4618

IMPACT OF THE GROWTH IN AMBULATORY PROCEDURES AND DIAGNOSTIC SERVICES UPON INPATIENT CARE

FINAL REPORT

Thomas J. Hoerger, Ph.D.
Task Leader
Vanderbilt University

Frank A. Sloan, Ph.D.
Vanderbilt University

Teresa M. Waters, Research Assistant
Vanderbilt University

April 1, 1992

Prepared as a Subcontractor to the Project HOPE-HCFA Health Policy Center
Under Contract No. HCFA 99-C-99168/3-03

Phil Cotterill
Project Officer
Health Care Financing Administration
2-B-14 Oak Meadows Building
6325 Security Boulevard
Baltimore, MD 21207

Thomas J. Hoerger, Ph.D.
Task Leader
Health Policy Center
Vanderbilt University
Box 1503, Station B
Nashville, TN 37235

IMPACT OF GROWTH IN AMBULATORY SERVICES ON HOSPITAL INPATIENT CARE

TABLE OF CONTENTS

Paee

Page

Page

APPENDICES

TABLES

Page

FIGURES

EXECUTIVE SUMMARY

There has been substantial growth in ambulatory care utilization, especially since the Medicare Prospective Payment System (PPS) was introduced in 1983. The growth has occurred in physicians' offices, freestanding clinics, and in hospitals. The increases in ambulatory care include to varying degrees increases in preventive, diagnostic, therapeutic, and rehabil- 'itative services. At the same time, the mean complexity of hospital cases has risen while the number of procedures performed on inpatients appears to have declined.

Several reasons have been advanced for the relative growth in ambulatory care. First, under PPS, there are direct financial incentives to shift services provided to particular patients from inpatient to ambulatory settings when this is clinically feasible. Second, the financial incentives have been reinforced by utilization review programs, such as preadmission review. Third, technological changes in diagnostic and therapeutic technology have enabled hospitals to perform more procedures on an ambulatory basis. Fourth, the addition of ambulatory surgery benefits under Medicare has stimulated the use of outpatient services.

The focus of this report is on the relationship between ambulatory care and inpatient services and how that relationship affects hospitals' decisions about the outpatient and inpatient care they offer. The purpose is to learn why hospitals invest in outpatient capacity, why they adopt particular technologies to be used in outpatient and inpatient settings, and what effect adoption has on the use and case complexity of inpatient services. Key to these decisions and impacts are insurer payment policies and competition among hospitals and freestanding clinics for patients and for physicians whose decisions determine where patients receive treatment. The overall objective is to advance current understanding of hospital decisionmaking, particularly as it pertains to choices about capacity, by noting that utilization of inpatient services is not determined in a vacuum. Instead, utilization of inpatient services is determined by the complicated interrelationships between physician, outpatient, and inpatient services. Policy should also reflect these interrelationships.

As part of our study, we have prepared an analysis plan for future empirical study of the relationship between ambulatory care and physician services. The plan is motivated by the conceptual models in Chapters 4 through 6 and is presented in Chapter 8. HCFA may decide that some parts of the analysis plan have higher priority than others. The parts are largely separable.

Literature Review

The subjects of technological change in the hospital sector and the growth of outpatient services, both as a consequence of technological change and for other reasons, are indeed broad. We review the literature on the following issues: the growth of ambulatory services, investment theory, nonprice competition between hospitals, physician-hospital interactions, the effects of reimbursement policy, technological change and diffusion in the hospital sector, previous work on technology adoption, and the yield from diagnostic testing.

Incentives Affecting the Relationship Between Ambulatory Services and Inpatient Care

Based on our literature survey, we identify and discuss the incentives which affect the linkage between the provision of ambulatory services and the utilization of hospital inpatient services. These incentives take central roles in the analytic models which we later construct. Special emphasis is placed on the role that Medicare and non-Medicare reimbursement policies play in influencing the decision to invest in ambulatory care capacity. While our primary interest focuses on the relationship between ambulatory care and inpatient care, the relationship cannot be studied by simply looking at hospital inpatient and outpatient care. Physicians and other providers, such as independent diagnostic labs and free-standing ambulatory surgical centers, compete directly with hospital outpatient departments in the provision of ambulatory care. Moreover, physicians have a great deal to say about where patients receive ambulatory care. Therefore, we discuss the incentives facing physicians and nonhospital providers of ambulatory care, as well as hospital incentives.

We describe how Medicare and non-Medicare reimbursement policies and regulations may influence the decision to provide ambulatory services. We next examine how interrelationships between the demand for ambulatory services and the demand for inpatient services may affect provider behavior. We then discuss how technological change will affect the linkage between ambulatory and inpatient care. Finally, we provide a complete specification of reimbursement mechanisms for Medicare and Medicaid inpatient, outpatient, physician, X-ray, laboratory, and ambulatory surgery services. We also discuss the reimbursement policies used by commercial health insurers and Blue Cross/Blue Shield plans.

Conceptual Analysis of the Relationship Between Inpatient and Outpatient Care

We provide a conceptual analysis of the relationship between ambulatory services and hospital inpatient utilization, with special emphasis on a hospital's decision to invest in ambulatory capacity. Our analysis consists of three related conceptual models.

In the first model, we examine a hospital's choice to invest in ambulatory capacity when it can produce a given service in either an inpatient or an outpatient setting. The decision to invest in ambulatory capacity will substitute outpatient care for inpatient care. In the second model, we examine the relationship between diagnostic testing, which may or may not be done on an ambulatory basis, and therapeutic procedures, which we assume will be performed on an inpatient basis. We present a simple model which formalizes and clarifies some of the issues raised by Klawanski and Gaumer (1990)'s analysis of the yield from diagnostic testing. Insights about yield are incorporated in the third model, which analyzes the hospital's choice to invest in outpatient diagnostic equipment. Unlike the first model which focuses on hospital substitution between inpatient and outpatient care, the third model emphasizes that inpatient and outpatient care can be complements. We also examine competition for the provision of ambulatory diagnostic services between physicians and a hospital, and between hospitals. In all three models, we analyze the effects of changes in reimbursement systems, levels of reimbursement, and technological change.

Although we recognize that outpatient and inpatient care can simultaneously be substitutes for some diagnoses while being complements for other diagnoses, our presentation of models is ordered by the implementation of PPS. PPS created strong incentives for the substitution of outpatient care for inpatient care. Once that substitution was made, however, we suspect that future investments in ambulatory capacity will tend to be in capacity to produce services that complement inpatient care, leading to increased expenditures for both inpatient and outpatient care.

Substitution Between Inpatient and Outnatient Settinns

Our first model focuses on hospital investment in ambulatory capacity for procedures than can be provided on both an inpatient and outpatient basis. The model can be used to analyze the effects of reimbursement policy, technological change, and payer mix on a hospital's outpatient investment. While we initially motivate the model with a discussion of the effects of PPS on substitution between inpatient and outpatient services, the model is designed for the more general analysis of any change in reimbursement policy.

The model shows that Medicare's switch from cost-based reimbursement for inpatient services to PPS increases the effective demand for outpatient care by restricting the amount of services available to inpatients. 'Despite the increase in outpatient demand, monopoly hospitals may be reluctant to install outpatient capacity. Building outpatient capacity may "cannibalize" the hospital's inpatient population; moreover, the patients most likely to switch from inpatient to outpatient settings are low severity patients who' are profitable to treat as inpatients under PPS. However, hospitals facing competition from other hospitals or ambulatory care centers are more likely to invest in outpatient capacity, since the gains from acquiring competitors' inpatients are more likely to outweigh the loss from cannibalizing one's own inpatients. Assuming that the competitive effect dominates, inpatient severity within DRGs will rise when PPS is implemented. The model also predicts that severity across diagnoses will rise following implementation of PPS. Once PPS is implemented, further changes in the reimbursement rate have unambiguous effects on outpatient capacity and demand. Increases in PPS reimbursement lower outpatient demand, while decreases expand outpatient demand.

Medicare reimbursement policy has its largest effect on outpatient investment decisions when a hospital faces a large population of Medicare patients. Hospitals are less likely to invest in outpatient capacity when they face large populations of commercially-insured patients who are covered by cost-based or charge-based reimbursement systems. Investment by hospitals run by HMOs will exceed investment of other hospitals if the HMOs' difference in per patient costs between inpatient and outpatient care exceeds the other hospitals' difference in per patient profits between inpatient and outpatient care. Utilization review will also increase investment by HMOs.

Decreases in patient copayment for outpatient care and technological advances which make outpatient care more convenient or more comfortable will increase patient benefits from outpatient care. Subsequently, outpatient demand and utilization will rise. Finally, decreases in the fixed cost of investment will increase hospital investment in outpatient capacity. Capital passthroughs and high inpatient vacancy rates will lower the fixed cost of investment.

Technoloev Imnrovement and the Yield from Diagnostic Testing

The second model defines two measures of the yield from diagnostic testing, We show that the socially optimal level of testing rises as the cost of testing falls, causing the total yield, defined as total treatments divided by total tests, to fall. However, the optimal level of treatment may rise or fall as more tests are performed. Extensions of the model produce three other results with important policy implications. First, moving diagnostic testing from inpatient to outpatient settings increases the optimal level of testing and lowers the total yield. Second, higher reimbursement levels will increase testing and treatments. Finally, if diagnostic testing can identify low severity patients who would not receive inpatient therapeutic treatment in the absence of the test, the shift from cost-based reimbursement to PPS will increase the frequency of diagnostic testing because the profits from treating low severity patients are higher under PPS.

Hospital Investment in Ambulatorv Diagnostic Testing

The third model examines a hospital's decision to invest in ambulatory diagnostic testing equipment. This model captures three essential characteristics of the relationship between ambulatory and inpatient care.

First, the diagnostic test complements inpatient therapeutic care: performing more diagnostic tests produces more inpatient episodes. In the previous chapter, we noted that diagnostic testing can actually reduce therapeutic treatments. Here, however, we assume that the ability of testing to identify new candidates for treatment dominates its ability to identify patients with high symptoms, but no need for testing. We focus on the incremental treatments produced by testing. Thus, testing itself may be viewed as an investment that sometimes yields inpatient care.

Second, the diagnostic equipment and facility is a workshop for the physician in the sense that testing is necessary to identify candidates for additional physician services. While the testing workshop complements physician services, substitution between physician-owned and hospital-owned workshops is possible. Thus, hospital diagnostic testing facilities may compete with testing done in physician's offices or in physician-owned diagnostic testing centers.

Finally, the physician controls where his or her patients receive their diagnostic tests. This provides advantages for physicians investing in diagnostic testing and heightens competition between hospitals. Both factors are considered within the hospital's investment decision.

Data Bases

We identify data bases suitable for analyzing the issues identified in this research design report. We emphasize parts of the data bases most relevant to the issues addressed in this report, and the years 1980-1990. Several data bases come from states. We focus on data from three states: California, Florida, and Tennessee with appropriate data. Each state data base has strengths and weaknesses. Other states collect cost reports and discharge abstracts from hospitals and make such data available as public use tapes. The National Association of Health Data Organizations maintains a list of states that make such data available (Appendix B). Final choice of data sets will depend in part on which of the specific aims listed in Chapter 1 are pursued.

Empirical Analysis Plan

The last section of the report provides a framework for empirical analysis which could be funded by HCFA at a later date. Its goal is to indicate how the work could be done and the data sources that might be used. The analysis plan is organized around (1) provider-level analysis and (2) beneficiary analysis. The hospital is the natural observational unit for analysis of investment and technology adoption decisions. These decisions are made at this level subject to various constraints the hospital faces. By performing some analysis at the beneficiary level, it is possible to identify specific illness episodes and exploit the detailed information available on types and amounts of care provided for various conditions. In particular, it will be possible to observe the relationship between inpatient and outpatient care during the course of an episode of illness.

Provider Level Analysis

We describe several related studies which would be performed with data at the provider level. The studies examine a hospital's overall investment and adoption of specific technologies, competition between hospitals, the costs and profitability of hospitals adopting new technology, and case studies tracing the dynamic, effects of technology adoption within hospitals.

Beneficiary Level Analysis

All parts of the beneficiary level analysis will use linked files created by or for HCFA. Analysis of these files allows one to create episodes of care and directly measure the interrelationships (complementarity and substitutability) of physician, hospital outpatient, and inpatient services.

The overall objective of this analysis plan is to determine the extent to which PPS caused substitution of outpatient for inpatient care to occur and, equally importantly, whether the substitution played out in the immediate post-PPS implementation period or whether the adjustment took longer than this. If the former is true, one should observe about equal growth in inpatient and outpatient services for particular types of episodes during the late 1980s. Consequently, the deceleration in the growth of Medicare inpatient expenditures that immediately followed implementation of PPS may provide an overly optimistic picture of future inpatient expenditures.

IMPACT OF GROWTH IN AMBULATORY SERVICES ON HOSPITAL INPATIENT CARE

CHAPTER 1: INTRODUCTION AND SPECIFIC AIMS

There has been substantial growth in ambulatory care utilization, especially since the Medicare Prospective Payment System (PPS) was introduced in 1983 (Mitchell, 1989). The growth has occurred in physicians' offices, freestanding clinics, and in hospitals. For example, between fiscal years 1983 and 1989, the average annual growth of Medicare payments for hospital outpatient services rose by 15.6 percent annually versus an annual increase in payments of 6.1 percent for inpatient services (U.S. Prospective Payment Commission (ProPAC), 1991). Twelve percent of the hospital sector's revenue came from community hospital outpatient care in 1983. By 1989, 19 percent of revenue came from such care (Lazenby and Letsch, 1990). The increases in ambulatory care include to varying degrees increases in preventive, diagnostic, therapeutic, and rehabilitative services. At the same time, the mean complexity of hospital cases has risen (ProPAC, 1991) while the number of procedures performed on inpatients appears to have declined.

Several reasons have been advanced for the relative growth in ambulatory care. First, under PPS, there are direct financial incentives to shift services provided to particular patients from inpatient to ambulatory settings when this is clinically feasible. Second, the financial incentives have been reinforced by utilization review programs, such as preadmission review. Third, technological changes in diagnostic and therapeutic technology have enabled hospitals to perform more procedures on an ambulatory basis. Fourth, the addition of ambulatory surgery benefits under Medicare has stimulated the use of outpatient services. Some surgical services are used to establish a diagnosis (Helbing and Latta, 1988; Russell, 1989).

Ambulatory and inpatient services may be either complements or substitutes depending on the service. Many therapeutic procedures are substitutes. By contrast, diagnostic services may be either substitutes or complements. They are substitutes to the extent that patients may be admitted or not to a hospital for diagnostic work. They are complements when a finding from a diagnostic procedure leads to an inpatient therapeutic procedure.

The focus of this report is on the relationship between ambulatory care and inpatient services and how that relationship affects hospitals' decisions about the outpatient and inpatient care they offer. The purpose is to learn why hospitals invest in outpatient capacity, why they adopt particular technologies to be used in outpatient and inpatient settings, and what effect adoption has on the use and case complexity of inpatient services. Key to these decisions and impacts are insurer payment policies and competition among hospitals and freestanding clinics for patients and for physicians whose decisions determine where patients receive treatment. The overall objective is to advance current understanding of hospital decisionmaking, particularly as it pertains to choices about capacity, by noting that utilization of inpatient services is not determined in a vacuum. Instead, utilization of inpatient services is determined by the complicated interrelationships between physician, outpatient, and inpatient services. Policy should also reflect these interrelationships.

As part of our study, we have prepared an analysis plan for future empirical study of the relationship between ambulatory care and physician services. The plan is motivated by the conceptual models in Chapters 4 through 6 and is presented in Chapter 8. The analysis plan has the following specific aims. HCFA may decide that some parts have higher priority than others. The parts are largely separable.

Snecific Aim 1. What factors determine hospitals' decisions to invest? In this work, we will build on past research on the effect of payment mechanisms on hospital investment (Wedig, 1989) and extend this work to incorporate the effects of competition among several sellers in a market area. Although the focus of the study is on outpatient investment, the data do not allow one to separate investment in outpatient from that in inpatient facilities. During the 1980s, much of hospital investment was in outpatient capacity. By studying total investment, it should be possible to learn about determinants of outpatient investment as well. Key to this decision is the cost of capital to hospitals.

Specific Aim 2. Which factors determine hospitals' decisions to adopt particular technologies? Here. we will emphasize diagnostic and therapeutic technologies that have moved to outpatient settings.

Snecific Aim 3. What determines hospitals' decisions to give relative emphasis to provision of particular services on an outpatient as opposed to-an inpatient basis? Relative emphasis will be measured by hospital revenue derived from provision of particular services (or groups of services) in each setting.

Snecific Aim 4. How does the level of outpatient care provided affect the amount of inpatient care demanded of the same hospital? Hospitals seem to weigh the impact on demand for inpatient care when deciding on outpatient service capacity (Souhrada, 1989).

Snecific Aim 5. How does provision of outpatient care affect the complexity of cases treated in the same institution's inpatient units? Hospitals may invest in outpatient diagnostic services in part to admit less complex cases within a particular diagnostic category to its inpatient units. However, provision of outpatient therapeutic care may result in transfers of the comparatively easy cases to the outpatient side. These are issues that can only be settled empirically, and very little is really known about these relationships currently.

Snecific Aim 6. To what extent did PPS cause care to shift from inpatient to outpatient settings? More importantly' from the standpoint of current policy decisions, is substitution between inpatient and outpatient settings still occurring, or do current increases in outpatient spending complement inpatient care? It is possible that PPS produced a one-time decrease in inpatient expenditures by shifting care to outpatient services. Future shifts may be difficult to obtain. Instead, growth in outpatient diagnostic testing which complements inpatient care may return growth rates for inpatient spending to near **prePPS** levels.

Snecific Aim 7. How have technological innovations affected the "yield" from diagnostic testing? Are yields lower on outpatient testing than on inpatient testing? Does hospital competition affect yields? Klawanski and Gaumer (1990) define the yield from diagnostic testing as the number of therapeutic treatments associated with a test divided by the number of tests. We expand upon this definition in Chapter 5.

