, which means they dropped this service based on the definition of adopters used in this study. In the same way, some hospitals that performed less than 25 bariatric procedures are categorized as non-adopters. Theoretically, droppers are included in non-adopters. However, when droppers are specified in this study, they are not a subcategory of non-adopters.

Table 9. The Number of Hospitals that Adopted the Bariatric Surgery in Each State, 1995-2000.

	Year					
State	1995	1996	1997	1998	1999	2000
Arizona	2	3	3	3	2	4
California	14	15	22	27	29	33
Colorado	0	1	2	2	2	1
Florida	5	5	4	9	9	16
Iowa	3	2	2	4	2	4
Massachusetts	3	3	7	6	8	10
Maryland	2	2	2	2	3	2
New Jersey	2	2	4	4	6	10
New York	7	9	12	17	18	20
Washington	1	0	1	2	6	7
Wisconsin	0	0	1	3	3	4

The adopters are subcategorized into two groups, new adopters and past adopters, for the further analysis. New adopter means those hospitals that adopted the bariatric procedure in one year but did not have the procedure (more than 24 cases) in the prior year. Past adopters are those hospitals that offered the bariatric services in prior year and continue to provide it in this year. Table 10 describes the four categories and their changes annually.

Table 10. The Number of Hospitals in Different Types Regarding the Adoption, 1995-2000.

	Year					
	1995	1996	1997	1998	1999	2000
dropper	—	12	8	8	16	15
nonadopters	1453	1477	1473	1442	1314	1288
past adopters	39	27	34	52	63	73
new adopters	—	15	26	27	25	38
total hospitals	1492	1531	1541	1529	1418	1414

Although it was expected that the number of droppers could remain at a stable level, the number varies greatly, which ranges from 8 to 16. The changes of number of droppers may influence the validity of analysis.

Using the four categories, Table 11 shows the number of bariatric procedures performed by each type of hospitals. As expected, the past adopters performed the majority of bariatric procedures. The number of bariatric procedure in those non-adopters remains quite stable during the six years. Consistent with the variation in the number of droppers, the number of bariatric procedures performed by droppers also fluctuates. Compared with other types of hospitals, the past adopters have the highest mean of procedures per hospital, which on average performed 70.38 cases in 1995 and 139.82 procedures in 2000. The average numbers of bariatric procedures performed by the new adopters range from 46.04 to 61.37 cases per year. In general, the new adopters performed fewer bariatric procedures than the hospitals with longer experience.

Table 11. The Overall and Average Bariatric Procedures Performed by Different Types of Hospitals, 1995-2000.

	Year					
	1995	1996	1997	1998	1999	2000
droppers	—	145	64	81	137	65
	—	(12.08)	(8.00)	(10.13)	(8.56)	(13.00)
nonadopters	1528	1521	1776	1718	1606	1642
	(1.05)	(1.03)	(1.21)	(1.19)	(1.22)	(1.27)
past adopters	2745	2215	3100	5670	7230	10207
	(70.38)	(82.04)	(91.18)	(109.04)	(114.76)	(139.82)
new adopters	—	709	1369	1243	1297	2332
	—	(47.27)	(52.65)	(46.04)	(51.88)	(61.37)
overall	4,273	4,590	6,309	8,712	10,270	14,246

* The bracketed numbers are the average volume of procedures performed by a type of hospitals.

The Expansion of Bariatric Procedures and Contributors

Table 12 shows the contribution of the three categories of hospitals to the increase in procedures from the prior year. The non-adopters in this analysis include droppers. The non-adopters performed fewer bariatric procedures since 1998, which means they contribute negatively to the expansion of volume of bariatric procedures over the period 1995-2000.

Table 12. The Contribution of Different Hospitals to the Increase of Bariatric Procedures, 1995-2000.

	Year				
	1996	1997	1998	1999	2000
new adopter	709	1369	1243	1297	2332
past adopter	-530	176	1201	317	1695
nonadopter	138	174	-41	-56	-36
overall	317	1719	2403	1558	3976

Although past adopters performed the major volume of bariatric procedures, it is the new adopters, instead of past adopters, that are the major contributor to the expansion of the procedures. The new adopters show a continuous, steady trend of contributing to the expansion of bariatric procedures. In general, more than 60 percent of the newly increased procedures are performed by the new adopters, except for the year 1998. Thus, it is apparent that the increase of bariatric procedures is mainly coming from two components: the entry of new adopters into the service market and the continuous increases of bariatric procedures from those hospitals that have adopted the surgery. Between the two components, the entry of new adopters contributes to the majority of the increase of bariatric procedures across the years 1995-2000.

The hospital characteristics of the analytical panel

Table 13 shows the hospital characteristics in the sample panel and in the whole nation from 1995 to 2000. There are 1310 hospitals in the panel. The information of nationwide hospital characteristics is derived from AHA Annual Survey. The comparison shows that the sample hospitals are bigger than the national average level. There is no significant difference in system membership between the sample panel and the overall hospitals. The percent of sample hospitals that are non-profit hospitals is higher than the overall hospitals portion. More hospitals in the sample are teaching hospitals than the overall level. A higher portion of sample hospitals is located in an urban area. In general, the average length of stay in the sample

Table 13. The Comparison of Hospital Characteristics of Sample Panel and Overall U.S. Hospitals, 1995-2000.

Hospital characteristics	Year											
	1995		1996		1997		1998		1999		2000	
	sample	nation	sample	nation	sample	nation	sample	nation	sample	nation	sample	nation
Size	207.26**	169.21	205.03**	168.95	204.36**	167.66	203.36**	165.41	202.66**	165.95	202.35**	166.16
System membership	0.48	0.46	0.51	0.51	0.55	0.54	0.55	0.55	0.56	0.56	0.60	0.57
Nonprofit status	0.83**	0.73	0.83**	0.73	0.82**	0.72	0.82**	0.72	0.82**	0.74	0.82**	0.75
Teaching status	0.074*	0.056	0.076*	0.059	0.077*	0.06	0.077*	0.06	0.077*	0.06	0.079*	0.061
Urban	0.71**	0.61	.71**	0.61	0.71**	0.61	.71**	0.61	.71**	0.61	.71**	0.6
Average LOS	9.28*	9.43	9.03*	9.08	8.79*	9.12	8.69*	9.21	8.56**	9.03	8.65	8.63
Occupancy rate	0.61**	0.57	0.58**	0.56	0.59**	0.57	0.59**	0.57	0.59**	0.58	0.61**	0.58

* $p<0.05$, **$p<0.01$

hospitals is lower than the overall level. The occupancy rates of the sample hospitals are significantly higher than overall hospitals.

The Descriptive Analysis of Independent Variables and Expansion Rate

Table 14 provides the results of the descriptive analysis of the independent variables used in the analytical model and the expansion rate over the six years. Generally, most of these variables significantly changed over the six years.

Table 14. Means and Standard Deviations of Independent Variables and Expansion Rate, 1995-2000.

variables	year						F value
	1995	1996	1997	1998	1999	2000	
size	207.257 (193.310)	205.025 (189.599)	204.359 (188.297)	203.365 (188.651)	202.657 (191.423)	202.346 (195.161)	0.11
Nonprofit status	0.832 (0.374)	0.831 (0.375)	0.822 (0.383)	0.823 (0.382)	0.822 (0.382)	0.818 (0.386)	0.22
System membership	0.463 (0.499)	0.51 (0.500)	0.554 (0.497)	0.554 (0.497)	0.561 (0.497)	0.598 (0.490)	9.36**
MCO dependence	0.339 (0.499)	0.342 (0.153)	0.339 (0.159)	0.355 (0.160)	0.34 (0.166)	0.339 (0.162)	1.99
Pay mix improvement	0.457 (0.183)	0.412 (0.199)	0.413 (0.184)	0.406 (0.173)	0.370 (0.180)	0.404 (0.165)	156.65**
Cumulative adoption (%)	1.674 (3.657)	1.797 (3.182)	2.845 (5.292)	4.127 (6.728)	4.66 (6.690)	6.126 (8.668)	110.93**
Herfindhal index	0.308 (0.336)	0.309 (0.336)	0.311 (0.336)	0.314 (0.336)	0.317 (0.337)	0.318 (0.337)	0.22
HMO penetration	0.295 (0.147)	0.332 (0.143)	0.366 (0.142)	0.313 (0.114)	0.391 (0.162)	0.391 (0.157)	64.87**
Obesity rate	0.150 (0.019)	0.154 (0.019)	0.160 (0.016)	0.172 (0.017)	0.181 (0.020)	0.189 (0.016)	1008.52**
Expansion rate		1.347 (5.936)	0.914 (1.847)	2.043 (7.510)	0.846 (2.280)	1.448 (3.892)	1.09

* $p<0.05$, **$p<0.01$

In the panel, mean hospital size and nonprofit status do not significantly change during the study period. The portion of hospitals with system membership increased significantly over the six years. The hospitals' dependence on managed care does not change significantly at the

level of 0.05. The payment mix improvement changed, but the trend does not indicate more payment mix improvement over time. Within the markets, more adopters emerged during the six years. The HMO penetration of markets increased during the period. Also, the obesity rate in the selected states rose gradually. However, the degree of competition in the markets did not change significantly.

Bivariate Analysis

Table 15 provides the comparison of independent variables between adopters and non-adopters. It is shown that adopter hospitals are generally larger than non-adopters. The portion of nonprofit hospitals is lower in adopters than non-adopters. This may suggest that for-profit hospitals are more likely to be adopters. A larger proportion of adopters are system members than non-adopters. The adopters have a higher degree of dependence on the managed care than non-adopters.

Table 15. The Comparison of Independent Variables between Adopters and Non-adopters.

	non-adopter		adopter			
Variables	mean	STD	mean	STD	T value	P
Size	194.85	181.63	405.84	264.64	20.65**	<.0001
Nonprofit status	0.83	0.38	0.74	0.44	3.81**	<.0001
System membership	0.53	0.50	0.66	0.48	3.95**	<.0001
MCO penetration	0.34	0.11	0.40	0.12	6.68**	<.0001
Pay mix improvement	41.24	18.14	35.61	19.09	5.63**	<.0001
Cumulative adoption	3.08	5.26	13.43	13.18	32.25**	<.0001
HHI	0.32	0.34	0.11	0.15	11.54**	<.0001
HMO penetration	0.35	0.15	0.37	0.15	2.93**	0.003
Obesity rate	16.73	2.31	17.11	2.04	3.02**	0.002

* $p<0.05$, **$p<0.01$

However, compared to the non-adopters, the adopters achieved less payment mix improvement than the non-adopters would have if they had offered this service. A greater proportion of the adopters are located in the markets where more hospitals have adopted bariatric procedures. The non-adopters are located in the markets with higher competition than

adopters. More adopters are located in the markets with higher HMO penetration than non-adopters. Compared to non-adopters, the states where adopters are located have higher obesity rate.

Table 16 shows the correlation coefficients and significance level between independent variables and dependent variables, adopter and expansion rate. The decision of adoption is positively correlated with hospital size, system membership, managed care penetration, adoption rate within local market, HMO penetration in the market, and obesity rate. However, the status of nonprofit, payment mix improvement and market competition are negatively correlated with adoption. Similar to the correlations between independent variables and the decision of adoption, the expansion rate is positively correlated with hospital size, system membership, managed care penetration, adoption rate within the local market, HMO penetration in the market, and obesity rate. It is also negatively correlated with the payment mix improvement and market competition. However, there is no significant correlation between the nonprofit status and expansion rate, though the correlation is also negative. No correlations were high enough to raise concern about multicollinearity.

Results of Panel Analysis

The Relationship between Hospital and Market Factors and Adoption

Because the dependent variable, adoption of bariatric procedures, is a dichotomous variable, logistic regression is conducted to examine the effects of hospital factors and market factors on the decision of adopting bariatric procedures in hospitals. Given the panel analysis, a conditional logistic model is used in the study.

Table 17 shows the results of fixed effects logistic regression. The results suggest that the hospital size is significantly related to the likelihood of adopting bariatric procedures at the significance level of 0.10. The larger hospitals are more likely to adopt the bariatric procedure

Table 16. The Correlation Coefficients between the Independent Variables and the Dependent Variables, Adoption and Expansion rate.

	1	2	3	4	5	6	7	8	9	10	11
1. Adoption	1.000										
2. Expansion rate	0.476**	1.000									
3. Hospital size	0.180**	0.114**	1.000								
4. System membership	0.034*	0.051*	0.187**	1.000							
5. Nonprofit status	-0.054**	-0.012	0.064**	-0.166**	1.000						
6. MCO dependence	0.075**	0.047**	0.207**	0.121**	0.101**	1.000					
7. Pay mix improvement	-0.064**	-0.044**	- 0.113**	-0.102**	- 0.029*	-0.486**	1.000				
8.Cumulative adoption rate	0.346**	0.167**	0.239**	0.083**	0.001	0.088**	-0.099**	1.000			
9. HHI	-0.120**	-0.066**	- 0.462**	-0.205**	0.118**	-0.186*	0.116**	- 0.291**	1.000		
10.HMO penetration	0.045*	0.028	- 0.081**	0.031	0.012	0.047**	-0.229**	0.057*	- 0.271**	1.000	
11.Obesity rate	0.038*	0.026*	- 0.092**	0.043*	-0.063**	-0.077**	-0.096**	0.097**	0.148**	0.030	1.000

* $p<0.05$, **$p<0.01$

Table 17. The Results of Fixed Effect Logistic Regression Model.

variables	coefficient	standard error	z	p value	Odds ratio
Hospital Size	4.061*	2.321	1.75	0.080	57.97
Nonprofit status[a]	0.467	1.457	0.32	0.748	1.59
System membership	-1.399*	0.799	-1.75	0.080	0.25
Managed care dependence	0.036	0.037	0.96	0.335	1.04
Payment mix improvement	0.027	0.018	1.52	0.128	1.03
Cumulative adoption	0.549***	0.135	4.07	0.000	-
Squared cumulative adoption	-0.006**	0.002	-2.11	0.035	-
HHI	-0.433*	0.203	-2.13	0.033	0.65
HMO penetration	0.028	0.032	0.90	0.368	1.03
Obesity rate	0.201	0.281	0.71	0.475	1.22
Y1996	0.033	0.801	0.04	0.967	1.03
Y1997	-0.051	0.839	-0.06	0.951	0.95
Y1998	-0.059	0.926	-0.06	0.952	0.94
Y1999	0.529	1.199	0.44	0.659	1.69
Y2000	0.431	1.352	0.11	0.916	1.54
Log likelihood = -46.878					
LR chi2(15) =125.09					
Prob > chi2 =0.000					
Pseudo R2= 0.572					

* P<0.10, ** P<0.05, *** P<0.01.
a. there are 51 hospitals switching their ownership status during the period 1995-2000.

than smaller hospitals. Given that hospital size is measured by natural logged number of beds, a $\log_e$ increase in number of beds is associated with a 57.97-fold increase in the odds of being an adopter. The nonprofit status has no significant effect on the hospital decision of adoption. This suggests that for-profit hospitals are not necessarily more likely to adopt the surgery. System membership has a marginally ($p<0.10$) significantly negative correlation with the adoption of bariatric surgery. This means that hospitals affiliated with a hospital system are less likely to adopt the bariatric procedures. According to the odds ratio, a hospital switching to be system member is associated with a decrease in the odds of adopting the surgery by a factor of 0.25, holding all other variables constant. Hospital dependence on managed care is not significantly associated with the decision of adoption. Unlike what is assumed in the

hypothesis, the payment mix improvement is not significantly associated with the decision of adoption though it shows a positive effect.

Within the market factors, given that the adopter rate has positive effect on the adoption and the squared adopter rate is negatively related to the adoption, an inverted-U relationship exists between the cumulative level of adopters in the local market and the hospital decision of adoption. This suggests that rather than a linear relationship, before a saturated point, hospitals are more likely to adopt bariatric procedures. Under the circumstance that all the other independent variables take their mean value, the probability of adoption of bariatric surgery would be maximized when the value of cumulative adoption within a local market reaches approximately 46 percent. However, after the point, hospitals are less likely to adopt the procedures.

The degree of market competition also has a significant effect on the decision of adoption. The hospitals located in highly competitive markets are more likely to adopt the surgery than those hospitals in the markets with low competition. A one-unit increase in Herfindhal index would is associated with a decrease in the odds of adopting bariatric surgery by a factor of 0.65. The penetration of managed care in local market is not related to the decision of adoption. Also, the prevalence of obesity within the state does not show any effect on the adoption of bariatric procedures.