This report is organized as follows:

Chapter 2 provides a literature review of pertinent studies. It begins with a description of the growth of hospital outpatient services. This is followed by discussions of pertinent articles on hospital investment, **nonprice** competition, the link between third party payment mechanisms and innovation, and technology diffusion. The chapter concludes with a description of a study on the inpatient yield from diagnostic testing.

Chapter 3 discusses incentives affecting the relationship between ambulatory services and inpatient care. Material for the chapter comes from a detailed review of incentives provided by Medicare and Medicaid programs from published sources and interviews with other insurers.

Chapters 4, 5, and 6, respectively, present three related models to explain the shift of services from inpatient to hospital outpatient settings. The first explains substitution of inpatient for outpatient care. The second focuses on the effect of technological change on the yield from diagnostic testing. The third deals with hospital investment in ambulatory testing.

In Chapter 7, we describe pertinent data sources. These include state hospital cost reports, American Hospital Association Annual Surveys, and linked Medicare data sets.

Chapter 8 presents a framework for empirical analysis of the growth of hospital outpatient services. The framework should be sufficient for HCFA to decide whether further work on the topic is feasible and fruitful. Further design work will be needed, however, before empirical research is begun.

CHAPTER 2: BACKGROUND AND LITERATURE REVIEW

The subjects of technological change in the hospital sector and the growth of outpatient services, both as a consequence of technological change and for other reasons, are indeed broad. We reviewed a number of studies for this research design. These are among the more important studies, but there are undoubtedly many others we did not review for this report.

2.1. Growth of Ambulatorv Services

2.1.1. Ambulatorv Surnerv. There was some substitution of outpatient surgery for inpatient surgery before 1983. Between 1979 and 1983, inpatient surgical utilization declined by 7 percent while ambulatory surgical procedures increased by 77 percent, but by 1986, the number of procedures in the latter settings had increased by 277 percent from 1979 (Detmer and Buchanan-Davidson, 1983). By 1986, 40 percent of all surgical procedures performed in hospitals were done on an outpatient basis, Freestanding ambulatory surgery centers performed a million procedures in addition to the 8.7 million outpatient hospital procedures in 1986 (Russell, 1989). In 1990, 37 percent of net hospital revenue derived from surgical cases came from procedures performed on an outpatient basis (Anderson, 1991). During 1988-89, 82 percent of outpatient surgery was done at hospitals, 6 percent at freestanding surgery centers, and 12 percent in physicians' offices (Anderson, 1990).

Both diagnostic and therapeutic surgical procedures are performed on an ambulatory basis. The 8 most common procedures done on an outpatient basis are (1) diagnostic dilation and curettage, (2) diagnostic cystoscopy, (3) myringotomy, (4) biopsy of breast tissue, (5) local excision of skin lesion, (6) diagnostic laparoscopy, (7) cataract extraction (laser), and (8) release of carpal tunnel. Criteria for selecting patients for ambulatory surgery include the nature of the procedure and probability of post-operative complications. Hospital-based ambulatory centers generally serve older patients than freestanding centers (Detmer and Buchanan-Davidson, 1989). According to a recent survey, about 80 percent of hospitals perform ambulatory surgery in the inpatient operating room (Nathanson, 1988). The overall trend, however, is toward dedicated outpatient facilities that are more attractive to consumers (Wilkinson, 1988). Recent surveys of hospitals revealed that ambulatory surgery programs were among the most profitable diversification strategy for most hospitals surveyed; the same has been said about diagnostic centers (Sabatino and Grayson, 1988; Sabatino, 1989). Some observers have voiced concern that ambulatory surgery, especially in nonhospital settings, is still largely unregulated; performance standards and data on volume and costs of ambulatory surgery'have just begun to appear (Bunker and Schaffarzick, 1986).

2.1.2. Cardiac Care. Major therapeutic cardiac procedures are performed on an inpatient basis, but diagnostic procedures are increasingly outpatient. Diagnostic studies may be noninvasive or invasive (see, e.g., Stason and Fineberg, 1982). The performance of the noninvasive tests per se is not a reason for hospital admission. Invasive cardiology may involve a higher risk to the patient and requires monitoring after the procedure is performed.

The most common of the invasive diagnostic procedures is cardiac catheterization which entails inserting a small hollow tube in the patient's arm or leg and advancing the catheter until the tip reaches in or near the heart. In 1987, 866,000 cardiac catheterizations were performed annually, making it one of the most frequently performed procedures (Souhrada, 1989). Growth in use began in the late 1970s and early 1980s. At one teaching hospital, cardiac catheterization was provided to 2 percent of patients with acute myocardial infarction in 1977 and to 40 percent in 1982 (Showstack <u>et al.</u>, 1985). There are about 1,000 cardiac catheterization labs in the U.S. (Souhrada, 1989).

Outpatient catheterization is said to offer several advantages, including convenience to patients and lower cost. Some even assert that the procedure is safer for the patient when performed on an outpatient basis because there is stricter credentialing of physicians there than is required in inpatient hospitals settings, better quality assurance mechanisms, and the availability of several choices of open heart' units in the center's vicinity if surgery is needed quickly (Jackson, 1989). Relative safety-quality is controversial, especially the point about the advantage of choice among hospitals in emergency situations (Mahrer, <u>et al</u>., 1987). If the patient is admitted to a hospital for this procedure, admission is often on the day prior to the study, and the patient spends the night at the hospital after the procedure is performed (Mahrer <u>et al</u>., 1987). National estimates of the outpatient percentage (about 40 percent in the mid 1980s) obscures appreciable variation at the local level. In a given community, one hospital may perform half of its catheterization procedures on in an outpatient department, but at the another hospital in the same city, all are performed on inpatients (Anderson, 1990). One motive for adopting outpatient cardiac catheterization is to lower the overall acuity of the hospital's cardiology patients. Another is to foreclose entry of physicians' offices into production of cardiac catheterization and certain therapeutic procedures, such as peripheral angioplasty (Souhrada, 1989).

<u>2.1.3. Diagnostic Imaging.</u> Radiology had its beginning in 1895 with Roentgen's discovery of x rays. Although there were some improvements in

radiological technology, major innovation did not occur until the 1960s with implementation of ultrasound, rectilinear scanners, and Gamma cameras. Advances in microelectronics and introduction of minicomputers made computed tomography (CT) scanners possible. CT began to defuse in 1973. CT was followed by major innovations in diagnostic imaging, including positron emission tomography (PET), digital subtraction angiography and digital fluoroscopy, major advances in nuclear medicine and ultrasound, and nuclear magnetic resonance (MRI).

Trajtenberg (1990, pp. 47-8) provides estimates of the dollar volume of sales of various diagnostic imaging technologies between 1972 and 1987. Expenditures on x ray increased through the early 1980s and were flat thereafter. Spending on CT increased rapidly between 1973 and 1983 and decreased thereafter. Nuclear medicine had about the same pattern of expenditure growth as CT while expenditures on ultrasound rose throughout 1973-87. MRI began to diffuse in 1982 and, as of 1987, spending was still increasing. By 1987, spending on MRI constituted about a quarter of the diagnostic imaging market and was expected to increase substantially further; almost twice as much was spent on MRI as on CT and about half as much as on x rays. In 1972, x ray's market share was about 90 percent. PET has not diffused beyond tertiary care centers (Sabatino, 1990). Diffusion has been impeded by limited approval by FDA and insurer lack of willingness to cover PET. In 1989, there were 70 PET scanners installed or ordered in the U.S. (McGivney, 1991; Wagner and Conti, 1991).

MRI has numerous clinical applications (Hoppszallern et al., 1990; Souhrada, 1990). It is the diagnostic procedure of choice for many cerebral diseases, diseases of the spine, musculoskeletal system, chest and lower neck, and abdomen. Applications in diagnosing heart diseases are just beginning to develop.

One of the major differences between the diffusion process of CT and MRI at early stages of the diffusion process is that MRI was used extensively on outpatients as well as inpatients from the beginning (Peddecord et al., 1987). In 1989, 81 percent of all MRI scans were performed on an outpatient basis; over 80 percent of scans were used to examine the head and the spine, but applications to other areas appear to be expanding rapidly (Hoppszallern et al., 1990). In the initial stages of development, most MRI units run by hospitals were housed in freestanding centers because of special architectural considerations required by the magnetic fields (Hoppszallern et al., 1990; Hospitals, 1986). Technological advances have resulted in declines in cost of construction to house MRI units. An undetermined percentage of MRI units are operated by imaging centers that are independent of hospitals. With the development of lower cost MRI units, it is anticipated that MRI will defuse into specialty clinics and emergency rooms (Hoppszallern et al, 1990).

2.1.4. Therapeutic Radioloev. Most of therapeutic radiology involves use of x rays or gamma rays to kill cancer cells. It is sometimes the only therapy the patient needs. It is often used in conjunction with surgery, preoperatively or postoperatively, and/or in combination with chemotherapy. Radiation may be administered externally or internally in the form of radioactive implants which may be inserted on an inpatient or outpatient basis.

Quantitative evidence on the use of such services in treating cancer on an outpatient basis is very sparse. One study of Medicare hospital outpatient claims for beneficiaries with cancer taken for one week in 1988 found the following distribution of expenditures: therapeutic radiology, 25.9 percent;

diagnostic radiology, 31.5 percent (with MRI, under 1 percent); surgery, 24.1 percent; chemotherapy (because of virulent side effects of many therapies), 5.4 percent; and other, 13.1 percent (Yarbro, 1991). Using physiologic imaging, physicians can evaluate the response to specific cancer therapies within hours of administration of therapy (Wagner and Conti, 1991). This should facilitate treatment of such patients on an outpatient basis.

2.1.5. Extracorporeal Shock Wave Lithotripsy (ESWL)

In December 1984, the Food and Drug Administration (FDA) granted Dornier Systems approval to market the ESWL in the United States. Despite the sizeable investment required[1], fifty units were in use by December, 1985 (US Congress, Office of Technology Assessment, 1986). One method that health care facilities have chosen to control these sizeable costs is the use of mobile equipment (Rajagopal and Bailey, 1991 and McCue, 1989). Numerous studies indicate that ESWL is at least as successful in the removal of kidney stones as the previously-used method: surgical lithotomy (see, for example, Aronne et al., 1988 and Charig et al., 1986). In addition, studies indicate that treatment using ESWL reduces post-procedural pain, hospital stays and length of time off work; these reductions may translate into significant cost savings (Bashkoff, Lehrer and Saltzman, 1989; Aronne et al., 1988; Lingeman et al., 1986; and Miller et al., 1984). In fact, several studies indicate that ESWL can be successfully conducted on an outpatient basis for the majority of the patient population (Ackaert et al., 1989 and Baert et al., 1989). Although there is evidence that ESWL will produce cost savings for patients who would

---

[1]Estimated operating costs for a hospital operating a Dornier Lithotripter in 1985 range from $1.24 to $1.54 million per year (Alder, 1985 and Blue Cross and Blue Shield Association, 1985.

otherwise have been treated surgically[2], some fear that the United States may not enjoy overall cost savings if the treatment is also used on many patients who previously were not candidates for surgery (Power, 1987).

2.2. Pertinent Economics Literature

There is much pertinent economics literature to review. Researchers on this topic should read studies in the industrial organization literature, especially those focusing on the relationship of investment and innovation to market structure. Our review here is limited to pertinent studies from the health economics literature. Hospital investment is pertinent since (1) innovations are often embodied in investment goods and (2) hospitals have made substantial investments in outpatient capacity in recent years. Nonprice competition is important because, at least historically, it appears that much of the growth in capacity has been in markets served by many competitors. PPS and other changes in third party payment mechanisms may have changed the nature of nonprice competition. Physicians have a special relationship to hospitals and play a key role in determining where patients receive care--at the office office, in the hospital outpatient department, or as inpatients. Physicians also have a role in decisions hospitals make about innovation. The studies we review on physician-hospital interactions and another recent article on technological change stress the roles of reimbursement mechanism as a determinant of hospital innovation. This work is clearly important and is also central to the models presented in later chapters. This chapter concludes with a brief review of past research on the economics of innovation,

[2]Lingeman (1986) estimates that using ESWL for patients who would otherwise have received surgery would reduce annual hospital costs by $1.24 million.

three empirical studies of diffusion of technology in the hospital sector, a description of work on the effect of PPS on diffusion of technology in the hospital sector, and a review of a study on the inpatient yield forthcoming from performing diagnostic procedures. The article by Zweifel reviewed below is only available in German.

2.2.1. Investment. Wedig and coauthors (1989) investigated hospital investment and the cost of capital to hospitals theoretically and empirically. Separate models of investment decisions were developed for for-profit (FP) and for not-for-profit (NFP) hospitals. They made these assumptions. The FPs maximize the hospital value, the summed market value of debt and equity, and NFPs maximize the discounted present value of flows of utilities of quantity and quality of output. Both hospital types face inverse demand curves which consist of three kinds of patients: insured charge-paying; insured cost-paying; and uninsured patients. (Prospective payment was not considered in the model since the empirical work covered 1974-82, and prospective payers used a capital cost passthrough methodology.) Both FP and NFP hospitals use capital and labor to produce services which have both quantity and quality dimensions. Quality depends on ratios of hospital inputs to outputs ("intensity"). FPs obtain their investment capital from three sources: retained earnings, stock issue, and debt issue. NFPs get them from two sources: debt (mainly) and retained earnings. Each problem was solved using optimal control.

The first order condition for capital for the FPs states that the marginal revenue product of capital equals the marginal input price. The contribution of this study is in defining the marginal input price when hospitals face a mix of payer types. A major issue investigated is the effect of hospital dependence on retrospective cost versus charge-based payment on the price of investment goods to hospitals. The authors showed that if the cost payers reimburse a hospital at a rate that falls short of the true cost of holding an investment good a period (Jorgensonian cost of capital), cost-based payment decreases hospital investment and conversely. The first order condition for the NFPs is similar to the FP variant except that the marginal revenue product of capital is replaced by the marginal value of the contribution of capital to hospital utility flows from quantity and quality. The input price is similar, with the only differences reflecting institutional differences between the two ownership types because of corporation income taxation of the FPs and the return on equity payment which the FPs realized at the time.

The empirical analysis, among other things, examined the sensitivity of hospital investment to variations in the input price using a flexible accelerator model of hospital investment. Investment was negatively related to price, but the associated elasticities were low.

This work should be extended in several ways. First, the effect of prospectively-determined capital payments on the cost of investment goods to hospitals should be assessed. Second, the authors treated hospitals as monopolists and had no role for other types of providers. The effects of competition should be evaluated conceptually and empirically. Third, the cost of capital measures should be updated.

2.2.2. Nonprice Competition Amonn Hospitals. Competition can take place among hospitals and between hospitals and other provider types, such as physician offices. We consider the latter types of interactions below. Here we focus on nonprice competition among hospitals. Although nonprice competition among hospitals has been 'described in several papers (e.g., Robinson and Luft, 1987; Noether, 1987), little attention has been devoted to the theoretical underpinnings of nonprice competition among hospitals. Empirically, it has been observed that because of nearly complete coverage for hospital care, competition among hospitals takes place on a non-price basis. Included in nonprice competition is quality as typically measured by clinicians, including the latest equipment, and such amenities as good food and good parking for medical staff.

Pope (1989) provides a good start at a theory of nonprice competition among hospitals. The first part of the paper deals with the basic nonprice competition model in which hospitals face a fixed PPS price and fixed demand for the hospital market as a whole. Later, the model is modified to consider the effects of alternative payment methodologies (cost versus prospective) which affect hospital quality and slack.

In the first part, there are n hospitals and K patients in the town. Each hospital competes for patients by increasing its quality as perceived by patients (or their doctors) (m). Perceived quality depends on hospital expenditure on quality-enhancing inputs (nurses, MRIs, etc.) (R). The number of admissions to a hospital depends on its R.

Each hospital decides on an R, assuming that the Rs of its competitors are fixed. (A more realistic assumption would have been a non-zero conjectural variation, but the model is quite complicated even with a Cournot assumption.) The elasticity of demand for admissions with respect to R (η) was shown to depend on (1) the number of hospitals in the town, (2) a parameter (B) reflecting the mobility of patients-physicians among hospitals (which reflects distances, road conditions, health of patients, etc.), and (3) the elasticity of R with respect to m.

The hospital's marginal (-average) cost per admission equals the sum of R and managerial slack per admission (s). Hospital profits are the product of the difference between price and marginal cost per admission and the number of admissions. The hospital determines optimal s and R by maximizing the sum of profit and total slack (s times admissions).

Equilibrium R (in which there is zero profit) was shown to increase with increases in the values of only two parameters--the sensitivity of patients to changes in R (η) and the fixed PPS price per case. Equilibrium slack increases with the PPS price but decreases with higher η. The intuition of the result is that, if patients are mobile, a greater share of hospital resources will be devoted to benefiting patients and doctors rather than on emoluments to administrators. If η were zero, hospitals would spend nothing on R. Empirical work (Pope did none) should measure determinants of the parameters underlying η.

In the second part of the paper, Pope considered a case in which hospitals receive a combination of a fixed price and cost-based reimbursement from a single payer, assumed for discussion purposes to be Medicare. The major change is that cost 'reimbursement reduces the price of both quality and slack. Medicare may not be satisfied with the level of R elicited under a pure prospective pricing scheme, and by paying partially on a cost basis, it can raise the equilibrium R over what it would be under pure prospective pricing. But at the same time, by paying cost, equilibrium slack increases. The reduction in the price of slack <u>partially</u> crowds out higher quality. A restraint on the hospital employing huge amounts of slack is that the marginal valuation of slack becomes zero at some level. In general, as the share of the total payment derived from a cost-based payment methodology increases, both R and s increase with the ratio of R to s being higher under pure cost-based than under prospective payment. Under pure cost-based payment, hospitals never earn a profit.

2.2.3. Physician-Hospital Interactions and the Effects of Hospital Payment Method. Custer and coauthors (1990) developed a model to assess the effects of PPS on production of hospital care, given alternative hospital-medical staff relationships. In the model, the number of inpatient services per medical staff member depends on the (1) level of physician office inputs (o), (2) physician time devoted to hospital production (t), and (3) level of hospital inputs per member (z). Both the physician and hospital maximize profits. Physician profits depend on exogenous physician output and factor prices faced by the practice and physician and hospital input levels selected respectively by the physician and hospital. Hospital profits depend on the same input variables. Payment per unit of output may be cost-based or prospective. Any switch from cost--based reimbursement to prospective payment was assumed to be budget neutral from the payer's perspective. They included a cost function to reflect scale economies/diseconomies and prices of hospital inputs.

The analysis starts with a noncooperative model in which each hospital and staff member takes the others' input levels as given when maximizing profit. Equilibrium values are derived for the three input levels alternatively under cost-based and prospective pricing regimes, Comparing optimal values for z under the two regimes, it is apparent that optimal z is less for every combination of the other inputs under prospective pricing. Input levels of o and t may be expected to change.

To determine equilibrium values of the inputs, one must specify whether hospital and medical staff inputs are complements or substitutes in the production of hospital care. If they are complements, a decrease in z will lead to decreases in physician inputs to hospitals leading to further declines in z until an equilibrium is achieved. If this occurs, a switch to prospective pricing of hospital care will reduce hospital output and physician income, while the effect on hospital profits is ambiguous. If, however, the two input types are substitutes, physicians will increase their inputs in producing hospital services. Then the effect of prospective pricing on output is ambiguous, but hospital profits rise and physician income falls. (z is lower than before the change.)

In a second model, there is perfect hospital-medical staff cooperation. Then income of the two parties is maximized jointly. There are several major differences between the results when physicians and hospitals cooperate. First, more output is produced (irrespective of the hospital pricing regime) than in the first (Cournot) case. Benefits of production that were previously external are now internalized. Second, now if there is input complementarity, the switch causes an ambiguous effect on physician input levels. If physician and hospital care are substitutes, physician inputs will increase and hospital inputs decrease, the same directions of effect as in the noncooperative variant. Third, joint profits are higher, making the gain from cooperation greater under prospective pricing.

A third model assumes physician dominance over hospitals. Here, one party maximizes profit knowing how the other will react (Stackelberg assumption). Now the medical staff's problem is to maximize profit subject to the hospital's reaction function. Inputs o and t are again the physician decision variables. The hospital maximizes profit over z subject to constraints that the two physician inputs be "paid" their marginal products. The authors investigated effects of employing Stackelberg versus Cournot assumptions and also the effects of changing pricing regimes on input levels, profits, and hospital output.

Clearly, the theoretical results depend on assumed behavioral relationships. Actual results must be determined empirically. The authors also provided some empirical analysis. One theoretical implication (not fully certain) is that hospitals will reduce their inputs per medical staff member (z) in response to the switch and that the magnitude of the effect partly depends on the payer's market share. Hospitals did in fact reduce input use relative to medical staff after PPS was implemented. In the signable cases, their theoretical analysis implies that PPS should decrease physician time devoted to hospital production (t) when z and t are complements. If substitutes, t should rise. For income, the general implication is that when a free-to-the-doctor input (z) decreases, physician income should fall. The authors used a variable for total hours rather than time spent by physicians in hospital care in their empirical work. They found that implementation of PPS reduced hours of medical specialists, which they argued makes sense since t and z are more likely to be complements for medical specialists. For the surgical specialists, however, they found that t fell, which makes sense if such specialists' t and z are substitutes. Physician income rose for surgical specialists post PPS, cet. par., declined for medical specialists, and declined for general/family practitioners and hospital-based specialists, but the effects for the latter two specialties were statistically insignificant.

Zweifel (1988) adopted Custer <u>et al.</u>'s model to examine the effects of reimbursement methods on hospital.adoption of product and process innovations. He examined innovation in the U.S. and Germany. For purposes of this study, the U.S. analysis is relevant.

Zweifel assumed that both the hospital and physicians maximize profits. Like the preceding article, the physician supplies practice inputs and time to the hospital. The hospital decides on an input level per medical staff member. He set up profit functions for the hospital and the typical staff member, both before and after the product or, alternatively, the process innovation. Adoption takes place (and takes place sooner because the foregone cash flow of waiting to adopt is greater), if the hospital's profit after adoption exceeds the profit before adoption. Although adoption is ultimately guided by hospital profit considerations, hospital profitability depends in part on the levels of physician time and practice inputs devoted to hospital production. These latter variables are under the physician's control. The problem thus was solved in two stages. He first solved the physician's model for the effects of an innovation on the two types of physician inputs (time and nonphysician office). Then these variables were substituted into the hospital profit function to evaluate the impact of the innovation of hospital profits and hence on adoption.

His theoretical work yielded few unambiguous results. Under plausible assumptions, he concluded that "larger" hospitals, measured both in terms of the input intensity of production (hospital inputs per staff member) and the number of medical staff members, are more likely to adopt product innovations. These conclusions were based on the assumption that both the hospital and doctor receive higher prices after the innovation, By contrast, product prices were assumed to be unaffected in the case of the process innovation (which is plausible).

The process case is made more analytically difficult because it is not clear what effect the innovation has on input use of physicians and aides. He concluded that a large hospital, defined as above, will only adopt process innovations sooner than a smaller one if the physicians profit from the innovation. This is not because of outright opposition of the doctors, but rather depends on how values of physician input levels change and how this in turn affects the pre-post innovation hospital profit differential. He argued without formal analysis that the transition to PPS should have reduced the rate of product innovation because a higher price post adoption is no longer guaranteed. However, the rate of process innovations should have accelerated.

<u>2.2.4. Interrelationships between Reimbursement Mechanism and Technological Change in the Hospital Sector.</u> Baumgardner (1991) focused on the effects of traditional retrospective charge-based payment versus HMO payment on diffusion of technologies. He described a technology in three parameters: marginal (-average) nonpecuniary cost per unit of medical care (n); marginal pecuniary cost per unit of care (a); and the technical boundary of treatment (B), which captures the extent to which treatment (e.g., life extension) is technically feasible. Technical change refers to combinations of reductions in n and a and increases in B.

In a world of perfect observability of insureds' behavior, the amount of insurance purchased is the one that equalizes marginal utility of income in well and sick states. Further, technical advances involving any or all of the three parameters are welfare-enhancing. Problems arise, however, when the insurer cannot perfectly observe the behavior of doctors-patients. That is, because of imperfect observability, actions of doctors-patients **may** not be reflected in premiums, leading to moral hazard.

Under conventional insurance, Baumgardner showed, among other things, that an advance in B may decrease consumer welfare. This is because the improvement in the ability to treat sick individuals leads to consumption of amounts of care for which marginal benefits fall short of marginal cost that were not consumed before the technical change because such treatment was not technically feasible. (Reductions in a and n by contrast are **welfare-**enhancing.) Although consumers may not be better off ex ante selecting a conventional policy covering a high B, **ex post**, if they have such insurance, they will often use it when confronted with a serious illness.

Now consider the technical change when the patient is covered by an HMO. HMO management sets a standard for the maximum amount of care that HMO doctors **may** provide (or prescribe) to patients which may vary by diagnosis. To the extent that advances in B are constrained by the maximums on utilization, consumption of care by severely ill insureds will be constrained by the **HMO-**imposed utilization maximums rather than by the treatment possibilities that technology allows. Thus, the welfare losses associated with enhanced B do not occur when an HMO is the insurer. Of course, more realistically, the HMO may be forced for reasons of competition in the insurance market to relax its rules and provide its insureds the full benefits of enhanced B, as Aaron and Schwartz (1984) and others have argued.

Now, how is this related to hospital decisions about adoption of particular product innovations? If increases in B are likely to be more welfare-improving under HMO-type insurance, one should observe that such technologies are more likely to be adopted by hospitals in areas with high HMO penetration to the extent that HMOs are better in controlling the use of such technology. The analytic problem is that this conclusion relies on an ex ante calculation. **Ex post**, once the individual has conventional insurance, he might just as well use it, and demand may be higher in areas in which a lot of patients have conventional insurance.

2.2.5. Technology Diffusion: Concents. As already seen, a number of studies have distinguished between process and product innovations. Process innovations make it less expensive to produce a good or service that was previously produced by the firm. Product innovations involve the introduction of a new product not heretofore available.

Clearly the distinction depends on how output is measured. If, in the context of hospitals, the unit of output is considered to be a patient day, admission, or outpatient visit, the vast majority of innovations that have been introduced in the past decades have been product innovations. If one considers output to be life extension or quality of life enhancement, at least some of the innovations that would be classified as product innovation using the narrower definition of output become process innovations. The narrower definition of output is probably the more useful one for our purposes for two reasons. First, the impacts of most of the innovations on life expectancy and quality of life have not been adequately documented. Second, from the standpoint of a payer like HCFA, new diagnostic and therapeutic technologies have tended to raise expenditures. The major shift from inpatient to outpatient care is properly viewed as a process innovation using the narrower definition of output.

The conceptional literature on product innovation in economics has been described by Kamien and Schwartz (1982), Scherer (1984), and others.

According to this theory, there are two decisions, whether or not to adopt the innovation at all, and if the innovation is to be adopted, when to adopt. The firm will innovate if the present value of the stream of profits expected from the innovation is positive. If the innovation is profitable at all, there is the question about optimal timing of innovation. In deciding on timing, the firm balances the costs of adopting later--potential competitors may secure a permanent share of the market'and loss of some early potential profits--against the possible gain from waiting--securing benefits of subsequent scientific advances and learning from others' mistakes. Risk averse firms consider the variance of net returns. Risk aversion is just one cost of adoption, and highly risk-averse firms (e.g., a public firm, perhaps a small one, or a highly leveraged one) may be expected, cet. par., to be a late adopter.

Monopolists are less likely to have their markets foreclosed by late adoption, and, for this reason, they may be slow to innovate. However, concentration reduces uncertainty and provides cash flow for innovation--the Schumpeterian hypothesis (Scherer, 1980; Levin, et al.,1985). Although numerous empirical studies have been conducted in a variety of industries, much of the empirical evidence on the relationship between market structure and innovation in other industries is inconclusive (Kamien and Schwartz, 1982).

Although some of the conceptual and empirical research on the economics literature on innovation is relevant to the hospital sector, it is important to recognize some important differences between innovations in the hospital sector and other industries. First, the vast majority of "firms" in the hospital sector are not organized on a for profit basis. This means that hospitals may adopt innovations for reasons other than profits, such as for teaching and research purposes and/or to enhance their prestige. This distinction does not seem to be as important as it might first appear since the hospital must break even in the long run unless it has access to various private and public subsidies. Second, innovations in other sectors often require substantial capital investments. This is only sometimes true in the hospital sector. Certainly, adoption of nuclear magnetic resonance involves a major investment, but such innovations as open heart surgery, or even transplantation are highly labor intensive. The major investment is in financial commitments made to specialized staff and training. Particularly for capital-intensive innovations, it is essential to consider the capital recovery that the hospital's various payers provide. For the labor-intensive innovations, the prices payers are willing to pay to cover the innovation's operating cost are of critical importance. Third, firms in various industries sell in more than one market. Computer firms, for example, sell to companies, to households, and to universities. Outputs in various markets are interrelated. Such firms may wish to capture a high share of the educational market and offer price reductions to achieve such shares because students often grow up to be corporate buyers. Hospitals sell in markets for inpatient and outpatient care. These markets also are interrelated. Hospitals' innovation decisions and pricing of new products should reflect these interrelationships.

2.2.6. Empirical Analysis of Adoption of Technologies in the Hospital Sector.

Russell (1979) used data for 1961-75 from the American Hospital Association to study the diffusion of various technologies within the hospital sector, including intensive care, cobalt therapy, open heart surgery, renal dialysis, diagnostic radioisotopes, respiratory therapy, and electroencephalograph.

Among the determinants of diffusion she found to be important were hospital size, teaching and research programs, and a general as opposed to specialty orientation. (Specialty hospitals were sometimes late adopters.)

Three major nonfindings are also noteworthy.- First, once size was controlled for, the difference in innovation adoption behavior between for-profit and private not-for-profit hospitals was relatively minor. The distinction between government and private hospitals was more important. Second, she found no major effect of the incidence of diseases pertinent to the technology in question and adoption. Third, she used the four-firm concentration ratio to measure hospital market structure. She was able to detect no systematic relationship between market structure and innovation. Lack of results on market structure may well reflect inadequate measurement. Also, the environment was quite different in the 1960s and 1970s from the 1980s and 1990s.

Romeo and coauthors (1984) studied the probability, speed, and extent of adoption of five specific new technologies in six states (three with state prospective reimbursement and three with retrospective reimbursement) using data from a special survey conducted by the American Hospital Association in 1980. The five technologies (all defined as "capital-embodying") were: electronic fetal monitoring; volumetric infusion pumps; upper gastrointestinal fiberoptic endoscopes; automated bacterial susceptibility testing; and centralized energy management systems. The first three innovations were said to be cost increasing (product innovations) and the last two to be cost reducing for large scale use (process innovations). The importance of prospective reimbursement to the hospital was measured by the proportion of the hospital's patient days covered by such payment systems. The authors' methodology allowed them to distinguish among the effects of the various prospective reimbursement programs. Market structure was measured by a Herfindahl index of concentration of patient days among hospitals in the hospital's county.

A major finding was that prospective reimbursement, especially in its most restrictive forms, impeded the diffusion of product innovations. At the same time, they found some evidence that diffusion of process innovations was encouraged by tough prospective reimbursement. The coefficients on the Herfindahl index variable were generally insignificant and varied in sign.

Sloan and coauthors (1986) studied the diffusion patterns of five surgical procedures. Roles of payer mix, regulatory policies, physician diffusion, competition among hospitals, and various hospital characteristics such as size and teaching status were examined. Data came from a time series cross section of 521 hospitals based on discharge abstracts sent by the hospitals to the Commission on Professional and Hospital Activities during 1971-81. The five technologies were total hip replacement, coronary bypass surgery, morbid obesity surgery, retina repair, and cataract surgery.

The authors found that payer mix affected diffusion of surgical technology although the marginal effects were comparatively small. A high share of commercially-insured patients, which pay the highest proportion of hospital charges on average, was conducive to diffusion and, conversely, high shares of public and self-pay payers typically were predictive of comparatively slow diffusion. Mandatory prospective reimbursement generally had small or no effect on diffusion with the exception of coronary bypass surgery, the "biggest ticket" of the technologies studied. Certificate of need had no effect on diffusion, a finding consistent with other work on the topic.

Market structure was measured as the ratio of beds in other community hospitals to community population. They defined "community" as the SMSA for metropolitan and the county for nonmetropolitan hospitals. A higher ratio meant more competition. Their regression results implied that diffusion is generally greater when there is less rather than more competition in the market area from other hospitals. 1971-81 is thought to be a period in which the "medical arms race" was in full swing. These results are inconsistent with this view. More rigorous measurement of market structure is needed to resolve this issue.

Trajtenberg (1990) assessed diffusion of CT scanners. His methodology differed appreciably from the others. He specified the choice problem as one of multinomial choice. In a first stage of his estimation approach, he estimated hedonic pricing models. The rationale was to decompose price variation of CT scanners of CT scanners into two components: the part due to differences in quality of the scanners and the residual. It is the latter that should motivate the hospital's adoption decision; the residual from the one stage (hedonic) regression was used in the second stage in which the adoption decision was estimated using multinomial logit analysis. The model was estimated separately for each year for 1975-81. The negative price effects on adoption was generally statistically significant at conventional levels.

2.3. The "Yield" from Diagnostic Testing

Klawansky and Gaumer (1990) studied how utilization of diagnostic procedures affects the use of therapeutic procedures. Defining the Medicare product as completed episodes of therapeutic interventions, they examined how changes in the volume of a diagnostic test affect the test's yield, measured as the ratio of therapeutic episodes to diagnostic tests. Klawansky and Gaumer focused on two diagnostic-therapeutic pairs. The first pair coupled diagnostic cardiac catheterization with therapeutic coronary artery surgery or balloon angfoplasty, while the second pair connected diagnostic flexible fiber optic colonoscopy with therapeutic removal of polyps in the colon. Using aggregate data on diagnostic and therapeutic volume, Gaumer and Klawansky showed that yields fell for both pairs as diagnostic volume increased significantly between 1984 and 1986. They noted that decreased yields increased total (diagnostic plus therapeutic) Medicare costs per therapeutic test, since the costs of more diagnostic tests were spread across each therapeutic procedure. They also suggested that diagnostic yields, coupled with data on the overall utilization rate of therapeutic procedures, can be used to identify areas with overly "aggressive" medical practice, as well as areas where patients lack access to therapeutic procedures.

Although Klawansky and Gaumer raised a number of interesting questions about the relationship between diagnostic and therapeutic procedures, some of their terminology is misleading. By defining Medicare product as the number of therapeutic procedures performed and equating yield with testing "efficiency," the authors left the impression that high yield rates are better than low yield rates. In fact, determining the optimal yield rate is much more complicated, as the authors eventually noted, almost as an afterthought, in the conclusion. Technological advances that make diagnostic tests feasible necessarily lower the yield.

To see this, note that if therapeutic tests are performed in the absence of diagnostic tests, the yield equals infinity. Presumably, whenever a patient's observable symptoms exceed a threshold level, the therapeutic procedure will be performed.

Introduction of a diagnostic test has two effects. First, some patients who would have been treated in the absence of the test will receive negative test results and no longer receive treatment. Second, some patients who previously would not have been treated will now receive testing. Some of these tests will be positive, leading to increased volume for the therapeutic procedure.

Assuming that symptoms are related to the probability of positive test results, both effects will lead to decreases in yield. However, the two effects will have different effects on the overall volume of therapeutic procedures. The first effect will lower volume and reduce costs, while the second effect increases volume and costs; overall effects will depend on the initial distribution of symptoms in the population, the cost of diagnostic tests and the benefits from receiving therapeutic procedures. Klawanski and Gaumer implicitly assume that the second effect is negligible, This assumption may hold for cardiac catheterization, where catheterizations almost always precede cardiac surgery since the "diagnostic" procedure is necessary to tell the surgeon if and how to perform the surgery. Because it provides information on how surgery should be performed, cardiac catheterization is really part of the therapeutic procedure itself. For other diagnostic/therapeutic pairs, the therapeutic procedure can be performed independently of the diagnostic test. (This model will be formalized in Chapter 5.)