In summary, in the hypotheses about the effects of hospital factors, hospital size (hypothesis 1a) and system membership (hypothesis 3a) are supported by panel analysis. The effect of cumulative adoption (Hypothesis 7a) and competition (hypothesis 8a) in the market factors are also supported. Although the result of conditional logistic regression shows the same relationship between other factors and the decision of hospitals adopting bariatric

procedures as the hypotheses state, these relationships are not supported at the significant level of 0.10.

The Effects of Hospital Factors and Market Factors on the Expansion Rate

According to the test described in Chapter 4, the serial correlation in the first-differenced equation is tested by regressing $\hat{e}_{it}$ on $\hat{e}_{i,t-1}$. It is obtained that $\hat{\rho}_1$ = -0.371 with t statistic =-4.36. The null hypothesis that ρ_1=-0.5 is accepted with p value=0.13. Therefore, the within transformation method is used in this study to evaluate the effects of the determinants on the rate of expansion of bariatric procedures in hospitals. Table 18 summarizes the results of the estimation.

Table 18. The Results of the Panel Model Regarding Expansion Rate of Bariatric Procedure.

variables	coefficient	standard error	t	p
Hospital size	0.550	0.781	0.700	0.482
Nonprofit status	-1.058*	0.617	-1.710	0.088
System membership	-0.014	0.241	-0.060	0.954
MCO dependence	0.210	1.285	0.160	0.871
Payment mix improvement	0.014**	0.007	2.080	0.039
Cumulative adoption	0.071**	0.027	2.570	0.011
Squared cumulative adoption	-0.001**	0.0006	-1.990	0.048
HHI	-0.005	0.043	-0.120	0.904
HMO penetration	-0.005	0.008	-0.600	0.551
Obesity rate	-0.077	0.074	-1.030	0.302
Y1997	0.281	0.192	1.460	0.146
Y1998	0.205	0.227	0.900	0.367
Y1999	0.082	0.273	0.300	0.765
Y2000	0.191	0.348	0.550	0.584
CONSTANT	-1.661	4.758	-0.350	0.727
	F =1.78		P=0.042	

* P<0.10, ** P<0.05

Contrary to the hypothesis, hospital size does not show a significant effect on the expansion rate. This suggests that both larger hospitals and small hospitals are not different in the behavior of increasing their volume of bariatric procedures. Given the achievement of more

revenue brought by performing the procedure, the for-profit hospitals are more likely to increase their ability to perform more bariatric procedures. On average, hospitals switching to nonprofit status have a growth rate roughly 65.28 (100*(exp(-1.058)-1)) percent lower. The factor of payment mix improvement shows a significant, positive influence on the hospitals' expansion of bariatric procedures. The higher the payment mix improvement the hospital could achieve through performing bariatric procedures, the more procedures the hospital would be willing to perform. One unit of increase in payment mix improvement increases the expansion rate of bariatric procedures by about 1.4 (100*(exp(-1.058)-1)) percent. In the hypothesis 3b, it is assumed that the hospital affiliated with a system or network would be more likely to expand the volume of bariatric procedures. Contrary to the hypothesis, the system membership is not significantly associated with the expansion rate. This implies that the hospitals with or without system membership are not different in increasing the volume of bariatric procedures. The hospital's dependence on managed care is also not associated with the expansion rate.

For market factors, only the cumulative adoption in local market is significantly associated with the hospitals' rate of expanding the bariatric procedures. The relationship between the portion of adopters within the local market and the hospital rate of expansion of bariatric procedures is also an inverted-U shape. Before more hospitals within the local market provide the surgery to patients, the adopting hospitals are more likely to increase their ability to perform more bariatric procedures. However, when the number of hospitals approaches a saturation point, the adopting hospitals are less likely to continue to increase their volume of bariatric procedures with the previous rates. According to the estimation model, when the cumulative adoption within a local market equals to 31.28 percent, the expansion rate of bariatric procedures in a hospital would reach a maximum point.

The Herfindhal index is not significantly related to the change of the number of procedures performed in the hospitals. This means that the competition within a local market has no significant influence on the hospital's rate of expanding the procedure. The HMO penetration within the local market, which represents the level of resource uncertainty, does not show a significant effect on the expansion rate of bariatric procedures in the hospital. The prevalence of obesity in the market is also not associated significantly with the expansion rate. This may suggest that the potential increase in the patient availability is not related to the hospitals' rate of expanding the volume of bariatric procedures performed.

In summary, in the organizational factors influencing the hospitals' rate of expansion of the bariatric procedures, the hypotheses regarding ownership status (H2b) and payment mix improvement (H4b) are supported. Only hypothesis 8b regarding the effect of cumulative rate of adoption in the market factors is supported by the panel analysis.

In chapter 3 that describes the hypotheses, it is assumed that the explanatory variables have similar effects on the hospitals' adoption of bariatric procedures and adopting hospitals' rate of expanding the procedure. However, the results of panel analysis show that the same factors influence the two events in different ways. Table 19 compares the effects of these factors on the adoption and expansion.

From the comparison of sign and significance of determinants on adoption and expansion, it is suggested that the effects of these determinants on adoption and expansion are mixed, or even at variance for few determinants. Despite insignificant effects, hospital size has a positive effect on a hospital's adoption of bariatric surgery, but has a negative effect on the hospitals' rate of expanding the procedure. Nonprofit status has positive but insignificant association with adoption. However, it shows a significant, negative relationship with the expansion rate. Although system membership is negatively related to both adoption and

Table 19. Effects of Determinants on the Hospitals' Adoption and Expansion of Bariatric Procedures.

Hypothesis	Determinants	Expected Sign	Sign and significance	
			Adoption	Expansion
Hospital characteristics				
H1	Size	+	$+^{**}$	$-^{NS}$
H2	Non-profit status	-	$+^{NS}$	$-^{**}$
H3	System membership	+	$-^{*}$	$-^{NS}$
H4	Payment mix improvement	+	$+^{NS}$	$+^{**}$
H5	Dependence on managed care	+	$+^{NS}$	$+^{NS}$
Environmental factors				
Resource munificence				
H6	Available patient with obesity	+	$+^{NS}$	$+^{NS}$
Resource complexity				
H7	HHI	-	$-^{*}$	-
H8	Cumulative rate of adopters	Inverted-U	Inverted-U**	Inverted-U***
Resource stability				
H9	HMO penetration	+	$+^{NS}$	$-^{NS}$

* P<0.10, ** P<0.05, *** P<0.01, NS, non-significant at the level of 0.10.

expansion, the relation is significant only with expansion. The determinant of payment mix improvement shows positive effect on both adoption and expansion. However, only its association with expansion rate is significant. The level of dependence on managed care also shows significant association with hospital adoption, but has an insignificant effect on hospitals' rate of expanding the bariatric procedures.

In the market determinants, only the accumulative rate of adopters has same significant effect on both adoption and expansion. The prevalence of obesity within local market has a positive, but insignificant, effect on adoption as well as expansion. Market competition is positively related to the hospital adoption of bariatric procedure. However, this determinant does not show a significant effect on the expansion rate despite the positive relation. Market-level HMO penetration has mixed relationships with the adoption and expansion though both the associations are not significant.

Generally, only five determinants affect the adoption and expansion in the same direction. The other four determinants have conflicted effects on the adoption and expansion. The complexity of the results will be discussed in Chapter 6.

The Analysis of Hospitals in California, Massachusetts, and New Jersey

Three states, California, Massachusetts, and New Jersey, are selected to do an additional analysis because the increases in the number of bariatric procedures in the three states are much higher than other states and the national average. The supplemental analysis is conducted in the order of description of bariatric procedures performed and distribution of adopters, description of sample panel and independent variables, correlation table between independent variables and dependent variables, and fixed effects logistic model for the panel.

Table 20 provides the number of bariatric procedures performed in the three states from 1995 to 2000. The table also shows the number of procedures done by different categories of hospitals. It is found that (1) bariatric procedures increased in the three states faster than other states (482 percent vs. 333 percent) over the six years. (2) The past adopters performed the majority of the volume of overall bariatric procedures (the minimum percent is 56.75% in 1996, and the maximum percent is 76.62% in the year of 1999). (3) The hospitals in the three states performed an increasing portion of overall procedures in the 11 states (the portion was 40.23 percent in 1995, and it increased to 58.15% in 2000).