Klawansky and Gaumer's empirical analysis suffers from a related problem. While they discussed how diagnostic tests lead to therapeutic procedures, data limitations forced them to use the total number of inpatient diagnostic tests and therapeutic, procedures to compute yields. This analysis is valid if diagnostic tests are performed before each therapeutic procedure. As mentioned, however, some patients who would be treated in the absence of diagnostic testing will no longer be treated; so it is important to be'able to see whether the proportion of patients who receive treatment without first receiving diagnostic testing changes as diagnostic testing increases. Data at the beneficiary level are necessary to directly link tests and therapeutic procedures; fortunately, such data are now available. Better data on outpatient diagnostic procedures are also available for more recent years than Klawansky and Gaumer had available; their availability is important since outpatient testing has been growing dramatically for many procedures, including cardiac catheterization.

CHAPTER 3: INCENTIVES AFFECTING THE RELATIONSHIP BETWEEN AMBULATORY SERVICES AND INPATIENT CARE

3.1. Introduction

The purpose of this chapter is to identify and discuss the incentives which affect the linkage between the provision of ambulatory services and the utilization of hospital inpatient services. These incentives will take central roles in the analytic models which we will construct during the following chapters. Special emphasis is placed on the role that Medicare and non-Medicare reimbursement policies play in influencing the decision to invest in ambulatory care capacity. While our primary interest is focused on the relationship between ambulatory care and inpatient care, the relationship cannot be studied by simply looking at hospital inpatient and outpatient care. Physicians and other providers, such as independent diagnostic labs and free-standing ambulatory surgical centers, compete directly with hospital outpatient departments in the provision of ambulatory care. Moreover, physicians have a great deal to say about where patients receive ambulatory care. Therefore, we discuss the incentives facing physicians and nonhospital providers of ambulatory care, as well as hospital incentives.

The rest of the chapter is organized in the following way. After briefly discussing possible objectives for providers of ambulatory care, we describe how Medicare and non-Medicare reimbursement policies and regulations may influence the decision to provide ambulatory services. We next examine how interrelationships between the demand for ambulatory services and the demand for inpatient services may affect provider behavior. We then discuss how technological change will affect the linkage between ambulatory and inpatient care. Finally, we provide a complete specification of reimbursement mechanisms for Medicare and Medicaid inpatient, outpatient, physician, X-ray, laboratory, and ambulatory surgery services. We also discuss the reimbursement policies used by commercial health insurers and Blue Cross/Blue Shield plans.

3.2. Provider Objectives

Basically three objectives have been used in models of the behavior of health care providers. The simplest models to analyze assume that providers maximize profits. This assumption is convenient because it allows researchers to apply the well-known predictions of the standard economic model of profit maximization. However, many health care providers, particularly hospitals, have not-for-profit status. Therefore, some researchers have proposed models in which not-for-profit hospitals maximize utility from choice variables such as output, quality, or slack, subject to a break-even or minimum profit constraint (see, for example, Newhouse, 1970). A third objective, used mainly in models of physician behavior, assumes that providers act as perfect agents for patients by comparing a patient's benefits from care to the patient's costs and choosing the level of care that maximizes the patient's net benefits (see Ellis and McGuire, 1986). The choice is usually subject to the constraint that the provider earns a fair rate of return.

It is not immediately clear whether the choice of objective affects predictions about provider behavior. For example, if Medicare's prospective payment system limits the resources that can be provided by hospital inpatient departments, but not in outpatient departments, both a profit-maximizing hospital or a perfect agent physician might be expected to try to substitute more outpatient care for inpatient care. Similarly, changes in reimbursement policy which reduce the profits of a profit-maximizer will also affect utility-maximizing providers through their break-even or minimum profit constraints. On the other hand, Dranove (1988) shows that decreases in reimbursement levels for Medicare or Medicaid patients will have qualitatively different effects on the prices charged by profit-maximizing and utility-maximizing hospitals.

3.3. Reimbursement Policy and Incentives

The way that Medicare and other insurers reimburse health care providers plays an important role in shaping the incentives for providing ambulatory care. In this section, we discuss the incentives provided by three aspects of reimbursement policy: differences in reimbursement methods across types of services, differences in reimbursement levels for a given type of reimbursement method, and differences in reimbursement policies between insurers. We describe how these aspects will affect the relationship between ambulatory and inpatient services.

3.3.1. Reimbursement for Different Services. Section VI describes how Medicare reimburses providers for a variety of services. The differences across services are striking: the Prospective Payment System reimburses hospitals a fixed amount which is based on an inpatient's diagnosis, not the services actually provided by the hospital; the customary, prevailing, and reasonable (CPR) method pays physicians a fee-for-service according to fee screens that are partially dependent on the physician's actual charges; and there are different systems for ambulatory surgery centers, X-ray and laboratory services, and hospital outpatient services. These differences affect provider incentives in a number of ways.

3.3.1.1. Prospective vs. Retrospective. Whether a reimbursement system is prospective or retrospective affects the risk facing a provider. Prospective payment systems, which establish--in advance--a fixed payment per service, diagnosis, per diem, or per person, increase the risk facing a provider. If the actual cost of treating the patient exceeds the fixed payment, the provider is responsible for the difference. Retrospective payment, in contrast, is determined after the services are actually provided, on the basis of the costs or charges for the services actually rendered. The provider consequently faces less risk. If providers are risk averse, they will prefer retrospective payment to prospective payment if the two reimbursement systems provide equal average payments. In addition, prospective payments are often based on regional or national average payments, while retrospective payments are often based on a provider's own costs or charges. The latter arrangement does little to encourage provider efficiency since lowering one's costs or charges simply leads to lower reimbursement levels.

3.3.1.2. Fee-for-service vs. Payment Per Person or Diagnosis. Fee-for-service reimbursement pays a fee, determined prospectively or retrospectively, for each service actually rendered. This gives providers incentives to provide more services (as long as fees are set above costs). Other types of payment, such as the DRG system in PPS or capitated payment in HMOs, sever the relationship between the quantity of services provided and payment, giving providers an incentive to provide fewer services.

3.3.1.3. Relative Levels of Payment. If reimbursement for one type of care becomes stingy relative to another type of care, and the two types are substitutes, providers will try to provide more of the type that is more generously reimbursed. For example, if adoption of Medicare's PPS made reimbursement for hospital inpatient services relatively less generous, hospitals would have an incentive to provide less care in inpatient settings and more care in outpatient settings. Medicare payment reforms have generally affected only one type of service at a time; such reforms may lower expenditures for the targeted services, but raise expenditures for other services.

3.3.1.4. Bundling and Unbundling. The preceding reasons suggest that the advantages (to insurers) of reimbursement based on diagnosis over fee-for-service reimbursement may be diminished if providers can "unbundle" the services associated with each diagnosis so that some of the services are treated (and reimbursed) before the patient is admitted as an inpatient. While unbundling may lead to higher reimbursement for the provider, it will also produce higher overall costs to society if bundling services is efficient.

3.3.1.5. Capital Costs. If capital investments lead directly to higher reimbursement (that is, capital costs are passed through) providers will be more likely to invest than if the investment has no effect on reimbursement. In the latter case, the investment must pay for itself by generating increased patient visits. If capital costs are reimbursed differently in inpatient, outpatient, and physician office settings, the location of care will be affected accordingly. Capital costs are more commonly passed through under hospital inpatient reimbursement policy than they are in reimbursement for other services.

3.3.1.6. Conflicting Incentives. Under current Medicare reimbursement policy, physicians, paid on a fee-for-service basis, have incentives to provide as many services as possible in all settings, including inpatient settings. Hospitals, reimbursed under PPS, have an incentive to reduce the amount of resources used in inpatient settings. These incentives conflict. Intensifying the conflict is the key role that physicians play in directing patients to hospitals: a hospital needs to attract physicians in order to fill beds, yet if it takes too many inpatient resources to attract physicians, the hospital will lose money under PPS. One way to mitigate these tensions is for hospitals to provide expanded outpatient facilities. Physicians will be happy to face fewer constraints, while the hospital is reimbursed for outpatient services on a fee-for-service basis.

3.3.2. Differences in Reimbursement Levels for a Given Reimbursement Method. No matter what reimbursement system is used to determine payment for a service, the level of payment has important effects on provider behavior. If payment is set at a high level, relative to costs, more providers will want to supply the service and entry will occur. Conversely, if reimbursement levels are low, few providers will be willing to provide a service. While this result is fairly obvious, it does complicate empirical tests of provider behavior. While information about the type of reimbursement system used by an insurer is frequently available, information about the relative generosity of the payments generated by the system is less uncommon. This suggests that collecting data on the generosity of insurer payments should be an important part of any empirical study of the relationships between ambulatory services and inpatient care.

3.3.3. Differences Between Insurers

3.3.3.1, Reimbursement Levels. Health care providers face an array of Medicare, Medicaid, Blue Cross/Blue Shield-insured, commercially-insured, and uninsured patients. While the mix of patients facing a particular provider will be affected endogenously by the provider's choice of price, quality, location, etc., the exogenous overall distribution of patients across insurers in an area will have important effects on the provider's choices. Physicians and hospitals in an area with many Medicare patients will place more weight on Medicare reimbursement policies when deciding whether to invest in ambulatory capacity, while providers in areas with many commercially-insured patients will place more weight on commercial insurers' policies, and so on. As Section VI shows, different insurers use different types of reimbursement systems to pay for each service. Equally important, when different insurers use the same type of insurance system to pay for a particular service, they usually pay different levels of reimbursement. Generally, commercial insurers **pay** more than other insurers, Blue Cross/Blue Shield pays more than Medicare, and Medicaid pays the least.

3.3.3.2. Utilization Review. Besides reimbursement systems, each insurer's approach to managing care by utilization review (UR) will affect the decision to invest in ambulatory care. For example, PPS does not provide direct incentives to perform surgery on an outpatient basis instead of in inpatient departments. In fact, if less severe cases within a DRG are the best candidates for outpatient surgery, hospitals actually have incentives to perform those cases on an inpatient basis, since PPS reimbursement is based on the average severity of cases within a DRG. The observed shift of surgery to outpatient settings may reflect pressures from Peer Review Organizations, which were created when PPS was adopted (Russell, 1989; Sloan et al., 1988). Wickizer **et al.** (1991) examined data from 43 privately insured groups that adopted utilization review (UR) between late 1984 and early 1985. They compared outpatient expenditures before and after adoption of hospital UR to gauge the effects of UR on outpatient use. They found no effect of UR on physicians' office expenditures or on diagnostic outpatient expenditures, but **they documented a 20 percent increase in hospital outpatient department** expenditures per insured person per quarter that, holding a number of other factors constant, they attributed to UR. It appears that diagnostic expenditures were not included in the hospital outpatient expenditure measure. HMOS in particular have especially strong incentives to keep patients out of the hospital; data on HMO enrollment is available by state in the Source Book of Health Insurance Data.

3.4. Interrelated Demand for Inoatient. Physician. and Ambulatory Services: Complements, Substitutes, and Comoetition

Inpatient services, outpatient, and physician services are not unrelated goods. Physician services complement outpatient or inpatient services, while outpatient services sometimes complement and sometimes substitute for inpatient care. Demand curves for each type of service also reflect competition within and between different types of providers. Providers will be acutely aware of the interrelationships between the demand curves.

3.4.1. Hospitals. Most hospitals operate inpatient and outpatient departments. If a hospital maximizes profits it will jointly set inpatient and outpatient prices to take account of the cross-price effects between the two types of services. Moreover, providing outpatient services may be an effective method of attracting physicians--and their patients--to a hospital. The hospital may even be willing to lose money on outpatient services if that attracts profitable inpatient business. Of course, the outpatient services may be profitable in their own right.

3.4.2. Physicians. Physicians may also decide to provide ambulatory services that are frequently performed in hospitals, either within their own offices or by investing in an ambulatory testing facility. Interrelations in the demand for different ambulatory services will affect this decision in at least two ways. First, the physician may invest in ambulatory capacity because it increases patient demand for other physician services. Possessing the ability to quickly and conveniently provide ambulatory services like test results and X-rays essentially increases the quality of the other services the physician provides. Second, the ambulatory services in question may be profitable in themselves, if insurers' reimbursement levels are set too high. Rather than see those profits flow to someone else, the physician invests in ambulatory capacity. A potential problem with such investment is that having made the investment in ambulatory capacity, the physician may change his or her behavior to prescribe more tests or procedures. Concerns about self-referral have prompted recent legislative-proposals to limit physician ownership of health care facilities (Iglehart, 1989).

3.4.3. Free-standinv Ambulatory Services Providers. Unlike physicians and hospitals, free-standing providers of ambulatory services, such as independent clinical laboratories or ambulatory surgery centers, will have to earn their profits from a single type of service. This may place them at a competitive disadvantage relative to hospitals, which may offset losses on ambulatory services with profits on inpatient services, and physicians, who can refer patients to their own facilities. To remain competitive, free-standing facilities will probably have to produce ambulatory service with lower costs.

3.5. Technological Progress

Medical technology has improved rapidly in recent years and has probably increased the substitutability between inpatient and ambulatory care. Two types of technological improvement can be distinguished: process innovation and product innovation.

3.5.1. Process Innovation. Process innovation involves refinements in the production of existing procedures which lead to lower costs per procedure. Process innovation will lead to reduced prices if medical care markets are perfectly competitive since the lower costs will encourage entry that eventually lowers prices. However, most current reimbursement systems are relatively inflexible in the downward direction because payments are based on charges or costs incurred in the past. With reimbursement stuck at its former level, and costs falling, process innovation may be responsible for recent increases in investment in office-based laboratory testing equipment by physicians. A possible problem with this investment is that office-based testing may be more expensive than testing in a large independent laboratory, despite the process innovation.

3.5.2. Product Innovation. Product innovation involves improvements in existing procedures that increase quality and the discovery, introduction, and diffusion of new--and frequently expensive--procedures and equipment. Product innovation may be responsible for shifts from inpatient to ambulatory care. In recent years, for example, improvements in anesthesiology have made ambulatory surgery safer, while advances in diagnostic testing equipment such as CT scanners and magnetic resonance imagers have reduced the need for invasive exploratory surgery.

3.6. Current Reimbursement Practices

This section describes current reimbursement practices by Medicare, Medicaid, commercial insurers, and Blue Cross/Blue Shield plans in several states where the plans enroll a high percentage of consumers.

3.6.1. Medicare. Medicare Part A provides insurance coverage to the elderly for inpatient hospital services, home health care, and hospice stays.

Medicare Part B benefits include physician services provided in any setting, outpatient hospital services, outpatient laboratory and radiology services, and some home health services. Current Medicare reimbursement policy for the inpatient, outpatient, physician, and ambulatory services is outlined below. Cur source is the Commerce Clearing House (CCH) Medicare and Medicaid Guide.

3.6.1.1. Hospital Inpatient. Hospitals are reimbursed on a prospective cost per discharge system based on Diagnosis-Related Group (DRG) classifications. The current set of **DRG's** contains 473 specific categories. The formula used to calculate the prospective payment for a specific case takes a hospital's payment rate per case and multiplies it by the weight of the DRG to which the case is assigned. Each DRG weight represents the average resources required to care for cases in that particular DRG relative to the national average resources consumed per case by the average hospital. Each Medicare discharge is assigned to only one DRG regardless of the number of services furnished or the number of days of care provided. There is, however, a provision for outlier cases with extraordinarily long length of stay or high cost relative to the average case in the DRG.

Prospective payment to hospitals based on the diagnosis-related group system was designed for short-term acute care hospitals. As a result, the following types of facilities are exempt from PPS: psychiatric and rehabilitation hospitals, long-term care hospitals, qualifying alcohol/drug hospitals, Veteran's Administration hospitals, nonparticipating hospitals and hospitals in most U.S. territories. These exempt facilities will continue to be reimbursed on a reasonable cost basis.

The prospective payment covers a hospital's inpatient operating costs for routine, ancillary, and special care unit services, including malpractice insurance costs. The amount paid is intended to cover all items and non-physician services furnished to hospital inpatients. Physician services furnished to individual patients are billed separately under Part B and reimbursed on a reasonable cost basis.

Capital-related costs 'are reimbursed on a reasonable cost basis. Allowable capital-related costs include the following: net adjusted depreciation expense, leases and rentals for the use of depreciable assets, costs of improvements, costs of minor equipment, insurance expense on depreciable assets, interest expense, return on equity capital for proprietary providers and capital-related costs of related organizations that provide services to the hospital. In addition, Direct Medical Education Expenses and Indirect Medical Education Costs continue to be reimbursed on a reasonable cost basis.

When a patient is transferred to a hospital that ultimately. discharges the patient, payment to the discharging hospital is made at the full prospective payment rate, while payment to the transferring hospital is based on a per diem rate. This payment method is based on the rationale that the transferring hospital will generally provide only a limited amount of treatment compared to the final discharging hospital. Transferring hospitals may qualify for "outlier" reimbursement if length of stay or cost is extraordinary relative to the average case.

By paying a fixed fee for inpatient care, while maintaining existing cost-based reimbursement for outpatient care, PPS gives hospitals disincentives to introduce technologies that increase inpatient operating costs. At the same time, it gives hospital incentives to shift services to outpatient settings and to adopt capital-intensive technologies because capital cost has continued to be reimbursed as a passthrough. Nevertheless, for reasons not well understood, certain expensive technologies have continued to diffuse, such as lithotripsy, open heart surgery, cardiac catheterization, and organ transplants (Propac, 1989).

3.6.1.2. Hospital Outpatient. When Medicare adopted PPS for inpatient services, prospective payment did not extend to outpatient services. Outpatient services (which include (1) those services which aid the physician 'in treatment and (2) diagnostic services such as laboratory and X-ray services) continued to be reimbursed on a reasonable cost basis under Part B. Reasonable costs were determined retrospectively for each hospital by allocating the hospital's direct and indirect costs to Medicare and non-Medicare patients.