Table 20. Number of Bariatric Procedures Performed by Types of Hospitals in CA, MA, and NJ, 1995-2000.

	Year					
	1995	1996	1997	1998	1999	2000
droppers		58	13	32	23	28
nonadopters	520	537	604	656	609	605
past adopters	1199	1135	1711	3675	4559	6088
new adopters		270	872	535	759	1563
overall	1719	2000	3200	4898	5950	8284

Table 21 shows the number of hospital adopters and non-adopters in the three states. There are 19 hospitals that adopted the bariatric procedures in 1995, and the number becomes 33 in 2000. The number of adopters in the three states increases 1.74 times. Compared with the increase in the 11 states, the rate of increase in the three states is lower than the trend in the 11 states. Given that the rate of increase in bariatric procedures in the three states is higher than the total 11 states, the average number of bariatric procedures performed by the hospitals in the three states is higher than the number of the procedures by the hospitals in the total 11 states.

Table 21. Number of Adopters in Three States (CA , MA and NJ), 1995-2000.

	Year					
	1995	1996	1997	1998	1999	2000
Dropper		6	3	4	8	10
Nonadopters	500	546	526	513	410	413
Past adopters	19	13	17	29	29	33
New adopters		7	16	8	14	20
Total hospitals	519	572	562	554	461	476

Table 22 shows the expansion of bariatric procedures by year and the contribution of past adopters and new adopters to the expansion. The new adopters are also the main contributor to the expansion of bariatric procedures in the six years except the year of 1998. In most years, the new adopters contributed more than 70 percents of the increase of bariatric procedures.

Table 22. The Contribution of Different Types of Hospitals to the Increase of Bariatric Procedures within the Three States (CA, MA and NJ), 1995-2000.

	Year				
	1996	1997	1998	1999	2000
new adopter	270	872	535	759	1563
past adopter	-64	306	1092	349	770
Non-adopter	75	22	71	-56	1
overall	279	1200	1698	1052	2334

Table 23 provides the descriptive analysis of dependent variables and a dependent variable, the expansion rate, of the panel in the three states. There are 408 hospitals in the analytical panel.

Table 23. The Means and Standard Deviations of Determinants and Expansion Rate in the Panel of Three States (CA, MA and NJ), 1995-2000.

	year						
variables	1995	1996	1997	1998	1999	2000	F value
size	213.58 (166.50)	209.15 (155.7)	210.37 (161.67)	208.54 (161.60)	207.58 (153.12)	207.91 (157.29)	0.08
Nonprofit status	0.83 (0.37)	0.83 (0.37)	0.82 (0.38)	0.82 (0.38)	0.81 (0.39)	0.82 (0.38)	0.2
System membership	0.57 (0.49)	0.62 (0.48)	0.67 (0.46)	0.64 (0.47)	0.62 (0.48)	0.70 (0.45)	2.74*
MCO dependence	0.33 (0.17)	0.34 (0.17)	0.36 (0.17)	0.36 (0.17)	0.35 (0.17)	0.35 (0.17)	2.33*
Pay mix improvement	0.44 (0.18)	0.44 (0.18)	0.45 (0.16)	0.44 (0.16)	0.37 (0.18)	0.37 (0.17)	12.69**
Cumulative adoption (%)	2.26 (3.29)	2.35 (3.32)	4.46 (6.75)	5.01 (7.20)	5.74 (7.27)	7.21 (8.72)	36.91**
Herfindhal index	0.17 (0.23)	0.18 (0.23)	0.18 (0.23)	0.18 (0.2)	0.18 (0.23)	0.18 (0.23)	0.18
HMO penetration	0.34 (0.14)	0.38 (0.13)	0.42 (0.12)	0.32 (0.10)	0.45 (0.15)	0.47 (0.14)	75.48**
Obesity rate (%)	14.47 (1.19)	14.17 (0.62)	15.82 (0.43)	16.52 (1.16)	17.79 (1.45)	19.18 (1.13)	1349.52**
Expansion rate	1234 123	1.07 (2.26)	1.18 (1.88)	3.17 (10.82)	1.38 (3.32)	1.03 (2.53)	1.19

* P<0.05, ** P<0.01

From the comparison of determinants by year, it is shown that in the three states: (1) more hospitals are system members over time; (2) the hospitals' level of dependence on managed care became slightly higher; (3) the payment mix improvement that hospitals can achieve through performing bariatric procedures was declining; (4) the number of hospitals that adopted the surgery increased over the six years; (5) the HMO penetration within the local markets increased gradually; and (6) the prevalence of obesity within the states also increased,

which means that the availability of patients for the bariatric procedure on the rise over the six years. However, it is also seen that (1) the hospital size did not change significantly; (2) the portion of nonprofit hospitals remains stable; and (3) the market competition indicated no significant change in the three states over the six years.

Table 24 shows the correlation coefficients and significance level between two dependent variables and the determinants. In general, the correlation between independent variables and dependent variables by using three states sample is same with the correlation obtained by using the total 11 states in the correlation direction, except for the significant levels.

Hospital size, system membership, level of dependence on managed care, the cumulative rate of adoption, HMO penetration within the local market, and the prevalence of obesity are positively correlated with adoption and expansion of bariatric procedures. However, nonprofit status of hospitals, payment mix improvement, and Herfindahl index are negatively correlated with the adoption and expansion. It is found that all the factors show similar correlations with both adoption and expansion.

Table 25 shows the results of the fixed effect logistic model that is used to estimate the effects of the determinants on the hospitals' decision of adopting the bariatric service. Because no hospital changed their nonprofit status over the six years, the variable of nonprofit status is dropped in this model.

According to the results of the conditional logistic model, hospital size and system membership have significantly effects on the hospital decision of adopting bariatric surgery. This suggests that larger hospitals are more likely to adopt the procedure than smaller hospitals in the three states. Based on above estimation, a loge increase in the number of beds is associated with a 10.371-fold increase in the odds of adopting bariatric surgery. Hospitals

Table 24. The Correlation Coefficients between Adoption and Independent Variables in the Panel of Three States (CA, MA and NJ), 1995-2000.

Variables	1	2	3	4	5	6	7	8	9	10	11
1.Adoption	1.000										
2. Expansion rate	0.532	1.000									
3. Hospital size	0.219**	0.143**	1.000								
4. System membership	-0.064**	-0.012	0.206	1.000							
5. Nonprofit status	0.046*	0.058*	0.136	-0.096	1.000						
6. MCO dependence	0.112**	0.078**	0.188	0.098	0.144	1.000					
7. Pay mix improvement	-0.077**	-0.020**	-0.246	-0.156	-0.103	-0.176	1.000				
8.Cumulative adoption rate	0.310**	0.211**	0.184	0.007	0.051	0.117	-0.111	1.000			
9.HHI	-0.106**	-0.050*	-0.313	0.104	-0.142	-0.129	0.122	-0.230	1.000		
10.HMO penetration	0.053*	0.016	-0.050	-0.133	0.137	0.001	-0.080	0.062	-0.174	1.000	
11.Obesity rate	0.070**	0.071**	-0.044	-0.155	0.070	0.155	0.077	0.193	-0.023	0.243	1.000

* P<0.05, ** P<0.01

Table 25. The Fixed Effect Logistic Regression Model for Three States Panel.

variables	coefficient	standard error	z	p value	Odds ratio
Hospital Size	2.339*	1.063	2.200	0.028	10.371
Nonprofit status		Dropped			
System membership	-3.643*	1.698	-2.150	0.032	0.026
Managed care dependence	0.048	0.030	1.560	0.119	1.049
Payment mix improvement	0.032	0.027	1.200	0.230	1.033
Cumulative adoption	1.506*	0.639	2.360	0.018	-
Squared cumulative adoption	-0.026*	0.013	-1.970	0.049	-
HHI	-0.903	0.689	-1.310	0.190	0.405
HMO penetration	-0.011	0.056	-0.200	0.845	0.989
Obesity rate	0.647	0.848	0.760	0.446	0.910
Y1996	0.329	1.834	0.179	0.787	1.389
Y1997	0.385	1.940	0.200	0.843	1.470
Y1998	-0.003	2.003	0.000	0.999	0.997
Y1999	0.418	3.144	0.130	0.894	1.519
Y2000	-0.639	4.051	-0.160	0.875	0.528
Log likelihood = -16.09					
LR chi2(15) =84.80					
Prob > chi2 =0.000					
Pseudo R2= 0.725					

* P<0.10, ** P<0.05

dependence on managed care is not significantly related to the decision of adopting the surgery for the hospitals in the three states. System membership shows a significant, negative relation with the adoption. Therefore, a hospital affiliated with a system is less likely to adopt the procedure than the hospitals without system membership. The rate of adopters within the local market is also an inverted-U related with the adoption, which is consistent with the hypothesis.

Compared with the results with the panel of 11 states, the model including three states is different in the effect of market competition. The Herfindahl index shows no significant effect on the adoption in the three states model. However, it is significant in the 11 states model. The effects of hospital size and system membership on the adoption are the same in both the three states model and the 11 states model. In addition, the relationships between the rate of

adopters with the local market and the decision of adoption show the same signs in both models.

According to the test using to select the method estimating the fixed effects model, the serial correlation in the first-differenced equation is tested by regressing $\hat{e}_{it}$ on $\hat{e}_{i,t-1}$. It is obtained that $\hat{\rho}_1$ = -0.351 with t statistic =-2.92. The null hypothesis that ρ_1=-0.5 is accepted with p value=0.22. Therefore, the within transformation method is used in this study. Table 26 shows the result of the fixed effects model evaluating the effects of determinants on the hospitals' rate of expanding the volume of bariatric procedures.

Table 26. The Fixed Effects Model of Expansion Rate for Three States Panel.

variables	coefficient	standard error	t	p
Hospital size	0.167	1.333	0.13	0.901
Nonprofit status		dropped		
System membership	-0.449	0.352	-1.28	0.205
MCO dependence	0.053	0.035	1.51	0.128
Payment mix improvement	0.047**	0.014	3.31	0.001
Cumulative adoption	0.175**	0.062	2.84	0.006
Squared cumulative adoption	-0.002	0.001	-1.20	0.233
HHI	-0.049	0.056	-0.89	0.378
HMO penetration	-0.010	0.011	-0.89	0.378
Obesity rate	-0.024	0.195	-0.12	0.901
Y1997	-0.428	0.463	-0.92	0.358
Y1998	-0.771	0.539	-1.43	0.156
Y1999	-1.085	0.765	-1.42	0.160
Y2000	-1.287	1.033	-1.25	0.216
CONSTANT	-4.497	7.686	-0.59	0.560
	F =2.10		P=0.02	

* P<0.10, ** P<0.05, *** p<0.01.

Hospital size does not show any significant effects on the expansion rate, whereas, it does on the adoption. The effect of system membership is not supported by either estimation methods. However, the direction of the coefficient shows that it might have a negative effect on the expansion rate, which means that the hospital with system affiliation would be less

likely to increase the procedures. The dependence on managed care and payment mix improvement is not significantly associated with the expansion rate. For market factors, the relation between the accumulative rate of adoption within local market and expansion rate shows a linear shape, instead of the inverted-U relation proposed in the hypothesis and supported by the 11 states model. This suggests that within the three states, hospitals located in the markets where there is the higher portion of hospitals adopting bariatric surgery would increase the volume of the procedures with a higher rate. The market competition, HMO penetration and obesity rate have no significant effect on the expansion rate. Generally, the analysis of three states only supports the relationship between the rate of increase in bariatric procedures and the payment mix improvement among the proposed hypotheses.

Compared with the model with 11 states, the model with three states does not examine the effect of hospitals' profit status on the rate of increase in bariatric procedures in the hospital, which is supported by the 11 states model. The effects of accumulative rate of adopters within a local market are different between the two models. According to the three states model, the cumulative rate of adoption in local market is significant and positive related to the expansion rate in a linear shape. However, the model with 11 states shows that this relation is an inverted-U shaped. Both the models support the effect of payment mix improvement on the hospitals' rate of increase in bariatric procedures.

In the Chapter 6, the results presented in this chapter are interpreted and discussed. The implications of this study are proposed. In addition, the limitations are reviewed and discussed. In the last chapter, the future research areas are also suggested.

CHAPTER 6 – DISCUSSION AND CONCLUSIONS

Stimulated by the high prevalence of morbid obesity in the United States., bariatric procedures continue to rise dramatically since mid 1990s. Simultaneously, the units of bariatric surgery are also proliferating rapidly across the U.S. hospitals. As stated in Chapter 1, the purpose of study is to clarify the contributors to the growth of bariatric procedures, and to identify the determinants associated with hospitals that adopt bariatric surgery units and expand the volume of bariatric procedures. Using an organization-based conceptual model and panel analysis, the current study explores how hospital characteristics and environmental factors affect hospitals' decisions of adopting bariatric surgery, a medical innovation, and how these factors influence these adopters' rate of increase in the utilization of this innovation. This chapter summarizes the results presented in the previous chapter, interprets the findings and implications, explains the research limitations, and suggests areas for future study.

Summary and Interpretation of Analysis Results

Descriptive analysis in this study shows that the 11 states selected in the study experienced a dramatic growth of bariatric procedures during 1995-2000, which is same as the trend across the United States. Based on the description of the trend, the increase in bariatric procedures is coming from two contributors: the entry of hospitals into the market of bariatric surgery, and the continuous expansion of capacity of offering the surgery by antecedent adopters. The number of hospitals offering bariatric surgery increased by near 300% between 1995 and 2000, from 39 in 1995 to 111 in 2000. The average number of bariatric procedures per adopter, meanwhile, increased from 70.38 in 1995 to 112.96 in 2000. The two components

are joined together to result in the rapid growth of bariatric procedures in the hospitals. This is consistent with an earlier study by Grossman and Banks (1998), who argue that the successful diffusion of medical innovation is composed of two components, adoption by an increasing portion of hospitals or physicians, and increase in the rate of utilization by these adopters.

The descriptive analysis and bivariate analysis may imply some potential associations among hospital characteristics, environmental factors, hospitals' decision of adoption, and the rate of expanding bariatric procedures. However, only the multivariate panel analysis examined the significance and magnitude of these associations by controlling unobserved effects. The panel model first examined the effects of hospital characteristics and market factors on the hospitals' decision of adopting bariatric surgery by using the data of 1995-2000. The relationships between these factors and the rate of expansion of bariatric procedures in hospitals are then examined by using the fixed effects model. As shown in Table 27, the hypotheses are partially supported.

Table 27. Summary Table of Hypotheses Tests.

Hypothesis	Determinants	Supported	
		Adoption	Expansion
Hospital characteristics			
H1	Size	Yes	No
H2	non-profit status	No	Yes
H3	System membership	No	No
H4	Payment mix improvement	No	Yes
H5	Dependence on managed care	No	No
Environmental factors			
Resource munificence			
H6	Available patient with obesity	No	No
Resource complexity			
H7	HHI	Yes	No
H8	accumulative rate of adopters	Yes	Yes
Resource stability			
H9	Penetration of Managed care	No	No

The panel, then, was used to examine the association between predictors and the rate of expansion of bariatric procedures in hospitals. Unlike what was expected in the hypotheses proposed in Chapter 3, the factors are not equally effective in predicting the adoption of innovation and the expansion of utilization of innovation. In the following section, the hypotheses and findings are discussed.

H1: Hospital Size

Consistent with the findings of previous studies (Kimberly and Envanisko, 1981; Damanpour, 1992; Rapoport, 1978; Banaszak-Holl, Zinn, and Mor, 1996; Burke, Wang, and Wan, 2002; Lavizzo-Mourey, et al, 1993; Arnet and Bigelow, 1995), the finding showsthat larger hospitals are more likely to adopt bariatric surgery, a medical innovation, than smaller hospitals. Hospital size is still a significant predictor of the adoption of innovations in the case of bariatric surgery. However, the size of a hospital makes little difference when it comes to being a leader to expand the capacity of offering more bariatric procedures. The study shows that hospitals of all sizes are not different in increasing the capacity of offering the procedures. Three explanations are supposed to answer the difference of effect of hospital size on adoption and expansion. During the study period, from 1995 to 2000, bariatric surgery was a relatively new technology to hospitals. Although significant barriers to entry do not exist, it was still risky for hospitals to adopt the surgery. Given that the market was quite immature at the middle of 1990s, it was uncertain for hospitals if adoption of the surgery could attract enough patients, obtain positive reimbursement, and control the relevant complications. Compared with the smaller hospitals, large hospitals have more capacity to handle the possible failure brought by adoption of the surgery, which was discussed in Chapter 3. Therefore, hospital size is shown as a positive predictor of adoption of bariatric surgery.