Faced with rapidly growing outpatient expenditures, Medicare has since added prospective components to outpatient reimbursement. Reimbursement for outpatient clinical laboratory testing has been set according to statewide fee schedules since 1984. Since October 1987, Medicare has paid the facility charge for hospital-based ambulatory surgery based on a blended amount that averages the hospital's usual cost-based payment with the prospective rate established for free-standing ambulatory surgery centers (Nathanson, 1988). Hospitals receive the lesser of costs or the blended payment. Medicare imposed limits on outpatient radiology during October 1988 (Robinson, 1988), when hospitals began receiving a blended amount that relates a percentage of the hospital's costs to a percentage of the prevailing charges that would apply if the services had been performed in a physician's office. Similar blended rates were applied to diagnostic cardiology procedures beginning in October 1989 (Souhrada, 1989). By the end of 1987, less than40 percent of Medicare charges in the outpatient setting were reimbursed on a purely, reasonable cost basis (Propac, 1991). Moreover, Congress has mandated a comprehensive prospective payment system for outpatient hospital services.

3.6.1.3. Physician Services. Physician services are normally covered under Part B of the Medicare program and are reimbursed on the basis of reasonable charges using the customary, prevailing., and reasonable (CPR) methodology. A reasonable charge is the lowest of the following:

1. The actual charge.

2. The customary charge[1] for similar services generally made by the physician or other person furnishing the service.

3. The prevailing charge[2] in the locality for similar services.[3]

---

[1]The "customary charge" is the amount that a physician charges in the majority of cases for a specific item or service. In practice, this charge is calculated as the median or midpoint of his charges, excluding token and substandard charges as well as exceptional charges on the high side. Customary charges are calculated for the particular year by using the actual charges for the 12-month period ending June 30. The customary charge level for new physicians can be no higher than 80% of the prevailing charge level for the service in the area.

[2]"Prevailing charges" refer to those charges that fall within the range of charges most frequently and most widely used in a locality for particular medical procedures or services. Carriers are required to calculate separate prevailing charge screens applicable to (1) physician services furnished in a non-provider setting, and (2) the physician services of provider-based physicians. In determining prevailing charges, the carriers have to base their.?screens on the customary charges of physicians and other persons rendering the covered services. In the calculation, the customary charges must be weighted by how often the physician or other person rendered the service during the period from which the customary charge data was derived. The prevailing charge for a service is then determined: to be the lowest customary charge which is high enough to include the customary charges of the physician who rendered 75% of-the cumulative services, In addition, Medicare-may cap the rate of increase of prevailing charges for a procedure.

[3]Until recently, Medicare carriers frequently paid differing reimbursement amounts to physicians of differing specialties. A recent U.S. Circuit. Court of Appeals ruling has threatened this practice. In some cases, no differential may exit; the Secretary is authorized to limit prevailing charges-, for specialists in the fields of surgery, radiology, and diagnostic services to the level of the prevailing charge applicable to nonspecialists with respect to a particular service.

4. The carrier's usual amount of reimbursement for comparable services to its own policy holders under comparable circumstances.

Provider-based physicians are reimbursed on a reasonable charge basis only for those services furnished to individual patients. Hospitals with approved teaching programs may be reimbursed on a reasonable charge basis for services rendered by physicians on staff if the hospital so elects and all the physicians agree not to bill Medicare beneficiaries for the physician services provided to them in the hospital. The physician services will qualify for reasonable charge reimbursement if the following conditions are met:

1. The physician renders sufficient personal and identifiable physician's services to the patient to exercise full, personal control over the management of the portion of the case for which the payment is sought.
2. The services are of the same character as the services the physician furnishes to patients not entitled to benefits under Medicare.
3. At least 25% of the hospitals's non-Medicare patients pay all or a substantial part of charges for such services.

Physicians may elect to participate in the "participation program". This program requires participants to accept all Medicare patients on assignment and to accept Medicare reimbursement amounts as payment in full. Incentives to participate have become increasingly more attractive for physicians; only 95% of the applicable prevailing charge is applied to non-participating physicians, while 100% is applied to those who participate,- In addition, the actual charge of a non-participating physician is subject to a maximum allowable charge (MAAC).

Physician reimbursement will undergo dramatic changes in 1992 when Medicare begins to phase in its new fee schedule. Fees will be based on the relative costs of producing a procedure, rather than historical charges. The new reimbursement system also incorporates Medicare volume standards, which will automatically reduce fee levels if Medicare volume rises too rapidly, and limitations on the amount of balance billing by nonparticipating physicians;

<u>3.6.1.4. Laboratorv Services</u>. Clinical diagnostic laboratory tests are subject to areawide fee schedules that apply to all clinical labs with the following exceptions:

1. Lab tests furnished to hospital inpatients whose stay is covered under Part A (reimbursed on a reasonable cost basis);
2. Lab tests performed by a Skilled Nursing Facility (SNF) for its own SNF inpatients and reimbursed under Part A or Part B (reasonable cost);
3. Lab tests furnished by hospital-based or independent End Stage Renal Dialysis (ESRD) facilities that are included under the ESRD composite rate payment (reasonable charges);
4. Lab tests furnished by hospitals in states or areas which have been granted demonstration waivers of Medicare Reimbursement Principles for outpatient services;
5. Lab tests furnished to inpatients of hospitals with waiver under the Social Security Act (1983) (reasonable charges paid);
6. Lab tests furnished to patients of rural health clinics under an all-inclusive rate;
7. Lab tests provided by participating. Health Maintenance Organizations (HMOs) or Health Care Provider Plans (HCPPs);

8. Lab tests provided by a hospice.

Medicare carriers are responsible for setting the fee screens at 60% or 62% of the prevailing[4] charge for the locality. The 60% rate applies to most labs including independent labs and hospital labs. The 62% rate applies only to those outpatient lab services performed in qualified hospital labs found in sole community hospitals. The codes and terminology in the HCFA Common.' Procedure Coding System should be used in the fee schedule to identify and describe the lab tests. In addition, lab tests performed on or after January 1, 1990, are subject to a national limitation amount equal to 93% of the median of all fee schedules established for a given test.

A carrier may negotiate an agreement with a lab under which Medicare payments for covered services will be made in accordance with agreed-upon rates for tests performed on an assignment basis, as long as the following three criteria are met: (1) eligibility; (2) the negotiated payment rate may not exceed the amount that would be paid in the absence of such a rate; and, (3) the duration of the contract period cannot be less than 1 year.

Physicians must accept assignment for all clinical diagnostic laboratory tests provided in physician offices. In addition, the physician may not add a mark-up fee in his billing to Medicare or the beneficiary that adds to the charge of the supplier that did the tests.

3.6.1.5. X-Ray Services. Payment for X-ray services is covered under Part B and reimbursed on a reasonable cost basis when 'the services are (1) furnished by a physician or incidental, to his 'or her services; (2) provided in

[4]Prevailing Charge: 75th percentile of customary charges, weighted by frequency, that were determined for the fee screen year beginning July 1, 1984 in (1) the carrier's existing service area or (2) no more than one state where carrier's service area includes more than one entire state.

participating SNFs or hospitals, either directly or under arrangement, in circumstances under which they cannot be covered under Part A (hospital PPS); or, (3) furnished by a portable X-ray supplier when furnished in a place of residence used as the patient's home or in non-participating institutions.

3.6.1.6. Ambulatory Surgical Centers. Payment for facility services in free-standing ambulatory surgical centers (ASCs) is on the basis of a prospectively-determined rate called the "standard overhead amount" for each covered procedure. Rates may be adjusted to take account of varying conditions in different geographical areas. In order to participate in the Medicare program, an ASC must agree to accept the Medicare payment as payment in full for its services. There are now eight distinct payment groups. Any covered procedure will fall into one of the eight categories and will be reimbursed at the flat rate corresponding to that category.

Reimbursement for hospital outpatient department and hospital-affiliated ASCs is the lesser of (1) the applicable provider reimbursement reasonable cost rules or (2) a "blended amount" that averages the provider reimbursement reasonable cost rules with the free-standing ASC payment rules described above.

3.6.2. Medicaid. Although state Medicaid programs receive federal financing, most of the decisions about eligibility, reimbursement methods, and provider payment levels are made at the state level; As 'a result, there are important cross sectional variations between state Medicaid programs: It may be possible -to exploit this variation in empirical studies to measure the effects of reimbursement policy on the relationship between inpatient, and ambulatory services.

General patterns in Medicaid reimbursement policy are described here. In Appendix A, we present each state's reimbursement systems for inpatient, outpatient, physician, X-ray, and laboratory services, and for ambulatory surgical centers. The source for the tables is the CCH Medicare and Medicaid Guide, which contains detailed descriptions of each state's Medicaid program. The tables for inpatient and outpatient hospital reimbursement are similar to tables compiled by Laudicina (1989) which are also based on CCH publications; we have made some modifications in these results based on our interpretations of the CCH descriptions and more recent CCH updates.

3.6.2.1. Hospital Inpatient. Most state Medicaid programs now use prospective payment systems for hospital inpatient services. 23 states, plus the District of Columbia, apply prospective rate of increase controls to update the previous year's reimbursement levels, while 18 states use a prospective case mix system, which is similar to Medicare's PPS. Five states still use retrospective payment systems, while four states negotiate and contract directly with hospitals.

3.6.2.2. Hospital Outpatient. Retrospective cost-based payment is much more common for Medicaid outpatient services than it is for inpatient services. 27 states currently use retrospective payment systems for outpatient services. 12 states, plus the District of Columbia, employ prospective payment systems; each of these programs also uses prospective payment for inpatient services, with the exception of Rhode Island, which negotiates directly with hospitals. Nine states set reimbursement levels with a fee schedule, while three states negotiate rates with hospitals..

3.6.2.3. Physician Services. All state Medicaid programs- reimburse physicians on a fee-for-service basis. 26 states set physician fees using the usual, customary, and reasonable (UCR) methodology, eight states directly apply Medicare's customary, prevailing, and reasonable (CPR) system, and 16 states use fee schedules. One state negotiates fees contractually. The differences between fee schedules, UCR, and CPR are largely a matter of degree. Fee schedules feature prospectively-determined payments per procedure that do not vary by provider. Both UCR and CPR ostensibly determine 'the reasonable charge to be reimbursed as the lowest of three fee screens: (1) the physician's actual charge, (2) the fee commonly charged by the physician ("usual" in UCR and "customary" in CPR), and (3) the fee commonly charged for the procedure by the physician's peers ("customary" in UCR and "prevailing" in CPR). Additional fee screens are also applied on a state-by-state basis, usually with the intent of lowering program expenditures. Many programs contain specific provisions requiring that Medicaid pays less than other insurers.

In principle, UCR and CPR have some aspects of a retrospective payment system since a physician's fee for a procedure is determined partly on the basis of the amount that physician charges for the procedure. In practice, however, the effect of additional fee screens and freezes or limits on-the growth of customary and prevailing updates is to give UCR and CPR many of the aspects of a prospective fee schedule.

Despite similarities in the' structure of physician reimbursement systems across states, differences in levels of reimbursement make some state Medicaid payments relatively more generous than others. As mentioned earlier,' Medicaid reimbursements are generally lower -than reimbursements by other insurers', although quantification of such differences is not available on a state-by-state basis.

3.6.2.4. Laboratory and X-ray Services. As with physician services, almost all states use fee schedules, Medicare CPR, or UCR systems to determine reimbursement for laboratory and X-ray services. For laboratory services, 22 states use UCR, 13 states and the District of Columbia employ fee schedules, 14 states use CPR, and one state negotiates rates. For X-ray services, 22 states employ UCR, 16 states and the District of Columbia apply a fee schedule, 10 states use CPR, one state uses a charge-based system, and one state negotiates rates. Most, but not all, states use the-same reimbursement system for both laboratory and X-ray services.

Most of the comments about physician reimbursement also apply to laboratory and X-ray services.

3.6.2.5. Ambulatory Surgical Centers. Perhaps because ASCs are a relatively new phenomenon, Medicaid reimbursement for ASCs differs from reimbursement for outpatient services and from reimbursement for other ancillary services, such as laboratory or X-ray services. Compared to outpatient services, ASCs are more likely to be reimbursed prospectively. Compared to laboratory and X-ray services, ASCs are less likely to be reimbursed using UCR or CPR. 17 states use fee schedules to reimburse ASCs, 12 states use other types of prospective payment, five states and the District of Columbia negotiate rates, 15 states apply UCR, three states use the CPR system that Medicare used to pay ASCs before adopting its current method, and one state bases reimbursement on charges.

3.6.3. Blue Cross/Blue Shield. Like Medicaid programs, Blue Cross/Blue Shield (BC/BS) plans differ by state', providing the measurable cross-sectional variation necessary for testing the effects of reimbursement policy on the relationship between inpatient and ambulatory services. Because BC/BS rates generally.exceed Medicaid rates, BC/BS reimbursement is likely to be more instrumental in encouraging hospitals or physicians to invest in ambulatory capacity. Unfortunately, no systematic data such as the CCH Medicare and Medicaid Guide exists for BC/BS plans.

To get a better idea of BC/BS policy, we contacted by telephone several. BC/BS plans in states with high percentages of enrollment in BC/BS plans. BC/BS reimbursement policy is likely to have its largest impact in such states. However, because BC/BS plans have more monopsony power to impose reimbursement innovations in these states, their reimbursement policies may not be representative of BC/BS policy nationwide. We also contacted Blue Cross and Blue Shield of California because a number of innovations in provider reimbursement have originated in the state of California. Complete results of our survey appear in Appendix B.

In general, BC/BS plans use more innovative reimbursement systems for hospital inpatient services than they use for other services. One plan applies Medicare's DRG system, while other plans negotiate inpatient contracts with individual hospitals. Inpatient reimbursement levels in Massachusetts are set by a state hospital rate-setting commission. Some plans negotiate reimbursement levels for outpatient services at the same time they negotiate inpatient rates, while other plans reimburse outpatient services on a reasonable cost basis, as does Medicare. UCR is still the most common reimbursement system for physician services, although BS of California uses a fee schedule that it distinguishes from UCR and BC/BS of Michigan recently- dropped UCR for a new fee schedule (not shown in Appendix B because the plan's spokesperson could not supply details), 3.6.4. Commercial Health Insurers. Commercial health insurers generally pay even higher reimbursement levels than Blue Cross/Blue Shield plans, and in many states their reimbursement systems probably have more impact on decisions to invest in ambulatory capacity. However, because of the number of commercial insurers, relatively little systematic information exists on the reimbursement systems used by commercial health insurers. Moreover, a commercial insurer may use.more than one reimbursement system and write policies in many states, making cross-sectional analysis of the effects of commercial insurers' reimbursement policies difficult. In one of the few studies of commercial insurers, Gabel, et al., (1989) surveyed 123 commercial health insurance companies in 1988. Their survey covered hospital and physician reimbursement systems only and reported summary statistics instead of firm-by-firm or state-by-state results. They found that conventional fee-for-service insurance accounted for about 75-80 percent of all group insurance, while HMOs and PPOs accounted for the other 20-25 percent. For conventional group insurers, the most common methods of reimbursement to physicians were UCR (74 percent) and billed charges (19 percent); UCR (28 percent) and billed charges (61 percent) also dominated conventional group insurers' reimbursement to hospitals. PPOs, the second most common form of group insurance, paid hospitals on the basis of discounted usual charges (55 percent), per diem (38 percent), and DRGs (6 percent). PPO reimbursement for physicians was determined by fee schedules (53 percent), discounted usual charges (34 percent), and usual charges (9 percent). HMOs primarily used discounted usual charges (61 percent) and per diem payments (29 percent) to reimburse hospitals, and capitation (71 percent) and billed charges (12 percent) to pay physicians.

3.7. Conclusion

A health care provider's decision to invest in ambulatory care capacity is shaped by a number of incentives. Medicare and other insurers' reimbursement policies can harness incentives to improve the efficiency of the mix of inpatient and ambulatory services, but reimbursement policies can also distort the mix. Other factors affecting the linkage between inpatient and ambulatory services, such as interrelationships in demand and technological change, are not as easily controlled by insurers.

This chapter has attempted to identify the incentives affecting inpatient and ambulatory care, and to describe current reimbursement policy. Throughout the rest of the report, we will study how the incentives and reimbursement policies interact to determine levels of inpatient and ambulatory care.

CHAPTER 4: A MODEL OF SUBSTITUTION BETWEEN INPATIENT AND OUTPATIENT CARE

The purpose of this and the following two chapters is to provide a conceptual analysis of the relationship between ambulatory services and hospital inpatient utilization, with special emphasis on a hospital's decision to invest in ambulatory capacity. Our analysis consists of three related conceptual models.

In this chapter we examine a hospital's choice to invest in ambulatory capacity when it can produce a given service in either an inpatient or an outpatient setting. The decision to invest in ambulatory capacity will substitute outpatient care for inpatient care. In the next chapter, we examine the relationship between diagnostic testing, which may or may not be done on an ambulatory basis, and therapeutic procedures, which we assume will be performed on an inpatient basis. We present a simple model which formalizes and clarifies some of the issues raised by Klawanski and Gaumer (1990)'s analysis of the yield from diagnostic testing. Insights about yield are incorporated in Chapter 6 which analyzes the hospital's choice to invest in outpatient diagnostic equipment. Unlike this chapter's model which focuses on hospital substitution between inpatient and outpatient care, the model in Chapter 6 emphasizes that inpatient and outpatient care can be complements. We also examine competition for the provision of ambulatory diagnostic services between physicians and a hospital, and between hospitals. In all three models, we analyze the effects of changes in reimbursement systems,' levels of reimbursement, and technological change.

Although we recognize that outpatient and inpatient care can simultaneously be substitutes for some diagnoses while being complements for other diagnoses, our presentation of models is ordered by the implementation of PPS. PPS created strong incentives for the substitution of outpatient care for inpatient care. Once that substitution was made, however, we suspect that future investments in ambulatory capacity will tend to be in capacity to produce services that complement inpatient care, leading to increased expenditures for both inpatient and outpatient care.

4.1. Chapter Overview

In this chapter, we build a general model of hospital investment in ambulatory capacity for procedures than can be provided on both an inpatient and outpatient basis. The model can be used to analyze the effects of reimbursement policy, technological change, and payer mix on a hospital's outpatient investment. While we initially motivate the model with a discussion of the effects of PPS on substitution between inpatient and outpatient services, the model is designed for the more general analysis of any change in reimbursement policy. The model's predictions are briefly outlined below.