After adopting the surgery, significant revenue was obtained through performing the procedures. As shown as the findings in the study, the improvement of payment mix that could be achieved by performing the procedure is considerable, which is at least 37 percent higher than the average level of other procedures. Another point is that no significant barriers exist to expand the capacity of bariatric surgery unit to perform more procedures. A program typically has one or two surgeons, who can perform an annual procedure volume between 200 and 300 cases based on the 2003 estimation (Zuckerman and Finarelli, 2003). Higher volume programs are reported to be able to perform from 600 to 1,000 cases each year (Zuckerman and Finarelli, 2003; Schoenthal and Getzen, 2005). Therefore, after the initial establishment, there is a room for a bariatric surgery unit to expand the procedure volume without additional investments into the program. Given the fact that a bariatric surgery unit can perform more procedures than the current volume and there is no additional barrier for expansion, it is not surprising that hospitals of any size show no difference in increasing the procedure volume.

H2: Nonprofit Status

The for-profit status of a hospital has different effects on the program adoption and expansion of procedure volume in this study. Unlike what is predicted in the hypothesis, for-profit hospitals do not show more willingness to adopt the program than nonprofit hospitals. According to the previous discussion, for-profit hospitals with a greater emphasis on profit should have been more likely to adopt the surgery given its high revenue margin. A possible reason for this is that bariatric surgery was relatively novel to most hospitals during the research period. Before 1999, the procedures performed in hospitals remained at a quite low level despite several years of increase, and little media attention was paid to the procedure (Trus, Pope and Finlayson, 2005). There was even a decrease in the use of bariatric surgery from 1994 to 1995 due to the introduction of and popularization of fenfluramine, a prescription

drug for weight loss (Goldstein, 1998; Trus, Pope and Finlayson, 2005). Thus, the volume of potential patients was uncertain for hospitals during this period. Additionally, very few studies were conducted on the utilization of bariatric surgery from the perspective of healthcare management or finance. Therefore, limited relevant information was diffused in the industry and available to hospitals whether a bariatric program could be profitable and how profitable, and hence restricts the innovative behavior, which is suggested by Jensen (1982). Given this, for-profit hospitals are not more likely to adopt the surgery than nonprofit hospitals because of information. However, the for-profit hospitals are faster than nonprofit hospitals in expanding the volume of bariatric procedure. After the adoption of the program, hospitals began to find out the increase in revenue by performing the procedure, which proved to be highly profitable in this study. Therefore, the for-profit hospitals are more likely to increase the volume of bariatric procedures in order to maximize the profit.

H3: System Affiliation

The third hypothesis offered in this study is that the system affiliation is a positive predictor of hospitals to adopt and expand the program of bariatric surgery. However, contrary to the expectation, this study found evidence that hospitals affiliated with systems or networks are less likely to adopt the surgery. It is possible that the effect of system affiliation on the hospitals' decision about adoption of bariatric program interacts with the time of adoption. In general, early adopters are motivated by technical efficiency gains from adoption (Tolbert and Zucker, 1983), and thus are more likely to customize their adoption behaviors to the organizations' unique needs and characteristics. According to the argument of Westphal, Gulati, and Shortell (1997), in the early stage of adoption, conformity by a hospital to the normative pattern will be negatively associated with organizational adoption. Therefore, given that the study period of 1995-2000 is an initial stage for the adoption of bariatric program, a hospital

affiliated with a system would be under more pressure to conform than independent hospitals when they adopt the surgery. This may be the most likely explanation for the negative relationship between system membership and adoption.

The result also indicates that no difference exists between the hospitals affiliated with systems and freestanding hospitals in the rate of expanding the volume of bariatric procedures. As the early discussion, there is no significant barrier for these adopters to expand the procedure volume. Although system membership helps the communication among hospitals, it does not necessarily facilitate hospitals on offering more procedures.

H4: Payment Mix Improvement

Although a great improvement in payment mix could be achieved by performing bariatric procedure, the payment mix improvement is not a significant determinant of adoption of bariatric program. A most likely explanation is that the information of possible revenue by performing the surgery had not been well realized during the period of 1995-2000, especially before 1999. As noted in the earlier discussion, before 1999 the surgery was not paid much attention as it is received currently. Therefore, hospitals were not sure how much improvement they could achieve in revenue by operating the program though this study shows that they could have obtained improvement in the payer mix if they had offered this service. Given the uncertainty of bariatric program in terms of the hospital revenue, hospitals were not significantly active in adoption of the surgery. An alternative reason is that financial success by performing the surgery is highly dependent upon the local reimbursement environment and individual negotiated contracts (Alt, 2001; Trinity Health, 2003). Even if a hospital knows that other hospitals within the local market have made financial improvement by performing bariatric procedures, it was still not certain that a hospital could also achieve the same improvement. In addition, the expected improvement on financial performance is even less

reliable to be used as the reference for the hospitals without any antecedent adopters in the local market because the success was obtained on a state average level. Because of the variation of financial performance, hospitals may be different in obtaining revenue through the adoption of bariatric surgery even if they expect similar level of payment mix improvement. After a hospital adopted the program, the improvement of financial performance becomes real and very clear to the hospital. Thus, a greater payment mix improvement motivates the hospital to perform more bariatric procedures, which was discussed in Chapter 3 and supported by the analytic results.

H5 and H9: Managed Care

In this study, the effect of managed care is measured from two perspectives, the dependence of hospitals on managed care and the HMO penetration within the market. Unlike the propositions in the hypotheses, neither hospitals' dependence on managed care nor the penetration of managed care within local market significantly influence the hospitals' adoption and expansion behaviors. As reviewed in Chapter 2, the interplay between managed care, hospital decisions about the adoption of new technology, and the hospital utilization of services is quite complex. Although the high managed care environment may drive hospitals to look for new services to increase the profit margin, compete for managed care contracts, and decrease the uncertainty of patients flow and revenue, some studies also reported that managed care has contributed to slowing the adoption or the use of new technologies, particularly the high-cost, high-profit technologies that have been the focus of the most attention (Baker and Wheeler, 1998; Baker, 2002; Baker, 2001;). In addition, some studies also found evidence that no relationship between managed care and adoption of technology exists, or was mixed (Baker and Spetz, 1999; Hill and Wolfe, 1997; Bokhari, Caulkins, and Gaynor, 1998). A possible explanation for the insignificant association is that managed care affects the adoption and

utilization of bariatric procedures in two opposite directions. On the one hand, hospitals facing high managed care pressures are likely to adopt or expand the bariatric program in order to promote their reimbursement level, or differentiate themselves from other hospitals to compete for managed care contracts. On the other hand, because bariatric surgery could be a highly expensive service, managed care would be reluctant to encourage hospitals to perform the surgery from the financial perspective. The balance of two sides may result in the little relationship between managed care and the adoption and expansion of bariatric surgery. However, the insignificant association may also be attributed to the analysis. It is possible that all confounding factors have not been accounted in the analysis here. It is also possible that the reverse causality, which adoptions of bariatric program may influence MCOs' location decisions, was not controlled.

H6: Market Demand

The variable of potential patients with morbid obesity, which represents the size of market demand, is not supported in the study to significantly influence the hospitals' decision of adoption and the expansion rate of procedure volume within adopters. This finding is not consistent with previous studies (Banaszak-Holl, Zinn, and Mor, 1996; Dirkson, Ament and Go, 1996; Dranove, et al, 1992), which found that the factor of market size or demand positively influence technology adoption and the utilization of innovation. Two explanations are supposed to answer the insignificance of the factor in this study. Because of the limitation of data availability, the obesity rate is measured at the level of state, instead of market level. The measurement based on state information surely underestimated the variation of market demand that might have influenced hospitals' behaviors of adoption or expansion. An alternative explanation is that the prevalence rates within the states have reached a level, which is so high for hospitals that they do not need to consider the issue of potential patients for bariatric

surgery when they decide to adopt the program or increase the procedure volume. Given that only 0.6 percent of the 11.5 million potential eligible people underwent the surgery based on 2002 estimation (Encinosa, et al, 2005), hospitals do not need to worry about the issue of patient availability. In addition, despite the increasing volume of bariatric surgery from more trained physicians at an increasing number of hospitals, the provision of this service is far behind the demand of patients for bariatric surgery (Davis, et al, 2006; Alt, 2001; Birkmeyer et al, 2006; Finarelli and Zuckerman, 2003). In some markets, patient wait lists are six to eighteen months long (Mitka, 2003; Finarelli and Zuckerman, 2003). There is huge room for patient demands left to hospitals to initiate a bariatric program or rapidly expand the procedure volume. Therefore, compared to the huge amount of potential patients across the whole nation, it is possible that the variation of obesity rate is not large enough to influence the hospitals' decision of adoption or expansion.

H7 and H8: Cumulative Adoption and Market Competition

Different from the linear relationship in previous studies (Arndt and Bigelow, 1995; Burns and Wholey, 1995; Walston, Kimberly and Burns, 2001), the study finds evidence that the relationships between cumulative rate of adopters and adoption and expansion rate are shown as a nonlinear shape. Rather than the measurement of institutional forces in these previous studies, cumulative adoption in this study represents the competition level among local hospitals on the provision of bariatric services. The finding suggests that when there are a certain number of hospitals within markets that have offered a bariatric service, which means that the competition on the service reaches to a high level, other hospitals will stop adopting the surgery. Further, these hospitals that have performed the procedures would not continue to expand the procedure volume when the number of adopters within the local market reaches a level.

The overall competition, which is measured as Herfindahl Index, is found to be a positive predictor of hospitals' decision about adoption of bariatric programs. This finding is consistent with previous studies (Luft et al, 1986; Rapoport, 1978; Dranove et al, 1992; Banaszak-Holl, Zinn, and Mor, 1996; Bokhari, 2001; Burke, Wang, and Wan, 2002; Dirksen, Ament, and Go, 1996). However, the market competition has small association with the expansion rate of procedure volume. This suggests that the overall competition has no effect on the hospitals' utilization of the services. The relationship illustrates that after adoption of bariatric program, a hospital's decision about the expansion of procedure volume is mainly influenced by the behavior of other adopters, rather than all hospitals within a local market.

This study also analyzed the adoption and expansion within the three states, California, Massachusetts, and New Jersey, where the volume of bariatric procedures increased most rapidly. The findings of the three states model are generally consistent with the eleven states model, expect for the effect of cumulative adoption on the expansion rate of procedure volume. In the three states model, cumulative rate of adopters shows a significant and positive effect on the expansion rate, instead of the nonlinear relationship in eleven states model. A possible explanation is that within the three states, the potential room for bariatric procedures is so large that the current volume of procedures is not enough to capture the turning point of nonlinear relationship. An alternative explanation is that the hospitals located in the three states discover that the demand did not decline as capacity grew encouraging further expansion.

The findings show that the explanatory factors do not have identical effects on the hospital decision about adoption of a bariatric program and the expansion behavior. Hospital size and market competition proved to be the positive predictors of hospital adoption of medical innovation, which is consistent with earlier reports. However, system membership shows a negative effect on adoption, which is opposite to earlier studies. This study also finds

evidence that the relationship between cumulative adoption and adoption of innovation is a nonlinear shape, which was generally reported to be linear in previous studies. Contrasted to the adoption, profit status and payment mix improvement motivate hospitals with bariatric programs to offer more procedures. The cumulative adoption also affects the hospitals' rate of procedure expansion in a nonlinear dimension.

In summary, from 1995 to 2000, the eleven states experienced a dramatic increase in the volume of bariatric procedures. An increasing number of hospitals began to offer the service within these states. Despite the rapid growth, bariatric surgery remains to be in a stage of early adoption in a diffusion process. This may result in the differences of effects of explanatory factors on the adoption and expansion.

Implications of the Findings

This study analyzed the trend of bariatric procedure volume from 1995 to 2000 by using all of the hospitals in the 11 selected states reported by HCUP data. The findings of this study provide limited support to the theory and hypotheses. Some of them are opposite of previous studies, and could provide a new view on the diffusion of innovations. There are several implications that could be derived from this study.

Policy Implication

First, since the volume of bariatric procedure increased rapidly and the growth of the trend still continues, health plans need to be aware of the accompanied cost growth. Within the eleven states, the total number of bariatric procedures grew 333 percent during the six years. Because most procedures are reimbursed by private health plans, commercial plans should be more cautious to evaluate the potential demands from enrollees and reimbursement costs of these procedures, and then decide the coverage of bariatric surgery and the reimbursement level. Given the continuous trend of increasing procedures, the volume of bariatric surgery

would have a great impact on aggregate health plan spending. For example, Blue Cross Blue Shield of Michigan has raised its payment for bariatric surgeries from $15.7 million in 2000 to $37.8 million in 2002 (The Advisory Board Company, 2003). With continuously increasing procedure volume and high portion in payment for the surgery, the trend of cost growth will be apt to worsen for private insurers. Therefore, some health plans may consider excluding bariatric surgery from their list of covered services. An example is that Blue Cross Blue Shield of Florida announced to drop bariatric surgery from their coverage list in 2005, which previously covered the service. For Medicare, which announced coverage of the surgery in 2004, the rapid growth of bariatric procedures also needs to be addressed. It is possible that the demand for the surgery by the elderly will increase greatly in near future because of the coverage change. This may make Medicare face more budget issues. This study also suggests that state policy makers should be prudent in deciding to mandate health plans cover bariatric surgery. According to the findings of this study and current trends, the growth of demand for bariatric surgery will remain rapidly increasing at least in near future. Regulatory agencies should estimate if a state can afford the rapid increasing healthcare cost accompanied with the bariatric surgery before they decide on the mandatory coverage of the surgery.

Second, this study also suggests to health plans and policy makers the factors motivating hospitals to adopt or expand the bariatric program. Based on the findings, health plans should pay more attention to the hospitals that are larger in size, located within a highly competitive market, and with some previous adopters in local market. These hospitals, according to the findings of this study, are more likely to be new adopters, which are major contributors to the rapid growth of procedure volume. This study would also encourage health plans to modify the reimbursement level to bariatric surgery in order to control the of speed growth of bariatric procedures. The findings suggest that profit maximization is an important motivation for

hospitals to increase their procedure volume. Within the factors influencing hospitals' expansion rate of bariatric procedures, for-profit status and payment mix improvement are shown as significant motivators for hospitals. If health plans matain the current level of reimbursement of bariatric surgeries, two results may be expected: hospitals continuously increase the volume of bariatric procedure to maximize the profit, and health plans are forced to increase insurance premium or to restrict the coverage.

Manager Implication

The findings show that the rapid increase in demand for bariatric surgery and generous payment for the service would make bariatric surgery a good business opportunity for hospitals. The current payer mix and reimbursement rate for the surgery allow hospitals to operate a well-run, high-volume bariatric program to generate contributions to income because the marginal cost of bariatric surgery is well within the reimbursement limits of private health plans. However, the findings of this study also suggest the adoption and expansion of bariatric surgery are limited for hospitals. Our findings show that the payment mix improvement obtained through offering bariatric surgery has decreased from 45.66 percent in 1995 to 40.45 percent in 2000. In addition to the decrease of private payment portion, the reimbursement rate for the surgery is also decreased (Schoenthal and Getzen, 2005). Some commercial health plans also stopped paying for the service. With the decrease in reimbursement and the increase in demand for the surgery, hospitals may experience trouble recouping the cost of maintaining a bariatric program. The findings also show that a hospital is less likely to adopt the bariatric program or expand the program too fast if there are enough hospitals offering bariatric service in local market. Therefore, despite the dramatically increased procedure volume, it still depends on unique situations of individual hospitals whether or whether not it is a good revenue opportunity to adopt or expand a bariatric program.