The model shows that Medicare's switch from cost-based reimbursement for inpatient services to PPS increases the effective demand for outpatient care by restricting the amount of services available to inpatients. Despite the increase in outpatient demand, monopoly hospitals may be reluctant to install outpatient capacity. (See Chapter 2 for a discussion of financial considerations that may lead to higher investment by monopoly hospitals. Such considerations are not incorporated in this chapter's model:) Building outpatient capacity may "cannibalize"' the hospital's inpatient population; moreover,. the patients most likely to switch from inpatient to outpatient settings are low severity patients who are profitable to treat as inpatients' under PPS. However, hospitals facing competition from other hospitals or ambulatory care centers are more likely to invest in outpatient capacity, since the gains from acquiring competitors' inpatients are more likely to outweigh the loss from cannibalizing one's own inpatients. Assuming that the competitive effect dominates, inpatient severity within DRGs will rise when PPS is implemented. The model also predicts that severity across diagnoses will rise following implementation of PPS. Once PPS is implemented, further changes in the reimbursement rate have unambiguous effects on outpatient capacity and demand. Increases in PPS reimbursement lower outpatient demand, while decreases expand outpatient demand.

Medicare reimbursement policy has its largest effect on outpatient investment decisions when a hospital faces a large population of Medicare patients. Hospitals are less likely to invest in outpatient capacity when they face large populations of commercially-insured patients who are covered by cost-based or charge-based reimbursement systems. Investment by hospitals run by HMOs will exceed investment of other hospitals if the HMOs' difference in per patient costs between inpatient and outpatient care exceeds the other hospitals' difference in per patient profits between inpatient and outpatient care. Utilization review will also increase investment by HMOs.

Decreases in patient copayment for outpatient care and technological advances which make outpatient care more convenient or more comfortable will increase patient benefits from outpatient care. Subsequently, outpatient demand and utilization will rise. Finally, decreases in the fixed cost of investment will increase hospital investment in outpatient capacity. Capital passthroughs and high inpatient vacancy rates will lower the fixed cost of investment.

4.2. PPS and Substitution from Inuatient to Outpatient Care: Background

Prior to implementation of PPS in 1983, hospitals received, cost-based reimbursement from Medicare for both inpatient and outpatient hospital care. Hospitals continued to receive cost-based reimbursement for Medicare outpatient care after PPS was adopted, but Medicare reimbursement for inpatient care changed dramatically under PPS. Hospitals began to receive a fixed payment for each inpatient admission which was based solely on the patient's diagnosis and was independent of the length of stay and intensity of services received by the patient. The asymmetry in reimbursement mechanisms for inpatient and outpatient care had three effects on the mix of inpatient and outpatient services: (1) unbundling, (2) reallocation of costs, and (3) true substitution between inpatient and outpatient care. The crudest effects, unbundling, can be discussed without a formal model. Unbundling will occur when complete episodes of inpatient care can be broken up into smaller segments, some of which (e.g., preadmission diagnostic testing, post-discharge rehabilitative services) can be done on an outpatient basis. By unbundling, the hospital can receive a (cost-based) payment for the outpatient care, plus the fixed PPS payment for the inpatient stay, with little or no increase in cost. This is clearly more profitable than continued bundling, which only earns the fixed PPS payment.

Reallocation of costs, the second substitution effect associated with PPS, is slightly more complicated. Under cost-based reimbursement, direct and indirect costs are allocated to different departments through a complex accounting mechanism. Hospitals have some control over the ways that costs are allocated and pre-PPS evidence suggests that hospitals use this control to maximize reimbursement (Danzon, 1982). Put simply, optimal allocation of costs involves allocating as much cost as possible to departments reimbursed on a cost basis. With the introduction of PPS for inpatient care, this implies reallocating costs from inpatient services to outpatient services. Hospitals can allocate more costs to outpatient services by increasing charges for outpatient services faster than inpatient services, increasing volume, creating outpatient cost centers, or changing assignment of indirect costs (ProPAC, 1990). Some partial, but incomplete, evidence of cost reallocation stemming from PPS exists in a study by the Center for Health Policy Studies (1990) which examined outpatient costs in eighteen hospitals in both 1982 and 1988. In 1982, before PPS, the hospital's reported outpatient costs generally understated actual resource costs, while reported inpatient costs overstated resource costs. By 1988, after PPS, the situation had reversed itself: most hospitals' reported costs for outpatient care exceeded resource costs. Increased allocation of indirect costs to outpatient care accounted for much of the change; between 1982 and 1988 indirect cost's share of total costs increased from 44 percent to 66 percent for clinic visits and from 46 percent to 54 percent for emergency room visits.

We define true substitution, the third effect of the shift to PPS, as occurring when the primary locus of care changes from inpatient to outpatient care or vice-versa. This definition distinguishes true substitution from unbundling, where some elements of care are switched from inpatient to outpatient settings but the primary setting remains inpatient, and from reallocation of costs, where the reallocation does not change the locus of care. To examine how true substitution is affected by PPS and, more generally, any other change in reimbursement policy, we form the following stylized **model of hospital investment in outpatient capacity.**

4.3. The Model

The stylized model consists of three sequential stages. In the first stage, the hospital decides how much to invest in outpatient capacity. For simplicity, we assume that a hospital initially possesses excess inpatient capacity, so the hospital's only investment choice affects outpatient capacity.[1] In the second stage, a physician chooses whether to send a patient to the hospital's inpatient or outpatient department. The physician chooses to send the patient to the department that maximizes the patient's benefit, given the patient's severity of illness. For now, we assume the physician receives the same payment no matter where the procedure is performed. Thus, the physician acts as the patient's agent when choosing between inpatient and outpatient locations. This decision, combined with the distribution of severity of illness across patients, determines the hospital's demand for inpatient and outpatient services. In the third stage, the physician and hospital jointly determine the optimal level of services for the patient, given the patient's severity of illness, the physician's choice of delivery location in stage 2, and the hospital's choice of outpatient capacity in stage 1. The optimal level of services is determined by maximizing the sum of the patient's benefit and the hospital's profit. For simplicity, we call the three stages the investment stage, the demand stage, and the services stage, respectively.

Sequential models are solved in reverse order. This method, known as backwards induction, matches the process used by rational economic agents to make sequential decisions: in order for the hospital to make its investment

---

[1]This assumption is probably acceptable for the 1980s, when most hospitals "enjoyed" high vacancy rates for inpatient care.

decision, it must anticipate whether physicians will decide to send their patients for inpatient services or for outpatient services, and in order to make that decision physicians must anticipate how many services their patients will receive in the alternative settings. Each agent should anticipate that subsequent decisionmakers will make decisions to maximize their objectives. Consequently, we first examine the service stage.

4.3.1. The Service Stage. We consider a model where the (divisible) number of patients with a particular disease is normalized to one. Patient i's severity of illness is measured by θ_i, which is distributed between 0 and 1 according to the probability function f(8). Patients can be treated either as outpatients or as inpatients. There is a separate benefits function for treatment in each mode; $\beta^O(X^O,\theta)$ is the patient's benefit from receiving X^O units of service as an outpatient and $\beta^I(X^I,\theta)$ is the analogous patient benefit from inpatient care, with $\beta^j_X > 0$, $\beta^j_{XX} < 0$ for j = O,I. Severity increases both the aggregate level of benefits and the marginal benefit of services:

$$\beta^j_\theta > 0 \text{ and } \frac{\partial \beta^j_X}{\partial \theta} \text{ for } j = O,I.$$

That is, care is worth more and the marginal benefit of care rises when the patient is sicker. Other factors which affect the relative benefits of inpatient and outpatient care include:

(a) the relative convenience of outpatient care versus inpatient care;

(b) technology;

(c) differential levels of patient copayment.

To see how many services the patient will receive in the outpatient department, assuming there is sufficient outpatient capacity to treat the patient, we maximize the following objective function:

$$\max_{X^o} V^o = \beta^o(X^o, \theta) + R^o(X^o) - C^o(X^o) \qquad (4.1)$$

where $R^o(X^o)$, the hospital's outpatient reimbursement, may depend on the amount of services provided, and $C^o(X^o)$ is the cost of providing X^o services.[2]

This objective function merits some explanation. Ellis and McGuire (1986) introduce this function as the objective of a physician acting as a "perfect agent" to maximize a patient's benefit while considering the effect of his or her behavior on hospital profits. The physician is a perfect agent because he or she chooses care levels to maximize the benefits to "society" (i.e., the patient and hospital). Another interpretation of (4.1) is that the hospital successfully constrains the physician's use of services through its choice of internal prices or rationing of services. While this objective function is somewhat unconventional, alternative objectives are more problematic. If the physician chooses X^o to maximize patient benefits only, he or she will order services until marginal benefits equal zero, regardless of hospital reimbursement or costs. Hospitals are unlikely to allow such utilization. Alternatively, if the hospital chooses service levels to maximize profits and faces a prospective payment per admission, the hospital will provide no services (since $R_x = 0$ under prospective payment). The first-order condition for (4.1) is

---

[2]For simplicity, we assume that hospital investment affects the number of outpatients who can be treated, while X^o measures the intensity of services the patient receives. In fact, investment may affect both capacity and intensity of care, but the assumption should have little effect on the model's predictions.

$$\beta_X^O + R_X^O - C_X^O = 0. \tag{4.2}$$

We denote the solution as $X^{O*}(\theta)$; it is easily shown that $X^{O*}(\theta)$ increases with severity,

The choice of services in the inpatient stage is set up and solved in the same way:

$$\max_{X^I} V^I = \beta^I(X^I, \theta) + R^I(X^I) - C(X^I) \tag{4.3}$$

The first order condition is

$$\frac{\partial V^I}{\partial X^I} = \beta_X^I + R_X^I - C_X^I = 0 \tag{4.4}$$

and its solution, $X^{I*}(\theta)$, increases with severity.

4.3.2. The Demand Stage. In the demand stage, the physician chooses whether to send a patient to the inpatient department or the outpatient department, given the expected amounts of services in both departments. We assume that the physician sends the patient to the outpatient department if

$$\beta^{O*}(X^{O*}, \theta) \geq \beta^{I*}(X^{I*}, \theta) \tag{4.5}$$

Otherwise the physician admits the patient as an inpatient. Note that the physician acts solely as the patient's agent prior to admitting the patient. At this point, the physician does what is best for the patient. However, the physician makes the admission choice knowing that he or she will be constrained to balance patient benefits and hospital profits once admission occurs.

Three possible cases exist.

1. $\beta^{O*} \geq \beta^{I*}$ for all θ.

   For such a procedure, patients always benefit more as outpatients.

2. $\beta^{O*} \leq \beta^{I*}$ for all θ.

   For such a procedure, patients always benefit more as inpatients.

3. The two benefit curves cross at $\bar{\theta}$ where $0 < \bar{\theta}$ c 1.[3]

This case has two subcases. The first subcase, which we focus on in the following analysis, has $\beta^{O*} > \beta^{I*}$ for 8 < $\bar{\theta}$ and $\beta^{O*} < \beta^{I*}$ for $\theta > \bar{\theta}$ (Figure 1). We-consider this subcase more intuitive because less severe cases are treated as outpatients and more severe cases are treated as inpatients. This situation may arise because patients find outpatient care more convenient and more pleasant than inpatient care, while inpatient care is safer for patients if complications arise. The convenience advantage of outpatient care is independent of severity, but the safety factor rises with severity since complications increase with severity, so the two curves cross at an intermediate level of e. While the second subcase, where $\beta^{I*} > \beta^{O*}$ for $\theta < \bar{\theta}$ and $\beta^{I*} < \beta^{O*}$ for $\theta > \bar{\theta}$, is less intuitive, it is still possible. This case involves treating low severity cases on an inpatient basis and high severity cases on an outpatient basis. This subcase will occur when the slope of β^{*I} with respect to θ is less than the corresponding slope of β^{*O}; this may occur if

$$\frac{\partial X^{I*}(\theta)}{ae}$$ is relatively small.[4]

Assuming that the first subcase holds, the effective demand for outpatient care will be given by $F(\bar{\theta})$, the probability that $\theta \leq \bar{\theta}$. We call this effective demand, because we have modeled physician behavior under the assumption that there is sufficient outpatient capacity to treat patients with severity $\bar{\theta}$. Actual capacity levels will be chosen by the hospital in the investment stage.

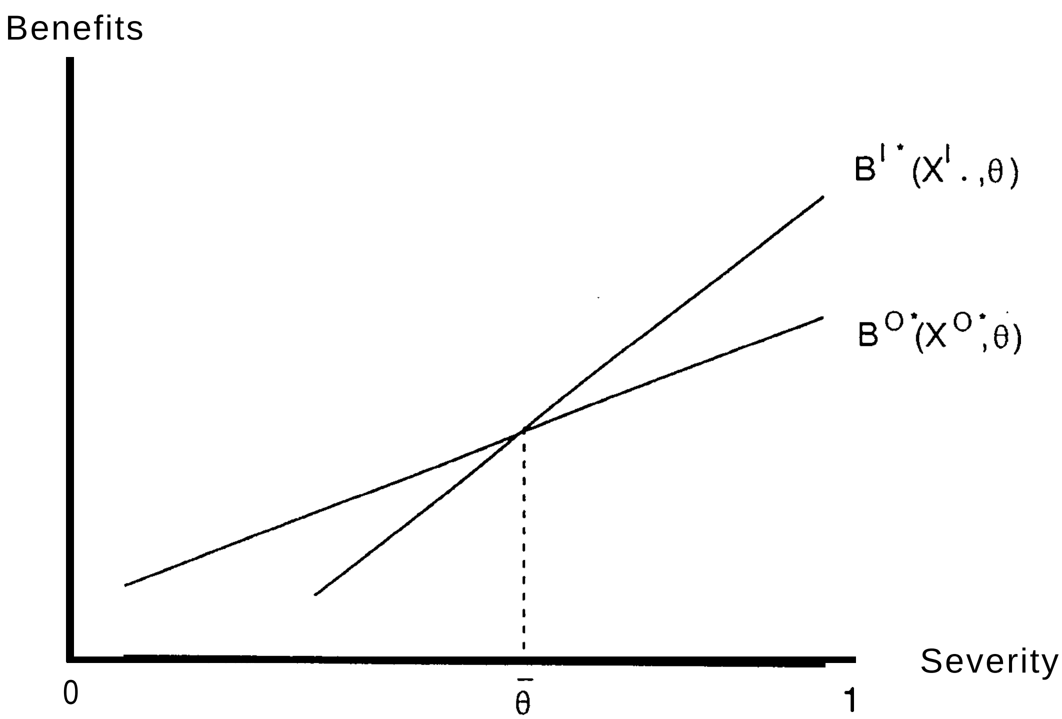
---

[3]We assume the curves cross only once.

[4]This subcase might occur when inpatient care is reimbursed under PPS, while outpatient cases are reimbursed with a cost-based system. Cost-based reimbursement might allow X^{O*} to rise rapidly with severity, while PPS limits the response of X^{I*} to severity,

Figure 1

Less Severe Cases are Treated as Outpatients



4.3.3. The Investment Stane. A hospital chooses to invest in outpatient capacity, K, to maximize profits, given physicians' optimal response functions in subsequent periods. Capacity costs d dollars per unit. The hospital's profit maximization problem is:

$$\max_{K} \ \pi = \int_{0}^{K} [R^{O}(X^{O*}(\theta)) - C^{O}(X^{O*}(\theta))]f(\theta)d\theta$$

$$+ \int_{K}^{1} [R^{I}(X^{I*}(\theta)) - C^{I}(X^{I*}(\theta))]f(\theta)d\theta - dK$$

$$\text{s.t. } K \leq F(\bar{\theta})^{5} \qquad (4.6)$$

The first integral is the hospital's profit from outpatient care; profit changes with θ, since hospitals provide more services as severity increases.' The second integral is the profit from inpatient care, and like the first integral, contains the optimal service choice in the service stage. The constraint incorporates physicians' effective demand for outpatient care; the hospital will never install more capacity than will be filled by demand. The first-order condition is:

$$\frac{\partial\pi}{\partial K} = [R^{O}(X^{O*}(K),K) - C^{O}(X^{O*}(K),K)] - [R^{I}(X^{I*}(K),K) - C^{I}(X^{I*}(K),K)] - d - \lambda \qquad (4.7)$$

For this problem, we have to be especially careful about corner solutions. Three cases can occur. We let K* denote the solution, including corner solutions.

'Implicit in this formulation is the assumption that if outpatient demand is rationed, lowest severity patients are first served on an outpatient basis. These patients receive the highest incremental benefit from outpatient care over inpatient care.

[6]We assume that insurers cannot base reimbursement on θ, although they may base reimbursement on the amount of services ($X^{O*}(\theta)$) provided.

1. $K^* = 0 < \bar{\theta}$.

Even for low severity cases, the hospital earns higher profits by treating the patient as an inpatient; outpatient demand is rationed.

2. $0 < K^* < \bar{\theta}$.

This is an interior solution where $\lambda = 0$. At K^* the difference between the net outpatient reimbursement and net inpatient revenue equals the fixed cost of investment. The hospital installs some outpatient capacity, but not enough to meet outpatient demand. As in the first case, further installation will "cannibalize" inpatient demand.

3. $K^* = \bar{\theta}$ and $\lambda \geq 0$.

The hospital-is demand-constrained. The hospital would like to install additional capacity because it's profitable, but higher severity patients prefer the benefits they receive as inpatients.

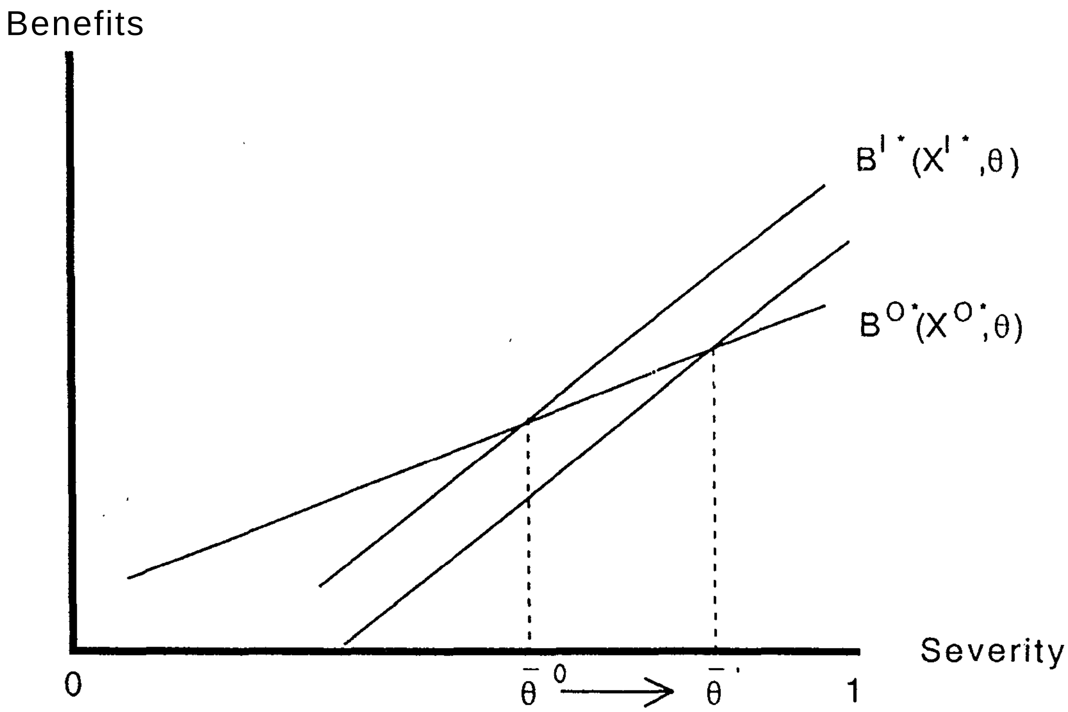
4.4. Comparative Statics

In this section, we examine how the hospital's investment decision changes in response to shifts in exogenous factors. We start with the effects of the implementation of PPS.

4.4.1. Cost-Based Reimbursement to PPS for Inpatient Care. Under cost-based reimbursement, the hospital's reimbursement depends in part on the services it provides. Thus $R^I_X > 0$. Under PPS, however, the hospital receives a fixed reimbursement per case, independent of the services provided, so that $R^I_X = 0$. Examining the choice of inpatient services in (4.4), we see that X^{I*}, and therefore β^{I*}, falls at every level of severity (Figure 2). Outpatient demand expands from $\bar{\theta}^0$ to $\bar{\theta}'$ because PPS gives hospitals incentives to provide fewer services to inpatients.

Figure 2

A Switch from Cost-Based Reimbursement to PPS



How does this affect outpatient capacity? It depends on whether the hospital's outpatient capacity is initially constrained by demand and what happens to reimbursement. In the spirit of PPS, we assume that the PPS reimbursement level, $\bar{R}$, is set at the average inpatient reimbursement level[7] prior to PPS. This implies that

$$\bar{R} = \int_{K^O}^{1} R^I(X^I(\theta))f(\theta)d\theta, \tag{4.8}$$

where K^O is the pre-PPS level of outpatient capacity. As long as $R_x > 0$ under cost-based reimbursement, $\bar{R}$ exceeds $R^I(X^I(K^O),K^O)$, the marginal inpatient cost-based reimbursement. Therefore, treating the marginal inpatient becomes more profitable under PPS, since this patient has lower severity than other inpatients. Looking at the hospital's initial capacity, if $K^* = 0$ or $K^* < \bar{\theta}^O$, increasing effective patient demand has no effect on outpatient capacity because it was not profitable to expand before when inpatients were less profitable. If anything, the hospital would like to transfer low severity--. patients from outpatient to inpatient locations, since low severity patients are the most profitable under PPS.

If $K^O = \bar{\theta}$, so that the hospital is initially capacity constrained, the implementation of PPS produces ambiguous results. On the one hand, outpatient demand rises, loosening the demand constraint. On the other hand, the inpatient profit from treating the formerly marginal patient rises discontinuously, making inpatient care more attractive. A necessary and sufficient condition for increasing outpatient capacity is that

$$[R^O(X^O(K^O),K^O - C^O(X^O(K^O),K^O)] - [\bar{R} - C^I(X^{IP}(K^O),K^O)] - d > 0,$$

[7]This assumes that cost-based reimbursement set reimbursement equal to costs.

where X^{IP} is the new, lower level of services which will be provided to a formerly marginal patient under PPS. Otherwise capacity will not change (if outpatient capacity cannot be removed) or fall.

This result highlights an important aspect of the implementation of PPS: while PPS increased the effective demand for outpatient services by reducing the amount of services provided to inpatients, it also gave hospitals the incentive to try to switch low severity patients from outpatient'to inpatient status. This incentive was expected to increase inpatient admissions. However, admissions actually dropped dramatically between 1983 and 1984 and outpatient surgeries apparently rose (Russell, 1989). In the simple model presented so far, this result could only happen in the demand-constrained case with $K^0 = \bar{\theta}$. In a moment, we will consider the role of utilization review.

4.4.2. Competition Between Hospitals. Until now, we have assumed the market is served by a single monopolistic hospital. Competition between hospitals can also explain the observed decrease in inpatient admissions and apparent increase in outpatient care. If other hospitals do not invest in outpatient capacity, a hospital that invests will capture previously unsatisfied outpatient demand from all hospitals, while only losing a fraction of its own inpatients. Once one hospital has invested in ambulatory capacity (or even in the presence of such a threat), other hospitals will have an incentive to invest since some of their inpatients would be lost completely otherwise.

A monopoly hospital may also face competition from a free-standing ambulatory surgery center (ASC). Given effective outpatient demand in the community of F(6), the ASC's problem is

$$\max_{K} \pi^{ASC} = \int_0^K [R(X(\theta),\theta) - C(X(\theta),\theta)]f(\theta)d\theta - dK$$

$$\text{s.t. } K \leq \bar{\theta}. \qquad (4.9)^{8}$$

The difference between this equation and the hospital's decision in (4.7) is that the ASC does not have to worry about cannibalizing itself, since it steals from the hospital's inpatient patients: Consequently, ASCs will be more likely to invest in outpatient capacity than hospitals. However, either entry or the threat of entry by ASCs may prompt hospitals to invest in outpatient capacity.

These results suggest that competition from other hospitals and ASCs spurred hospitals to invest in outpatient capacity when PPS increased outpatient demand, even though the net effect of such investment was to drain profitable low severity patients from inpatient to outpatient settings. For empirical work, the results imply that we will see greater utilization of outpatient care in areas with high levels of competition between hospitals.

4.4.3. Changes in Pavments within the PPS System. As we have shown, the regime switch from cost-based reimbursement to PPS broke the link between reimbursement and the amount of services provided to inpatients. This break lowered the services provided to inpatients, increasing the demand for outpatient services. Changes in reimbursement within PPS have no further effect on X^{I*} since R^I_X remains zero. Consequently, there will be no further changes in outpatient demand. However, K* will change since inpatient profit

'This formulation assumes that ASC's face the same reimbursement and costs as a hospital outpatient department. If they do not, the revenue and cost functions will change accordingly and the optimal levels of service and demand will have to be determined in the three-stage process used before. The new θ will equate the patient's benefits in the ASC with benefits as an inpatient in the hospital.

per patient changes. K* will rise if PPS reimbursement rises, and fall if PPS reimbursement falls.

4.4.4. Other Pavers. The previous analysis assumes that the hospital faces a single payer and type of reimbursement mechanism. In fact, hospitals face multiple payers using charge-based, cost-based, and prospective payment systems. The effect of any one payer's actions on the hospital depends. on the percentage of patients covered by the hospital, whether the payer's reimbursement system sets $R^I_X > 0$, the relative levels of reimbursement between inpatient and outpatient care and between payers, and whether the hospitals can provide different levels of care to patients covered by different providers. This suggests that Medicare policies will have greater effects on outpatient care in hospitals that treat a greater percentage of Medicare patients. There will be less investment in outpatient capacity in areas where there are many patients covered by cost-based or charge-based reimbursement. Commercial insurers have traditionally used such systems, which set $R^I_X > 0$.

4.4.5. HMO-run Hospitals. A special case occurs when an HMO runs a hospital. HMO reimbursement is fixed, whether the hospital provides care on an inpatient or an outpatient bases, making the hospital's problem

$$\text{Max } \pi^{HMO} = R^{HMO} - \int_0^K C^O(X^{HMO}(\theta),\theta)f(\theta)d\theta$$

$$+ \int_K^I C^I(X^I(\theta),\theta)f(\theta)d\theta - dk$$

$$\text{s.t. } K \leq F(\bar{\theta}). \tag{4.10}$$

The HMO will install ambulatory capacity so it can provide care in the lowest cost settings. HMO hospitals will invest more in outpatient care than other hospitals if the difference in the inpatient and outpatient costs for the marginal HMO patient is greater than the difference between inpatient and outpatient profits (which drives nonHMOs' decisions). We would expect similar results for hospitals treating a large number of HMO patients.

4.4.6. Utilization Review. Utilization review such as pre-admission certification and retrospective claims review can also cause shifts between inpatient and outpatient settings.. One of the major efforts of utilization review is to ensure that patients receive care in outpatient settings whenever that reduces costs without substantially lowering patient benefits. Utilization review can affect a hospital's decision to invest in outpatient care by refusing to reimburse hospitals for inpatient care when outpatient care is more benefiial.[9] The hospital no longer has to worry about cannibalizing its inpatients, since reimbursement would be denied for any inpatients with severity less than $\bar{\theta}$.

Both Medicare and nonMedicare payers use utilization review. Russell (1989) attributes much of Medicare's dramatic shift in minor surgery from inpatient to ambulatory surgery between 1983 and 1984 on the creation of Peer Review Organizations (PROs) that accompanied PPS, rather than the direct effects of PPS. There is some question on the timing of this effect, since contracts for PROs were not signed until 1984. Comparing hospitals with different Medicare percentages provides a test to determine whether the direct effects of PPS (through increased outpatient demand and competition for that demand) or utilization review caused the shift in ambulatory surgery. If the direct effects dominated, the shift should have been more pronounced in hospitals with high Medicare percentages, while the shift would be more uniform if it was caused by utilization review assuming that Medicare and

---

'This assumes that the review selects the optimal site of care to maximize patient benefits, as does the physician in the demand stage of the model. Of course, utilization review might be even more aggressive.

other insurers used similar amounts of utilization review. Data to check the latter assumption may be difficult to find, however.

4.4.7. Changes in Patient Copayment for Outpatient Care. Medicare beneficiaries generally pay 20 percent coinsurance for outpatient services. To encourage ambulatory surgery, Congress waived the coinsurance requirement when it approved facility changes for. freestanding ambulatory surgery centers in 1982. This waiver had three effects on our model, all of which tended to increase outpatient and ambulatory demand. First, reduced coinsurance directly increased patient benefits from outpatient care, since patients no longer made out-of-pocket payments. Second, the change probably increased R_x^o since the hospital no longer faced the risky prospect of collecting the patient's share of the bill. Together these effects increased the amount of services ordered for outpatients. Thus outpatient benefits rose, increasing outpatient demand. Finally, to the extent that the additional Medicare payment replaced the fraction of coinsurance which could not be collected from patients, the change increased the hospital's marginal profit from outpatients, giving hospitals a further incentive to increase K*. Conversely, when copayment for ambulatory surgery was restored in 1987, outpatient demand and capacity probably fell, although utilization review might have prevented major shifts back from outpatient to inpatient care.

4.4.8. Technological Advances in Outpatient Care. Technological advances which make outpatient care more convenient or less painful will increase outpatient benefits and therefore outpatient demand. Aside from monetary costs, outpatient care's main advantage over inpatient care is its relative convenience and lower psychic costs. This advantage has increased during the last decade with the introduction of safer and more localized anesthesiology and more precise, but less invasive, diagnostic and surgical equipment. Moreover, such advances can increase the total number of procedures which can be performed. In the model, we have implicitly assumed that β^{O*} and β^{I*} exceed 0 for all levels of θ. This need not be the case. If both benefit curves are less than zero, patients will not receive care. However, advances which make the care more convenient will shift up the outpatient benefit curve, leading to the delivery of care to a new set of relatively low severity patients (Figure 3).

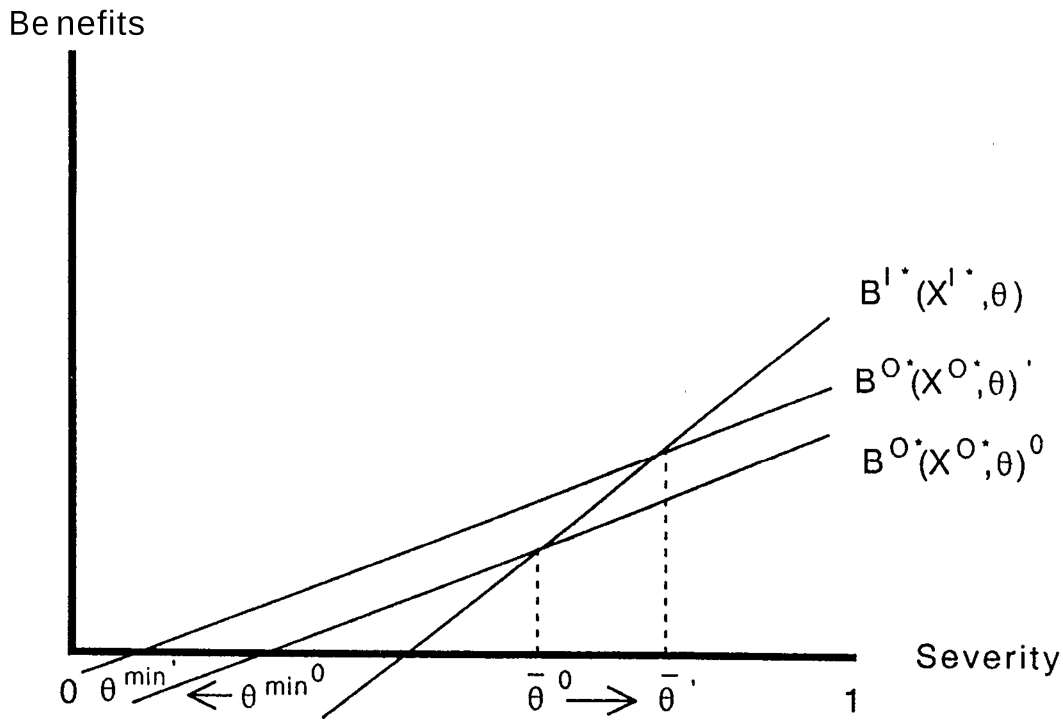
4.4.9. Fixed Costs. Although the fixed costs of outpatient capacity (F) have no effect on the demand- for outpatient services, since X^{O*} is only affected by the marginal cost of outpatient services, they clearly influence hospital investment in ambulatory capacity (Equation (4.7)). As intuition suggests, higher fixed costs lower ambulatory investment. Two factors which lower fixed costs are especially relevant to Medicare. First, cost-based reimbursement and Medicare capital passthroughs incorporate the cost of capital into reimbursement. Second, hospitals with high inpatient vacancy rates also face low fixed costs because it is relatively inexpensive to convert excess inpatient capacity into outpatient capacity, particularly if the same operating room or piece of diagnostic equipment can be used to treat both inpatients and outpatients. Therefore, outpatient capacity is probably greater in hospitals that have (or, prior to conversion, had) high inpatient vacancy rates.

4.4.10. Changes in Inpatient Severity.

4.4.10.1. Within a Procedure or Diagnosis. Whether PPS leads to higher inpatient severity within a procedure or diagnosis depends on whether the hospital is a monopoly and is initially capacity-constrained, or whether the

Figure 3

Technological Advances that Increase Outpatient Demand



hospital is initially demand-constrained or faces competition. In the latter cases, capacity will expand to satisfy increases in outpatient demand. Inpatient severity will rise as marginal low-severity cases are shifted to outpatient settings;- In the former case, the hospital will not want to expand its capacity, so patient severity will stay the same or, if the hospital can restrict outpatient capacity, fall.

4.4.10.2. Across Procedures or Diagnoses. Testing for changes in the severity of illness within a diagnosis is difficult. Using the Medicare casemix index to measure changes in severity across diagnoses is possible, however, and researchers have reported that they increased significantly following implementation of PPS (see Russell, 1989, for a summary). Although our model examines severity within a single procedure, it can be used to explain the overall increase in inpatient "severity."" Recall from the model that corner solutions are possible in which either all inpatient or all outpatient services are pravided for a given procedure. It is probable that procedures which are always performed in inpatient settings also have relatively high length of stays, and, therefore, high Medicare casemix numbers. Although the switch from cost-based to PPS reimbursement will reduce the amount of services provided to inpatients for these procedures," services may not fall far enough to create positive outpatient demand. Procedures initially performed on both inpatients and outpatients will generally have' lower casemix indices. If increases in outpatient demand for these procedures

---

[10]The Medicare casemix actually measures resource utilization, not the patient's degrees of sickness which θ, our severity index, is designed to represent.

"Length of stay decreased for most DRGs following the introduction of PPS .

lead to expansion of outpatient capacity, the average **casemix** index will rise since procedures with lower than average **casemix** numbers shift to outpatient settings.

CHAPTER 5: TECHNOLOGY IMPROVEMENT AND THE YIELD FROM DIAGNOSTIC TESTING

In this chapter, we outline a conceptual model, based on the work of Phelps and Mushlin (1988), which formalizes and clarifies some of the issues raised by Klawanski and Gaumer (1990) in their paper on the yield from diagnostic testing. Unlike- Klawanski and Gaumer, we define two measures of' yield. We show that the socially optimal level of testing rises as the cost of testing falls, causing the total yield, defined as total treatments divided by total tests, to fall. However, the optimal level of treatment may rise or fall as more tests are performed. Extensions of the model produce three other results with important policy implications. First, moving diagnostic testing from inpatient to outpatient settings increases the optimal level of testing and lowers the total yield. Second, higher reimbursement levels will increase testing and treatments. Finally, if diagnostic testing can identify low severity patients who would not receive inpatient therapeutic treatment in the absence of the test, the shift from cost-based reimbursement to PPS will increase the frequency of diagnostic testing because the profits from treating low severity patients are higher under PPS.