Methodology Implication

From the perspective of methodology, the study uses a new measurement to estimate the influence of reimbursements and the attractiveness of services. Generally, the reimbursement benefit is measured by using the reimbursement rate for a procedure (Dismuke and Sena, 1999, Cutler and McClellan, 1996), or by discrete scale describing the generosity level of reimbursement (Teplensky et al, 1995; Dirksen, Ament and Go, 1996). The measurement used in this study compared the portion of private payment in bariatric procedures and overall procedures to estimate a relative improvement on reimbursement. The findings show that the improvement on reimbursement is well-measured by the method. Therefore, this measurement may suggest a new perspective of estimating the reimbursement benefit change for future studies.

Theoretical Implication

This study finds evidence that the effects of some factors on adoption and expansion are opposite or inconsistent to earlier studies on hospital adoption of innovations. Based on the literature review, the system membership is firstly reported to negatively influence the hospital decision about adoption of innovations. In addition, the findings show that the cumulative adoption has a nonlinear relationship with adoption and expansion, which is linear in earlier studies. It is hard to explain these relationships by using the theoretical model in earlier studies. This may imply that some interactions or new relationships are still not uncovered in theoretical frameworks used in previous studies.

Limitations of Study

The study offered insights into the relationships between hospital characteristics, market factors, hospitals' decisions about the adoption of a bariatric program, and expansion rate of procedure volume. However, there are still several limitations to this study.

First, this study uses the panel from 1995 to 2000. However, before the study period, the volume of bariatric surgery decreased in 1995 compared to 1994. In addition, only after 1999, the number of procedures began to soar according to the national estimation, and this study only captured two-year rapid increase. In general, the study period of 1995-2000 reflects an initial stage of innovation diffusion. Compared to the seven-year trend of growth since 1999, the factors influencing growth within 1995-2000 may or may not be the same as those in the stage of large-scaled diffusion of bariatric surgery in the United States.

Second, several weaknesses of measurement exist in this study. As we discussed earlier, the prevalence of morbid obesity is measured at the state level instead of the market level because of the issue of data availability. This measurement just provides the gross information on the obesity rate, and can not reflect the variation across different markets. Therefore, it underestimates the influence of obesity rate on the adoption and expansion. Another measure is the percent of patients contracted with managed care. The variable should have been measured as the number of inpatient discharges paid by managed care organizations divided by the total inpatient discharges. However, HCUP SID only provides the category of payment sources for private health plans, which shows that patients are paid by HMO, PPO, or else. The patients paid by Medicare and Medicaid are not categorized into the MCO paid or not-MCO paid, except for the state of California. Therefore, this study used the percent of patients contracted with managed care private plans to measure the variable. Because of the exclusion of Medicare and Medicaid patents, the validity of measurement for this variable may be questionable. In addition, HMO penetration within local market is only measured in metropolitan areas. The HMO penetrations in rural areas are not available in this study because of data limitations. Therefore, the missing HMO penetration for rural areas may influence the examination of the relationships between explanatory factors, adoption and expansion.

Third, this study does not include the factor of surgeons in the analysis. Because we did not find appropriate data about physicians to match the HCUP SID, only organizational factors are included in this study to explain the hospitals' decisions about adoption and expansion of bariatric procedures. However, earlier studies suggest that physicians play a crucial role in deciding the adoption, or utilization of innovations, especially the technology innovations (Escarce, 1996; Meyer, Goes, 1988; Kimberly and Evanisko, 1981; Greer, 1981). The completeness of conceptual model is weakened by the lack of a physician factor in this study, and thus challenges the validity of this study.

Finally, the factors of regulation of states and policies of health insurers are not included in this study. Before 2000, none of the eleven selected states issued the regulations to mandate health plans cover the surgical treatments for morbid obesity although some other states had legislated at that time. The information of health plans about the coverage of bariatric surgery is also not included in this study. Given the importance of reimbursement on the hospitals' decision of adoption and expansion of bariatric surgery, the factors of legislation and health insurers might have significantly influenced the hospitals' decision about the adoption and expansion of the surgery. The lack of these factors may also weaken the validity of findings.

In general, two kinds of limitations exist in this study, theoretical weaknesses and methodological weaknesses. The theoretical limitations raised by the lack of some important factors may make the conceptual framework less comprehensive and undermine the ability of this study to explain the relationships. The methodological weaknesses generally resulted from lack of data availability. As we discussed above, limited datasets restricted the accuracy of measurement for some variables. These weaknesses of measurement may bias the results of analysis and hence influence the validity of the study.

Suggestions for Future Study

This study raises several questions for future research. While the theoretical framework developed in this study includes only organizational factors and environmental factors, future research might extend the research on the adoption of bariatric surgery by including the factors related to physicians in the conceptual model. Additional perspectives, such as timing, insurance coverage, features of the innovation, and interactions among the factors, could also be included in theoretical framework. The adoption and expansion of bariatric surgery is a complex process. Therefore, by constructing a comprehensive theoretical model, future studies might obtain more power to detect and explain the determinants of adoption and expansion of bariatric surgery.

Future studies might also extend the length of the research period to examine the relationships in different time stages. As we discussed earlier, this study only covered the early stage and two years of large-scaled adoption. By including a longer research period in the study, future research could find the interaction of time with other factors, which are suggested to influence the hospitals' behaviors on adoption of innovations (Westphal, Gulati, and Shortell, 1997). Because the rate of increase in bariatric procedures is greater after 1999, it is possible that these factors influence the hospitals' adoption and expansion of bariatric procedures in different way. For example, a factor that significantly influenced hospitals' decision about adoption in the early stage of diffusion may become insignificant in later stage of diffusion of bariatric surgery. A longer research period, for example, from 1995 to 2003, could help researchers detect the interaction effects between timing and adoption. In addition, the different effects of the same factors on hospitals adoption and expansion in different diffusion stages could also be examined with a longer research period.

Future studies might also use a national sample to estimate the relationships between explanatory factors, hospitals' adoption of bariatric surgery, and expansion rate of procedure volume. This study used a sample including the hospitals located in eleven selected states. The advantage of the study is the information about adoption and expansion of bariatric procedures can be obtained accurately, rather than the estimations based on samples widely used in earlier studies (Trus, Pope, and Finlason, 2005; Santry, Gillen, and Lauderdale, 2005; Davis et al, 2006; Livingston, 2005; Encinosa et al, 2005). However, a national sample, such as HCUP NIS (National Inpatient Sample), would be more inclusive from the perspective of sampling issues. Therefore, future study might use the national sample to examine the relationships to obtain more validity of the study.

Finally, future studies might extend the research by considering the issue of outcome or quality of bariatric surgery under the situation of rapid growth of the volume of bariatric procedure. Given the dramatic increase, it is important to see if the quality of this surgery is affected by the increased volume of procedures. Future studies might also examine the change of quality/outcome of bariatric surgery during several years from the perspective of organization.

Conclusions

By using the aggregate data in eleven selected states, this study provides a detailed description of the trend of utilization of bariatric surgery over the period 1995-2000. Accompanied with growth in the number of adopters, the volume of bariatric procedures performed by hospitals increased rapidly from 1995 to 2000. The growth consists of two components, a large number of adopters and the increasing utilization of the surgery by each adopter. The panel analysis provides partial support to the relationships proposed in the hypotheses. These factors do not show identical effects on hospitals' adoption and expansion of

bariatric procedure. During the early stage of innovation diffusion, hospital size and competition pressure drives hospitals to adopt the service. However, profit-maximization makes hospitals increase the volume of procedures. To our knowledge, despite some limitations existing in this study, this study is the first study that examined the diffusion of bariatric surgery, a medical innovation, from an organizational perspective. The findings provide implications to health plans, hospitals, policy makers, and researchers from the perspective of health costs, regulations, theory and methodology. Further investigations are still needed to examine the diffusion of bariatric surgery across all U.S. hospitals.

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VITA

Wenqiang Tian was born in Puyang, Henan Province, People's Republic of China on November 05, 1976. He graduated in 1998, with a Bachelor of Medicine from Zhengzhou University, Henan Province, China. In 2001, he received a Master of Science, majoring in Epidemiology and Health Statistics, from Chinese Center for Disease Control and Prevention, Beijing. After receiving his MS degree, he worked for one year as a government officer in the Office of Economic System Reformation, Shanghai Municipal Government. In August 2002, he enrolled in the Department of Health Administration's doctoral program, and completed the requirements for the Ph.D. degree in August, 2006.