5.1. Optimal Testing and Treatment

Klawanski and Gaumer (1990) define the yield from diagnostic testing as the number of therapeutic procedures associated with the test divided by the number of diagnostic tests. To examine this issue, we first model treatment behavior when there is no diagnostic test. In keeping with our discussion in the previous model, we allow patients to differ by the variable ρ_i, which is distributed between 0 and 1 according to f(p). Here, ρ represents the probability that the patient has an illness, as well as the extent of the patient's symptoms of illness. That is, patients exhibiting many symptoms are more likely to be sick.[1] We again normalize the number of patients to 1. Patients who actually are sick and undergo a therapeutic treatment receive the positive benefit B_S (relative to no treatment).. Patients who are healthy and undergo treatment receive benefit $-B_H$, which is negative because of the treatment's risks and side effects. The cost of the therapeutic treatment is C^T. The net expected benefit from treatment is

$$\rho[B_S - C^T] + [1 - \rho][-B_H - C^T] \tag{5.1}$$

and clearly increases with the patient's symptoms ρ.

To maximize expected benefits, the physician will choose a symptom threshold that sets (1) to zero, and treat all patients with symptoms greater than the threshold. The threshold is

$$\bar{\rho} = \frac{B_H + C^T}{B_S + B_H}$$

which is less than 1 if $C^T < B_S$.[2] The threshold rises with the cost of treatment and the magnitude of disutility from treatment when healthy, and falls as the benefits from treatment when sick rise, as intuition suggests. The number of patients treated is 1 - F(p). Note that some patients who are treated are not really sick, while others who are not treated could benefit from the therapeutic procedure. A diagnostic test will benefit both sets of patients.

[1]This specification implies a perfect correlation between symptoms and the probability of illness. All that is necessary is a positive correlation.

[2]B_H is defined to be positive.

Now suppose that a diagnostic test is invented. We assume that the test, which has cost C^D, has perfect accuracy.[3] The test will produce two thresholds. The first, or testing, threshold is the level of ρ where the benefits from testing just equal the benefits of not testing. Since healthy patients who receive the test will not be treated, $-B_H$ now equals zero, so the testing threshold $\rho*$ solves $\rho*[B_S - C^T] - C^D = 0$ or

$$\rho* = \frac{C^D}{B_S - C^T} \tag{5.2}$$

The upper, or treating, threshold is the point where patients are just indifferent between being tested and receiving treatment if the test is positive and being treated without receiving testing. As this point $\rho[B_S - C^T] - C^D = \rho[B_S - C^T] - [1 - \rho][B_H + C]$. Calling the solution $\rho**$, we get

$$\rho** = \frac{B_H + C^T - C^D}{B_H + C^T} \tag{5.3}$$

In order for testing to occur, we must have $\rho** > \rho*$. If so, the number of diagnostic tests equals $D = F(\rho**) - F(\rho*)$, while the number of therapeutic treatments is

$$T = \int_{\rho*}^{\rho**} \rho f(\rho)d\rho + [1 - F(\rho**)]. \tag{5.4}$$

The first term in (5.4) measures the expected number of treatments received by patients who receive tests, while the second term is the number of patients whose symptoms are so strong that they receive treatment without testing. The

[3] Phelps and Mushlin (1988) discuss the choice of testing when the test's sensitivity (probability of true positive if sick) and specificity (probability of true negative if healthy) are not perfect.

yield from diagnostic testing can be defined in two ways. The actual yield from diagnostic testing, Y^D, is the number of patients receiving treatment after undergoing the test. The total yield, Y^T, includes all patients who receive the treatment, even if they did not receive the diagnostic test. Thus,

$$Y^D = \frac{\int_{\rho*}^{\rho**} \rho f(\rho)d\rho}{F(\rho**) - F(\rho*)} \tag{5.5}$$

and

$$Y^T = \frac{\int_{\rho*}^{\rho**} \rho f(\rho)d\rho}{F(\rho**) - F(\rho*)} + \frac{[1-F(\rho**)]}{F(\rho**) - F(\rho*)} \tag{5.6}$$

5.2. Comparative Statics

We can model process innovations in diagnostic testing as decreases in the cost of testing. The cost decrease may result from either a decrease in monetary costs or a decrease in nonmonetary cost of diagnosis, such as a shorter or less painful test. Performing comparative statics yields:

$$\frac{\partial\rho**}{\partial C^D} = \frac{-1}{B_H + C^T} < 0 \tag{5.7a}$$

$$\frac{\partial\rho*}{\partial C^D} = \frac{1}{B_S - C^T} > 0 \tag{5.7b}$$

$$\frac{\partial D}{\partial C^D} = f(\rho**)\frac{\partial\rho**}{\partial C^D} - f(\rho*)\frac{\partial\rho*}{\partial C^D} < 0 \tag{5.8}$$

$$\frac{\partial T}{\partial C^D} = -[1 - \rho**]f(\rho**)\frac{\partial\rho**}{\partial C^D} - \rho*f(\rho*)\frac{\partial\rho*}{\partial C^D} \qquad \text{-- ambiguous sign} \tag{5.9}$$

$$\frac{\partial Y^D}{\partial C^D} = \frac{1}{D^2}\Big\{ [\rho^{**}D - \int_{\rho^*}^{\rho^{**}} \rho f(\rho)d\rho]f(\rho^{**})\frac{\partial\rho^{**}}{\partial C^D}$$

$$- [\rho^*D - \int_{\rho^*}^{\rho^{**}} \rho f(\rho)d\rho]f(\rho^*)\frac{\partial\rho^*}{\partial C^D}\Big\} \quad - \text{ ambiguous sign} \tag{5.10}$$

$$\frac{\partial Y^T}{\partial C^D} = \frac{1}{D^2}\Big\{ [-[1-\rho^{**}]D - \int_{\rho^*}^{\rho^{**}} \rho f(\rho)d\rho \; - [1-F(\rho^{**})]\,]f(\rho^{**})\frac{\partial\rho^{**}}{\partial C^D}$$

$$+ \left\{\int_{\rho^*}^{\rho^{**}} \rho f(\rho)d\rho - \rho^*D + [1 - F(\rho^{**})]\right\} f(\rho^*)\frac{\partial\rho^*}{\partial C^D}\Big\} > 0. \tag{5.11}$$

Recalling that technological advance causes C^D to fall, the comparative statics show that advances cause the testing threshold to fall and the treatment threshold to rise. Indeed, as C^D approaches 0, ρ^* approaches 0 and ρ^{**} approaches 1; all patients will receive a costless, perfect diagnosis. The result in (5.8) is equally intuitive: diagnostic testing increases when tests become less expensive. The ambiguous result for treatments is less obvious. The first term in (5.9) measures how treatments are affected by an increase in the treatment threshold. For an increase in the treatment threshold, the number of treatments fall, since all patients above the threshold receive treatment, while only a fraction of the patients below the threshold receive treatment. Since

$$\frac{\partial\rho^{**}}{\partial C^D} < 0,$$

the entire first term is positive. The second term shows how treatments are affected by an increase in the testing threshold. Such an increase causes the number of treatments to fall, since patients below the threshold are no longer tested and therefore never treated. Since

$$\frac{\partial \rho}{\partial C^D} > 0,$$

the entire second term is negative. The entire term is ambiguous without further information on the distribution of symptoms. If $f(\rho^{**})$ is high, the first term will dominate, meaning that a technology change lowering C^D will actually cause treatments to fall. Otherwise, treatments will rise as testing technology rises.

The change in actual yield is ambiguous for the same reasons that the change in treatments is. The total yield falls when C^D falls, however. Y^T has an unambiguous sign because an increase in ρ^{**} lowers the number of treatments provided without testing more than enough to offset the partial increase in treatments after testing caused by increasing ρ^{**}.

Other comparative statics can be derived in similar fashion (Table 1). A process innovation which lowers the cost of treatment causes both the testing and the treating thresholds to fall. This causes treatments to rise and actual yields to fall, but has ambiguous effects on testing and total yields. A product innovation which increases the quality of treatment can either increase the benefits to sick patients (B, rises) or decrease the side-effects to healthy patients (B_H falls). The two types of innovation actually have different effects because they affect ρ^* and ρ^{**} differently. Increases in B_S have no effect on the treatment threshold because patients at this margin either receive tests and the treatment if necessary or the treatment without the test. Higher B_S does make patients at B_S better off. Conversely, innovations in B_H have no effect on patients at the testing threshold, but they do make patients who receive treatment without testing better off. Since only one of the thresholds changes when the product innovation occurs,

Table 1. The Yield from Testing: Comparative Statics

	c^D	c^T	B_S	B_H
ρ^*	+	+		0
ρ^{**}		+	0	+
D		Ambig.	+	+
T	Ambig.		+	
Y^D	Ambig.	+		+
Y^T	+	Ambig.		
Costs	Ambig.	Ambig.	+	Ambig.

comparative statics for the other variables can be signed. Both types of product innovations increase treatment and lower actual yields. Innovations in B_S increase testing and lower total yields, while innovations in B_H have opposite effects.

5.3. Costs

The total costs of diagnosing and treating the illness will equal. $C^D D + C^T T$. Because of ambiguous or opposite effects on D and T, most of the exogenous variables have ambiguous effects on costs. An exception is B_S; product innovations which increase B_S cause both tests and treatments to rise, increasing costs.[4]

5.4. Discussion

This analysis produces several insights about the yield from diagnostic testing. First, it is not necessary that more testing will lead to more treatments. Testing may allow the physician to better distinguish between patients with many symptoms who do or do not require treatment. On the other hand, if the main effect of testing is to identify new candidates for treatment (because the testing threshold falls), treatment and overall costs will rise. Second, there are two ways to measure test yields. The actual yield is based purely on patients who are tested, while the total yield is based on all patients. The two measures will differ if it is optimal to treat some high symptom patients without testing. Data which link a patient's diagnostic test to his or her therapeutic treatment are necessary to calculate the actual

---

[4]With a single period model it is impossible to capture the dynamic effects of diagnosing and treating an illness at an earlier, less severe stage. In a dynamic model, better diagnosis might lead to an initial increase in costs, but lower the costs in the long-run since more severe and costly illnesses are prevented. On the other hand, if more severe cases are incurable (i.e., deadly heart attacks), early detection will increase costs unambiguously.

yield, while unlinked data which simply aggregate all tests and all treatments are sufficient to calculate the total yield. Finally, neither type of yield should be confused with measures of efficiency. The optimal levels of testing and treatments derived here are efficient in that they ma-ximize patients' net benefits. These efficient levels change as the exogenous cost and benefit parameters change. As a result, efficient yields may fall as well.

5.5. Extensions

5.5.1. Outpatient Testing. Many diagnostic tests, including cardiac catheterization, CAT scan, and magnetic resonance imaging, are now being performed on an outpatient basis. Relative to inpatient testing, outpatient testing probably lowers C^D by making testing more convenient. Consequently, movements to outpatient testing should increase the number of tests and lower the total yield. The actual yield and number of treatments may also rise. Treatment in freestanding ambulatory centers may have even lower costs than testing in hospital outpatient departments or testing as an outpatient in hospital inpatient departments because the centers can be designed with more convenient parking, more comfortable facilities, and a less intimidating environment.

5.5.2. Reimbursement. So far, the model assumes that testing and treatment are chosen to maximize net patient benefits. Nothing has been said about reimbursement. If physicians maximize net patient benefits, the inclusion of reimbursement will not change the analysis. If physician's maximize patient benefits plus profits, the preceding equations can be modified by replacing $-C^T$ with $p^T - C^T$ and $-C^D$ with $p^D - C^D$, where p^T and p^D are the reimbursement for performing tests and treatments. This modification will increase treatments and lower the testing threshold.[5] In fact, if the margin on testing, $p^O - C^O$, exceeds 0, ρ^* will equal 0 and all patients will either be tested or treated without testing. Recall, however, that C^O includes the patient's nonmonetary costs from testing as well as the test's monetary costs.

5.5.3. Severity. Until now, the model has assumed that all patients with the illness have the same severity. This implies that all patients receive the same benefits and the same amounts of treatment. Differences in severity can be introduced by letting ρ represent severity, as well as symptoms and probability of disease.[6] As in the substitution model, higher severity patients will use more services in-treatment than low severity patients. Combined with PPS, asymmetric utilization produces stronger incentives for diagnostic testing. With PPS reimbursement rates initially set to cover the costs of an average severity case, hospitals have an incentive to install diagnostic equipment that identifies additional low severity candidates for treatment. Therefore, installation of diagnostic testing, especially on an outpatient basis, may produce lower average severity levels within DRGs. Note that the incentive to reap low severity patients was not as strong under cost-based reimbursement because reimbursement for a patient rose and fell with the patient's utilization of services.

---

[5]In the table of comparative statics, p^O will have the opposite effect of C^O, and p^T will have the opposite effect of C^T.

[6]This probably loads too many characteristics onto a single parameter, but the results should hold if there are positive correlations between severity, symptoms, and probability of illness.

CHAPTER 6. HOSPITAL INVESTMENT IN AMBULATORY DIAGNOSTIC TESTING

In this chapter, we model a hospital's decision to invest in ambulatory diagnostic testing equipment. This model captures three essential characteristics of the relationship between ambulatory and inpatient care.

First, the diagnostic test complements inpatient therapeutic care; performing more diagnostic tests produces more inpatient episodes. In the previous chapter, we noted that diagnostic testing can actually reduce therapeutic treatments. Here, however, we assume that the ability of testing to identify new candidates for treatment dominates its ability to identify patients with high symptoms, but no need for testing. We focus on the incremental treatments produced by testing. Thus, testing itself may be viewed as an investment that sometimes yields inpatient care.

Second, the diagnostic equipment and facility is a workshop for the physician in the sense that testing is necessary to identify candidates for additional physician services.[1] While the testing workshop complements physician services, substitution between physician-owned and hospital-owned workshops is possible. Thus, hospital diagnostic testing facilities may compete with testing done in physician's offices or in physician-owned diagnostic testing centers.

Finally, the physician controls where his or her patients receive their diagnostic tests. This provides advantages for physicians investing in diagnostic testing and heightens competition between hospitals. Both factors will be considered within the hospital's investment decision.

To better illustrate the model's insights, we first show the investment decision by a monopoly hospital when physicians cannot invest in the diagnos-

[1]The workshop terminology comes from Pauly, (1980).

tic equipment. We next examine a single physician's investment decision in the absence of a hospital, before allowing competition between the physician and hospital. We then introduce complications such as physician demand inducement, marketing, and competition between hospitals.

6.1. The Hospital's Decision in the Absence of Physician Comnetition

Let p^H and c^H be the hospital's reimbursement and constant marginal cost from the diagnostic test, π^{HI} be the hospital's (marginal) profit from related inpatient services, and ID be the fraction of patients receiving the diagnostic tests who then undergo inpatient therapeutic treatment.[2] Q^{TOT} is the total demand for outpatient testing if diagnostic equipment is present and F^H is the hospital's fixed investment cost. The hospital should invest if:

$$\{[p^H - c''] + [\pi^{HI} - c^{HI}]ID\}Q^{TOT} \geq F^H. \tag{6.1}$$

The equation contains few surprises; the probability of investment increases with p^H, π^{HI}, ID, and Q^{TOT}, and falls with c^H and F". The equation's main insight is the interrelationship between diagnostic tests and inpatient care. Because the two are complements, investment is more likely to occur if inpatients treatments are profitable. Indeed, if inpatient care is profitable, the hospital could invest in outpatient testing even though it loses money on the testing itself. Recall also from the last chapter that testing may uncover low severity patients who may be treated profitably as inpatients under PPS. Consequently, PPS may encourage investment in diagnostic equipment.

[2]The fraction is measured incrementally relative to the number of patients receiving treatment in the absence of the test.

6.2. The Physician's Decision in the Absence of Hospital Outpatient Testing:

6.2.1. No Inducement. We first assume that the physician has no power to induce patient demand. Physician j's patient base is Q_j, D is the fraction of patients receiving the test, p^P and c^P are the reimbursement for physician services for the test and the resulting inpatient services, p^F and c^F are the reimbursement and costs for the physician's diagnostic facility, and F^P is the fixed cost of the facility. The physician will invest if

$$\{[p^P - c^P] + [p^F - c^F]\}DQ_j \geq F^P. \tag{6.2}$$

As in the previous section, there are no surprises here.

6.2.2. Physician Inducement. Physician behavior may change if the physician owns and profits from diagnostic testing equipnient. Many observers worry that physicians owning testing equipment will order more tests than they otherwise would (Iglehart, 1989). To consider that possibility, let D(I), the percentage of patients demanding tests, increase with physician inducement activities, I. Inducement is not costless; physicians feel bad about demand inducement and must be compensated for its disutility. We incorporate inducement and its costs, C(I), within the physician's profit function[3] as

$$A = \{[(p^P - c^P) + (p^F - c^F)]D(I) - C(I)\}Q_j - F^P. \tag{6.3}$$

[3]Because our emphasis is on investment in testing equipment, we provide only an incomplete specification of demand inducement in the physician's objective function. Our specification captures the idea in most formal models of demand inducement that physicians feel bad about demand inducement. Unlike our specification, these costs are usually embedded within a physician utility function. That formulation introduces the possibility that an increase in income or reimbursement would cause inducement to fall or, conversely, that a cut in reimbursement would increase demand inducement (See McGuire and Pauly, 1991). Our specification guarantees that an increase in reimbursement will lead to more demand inducement. This seems to be the major worry of policy-makers concerned with physician ownership of testing facilities.

Maximizing the first-order condition,

$$\frac{\partial \pi}{\partial I} = \{[(p^P - c^P) + (p^F - c^F)]D_I - C_I\}Q_j = 0 \qquad (6.4)$$

determines the optimal level of demand inducement, I*.[4] The physician will invest if $\pi(I^*) \geq 0$. The main insight from this model is that the possibility of inducement will increase physician investment in ambulatory testing. Factors that encourage inducement such as low coinsurance rates, more convenient facilities, and less invasive or uncomfortable tests, will further increase physician investment.

6.3. Hospital and Physician Inducement

Now suppose that a hospital and M physicians are considering investment in ambulatory testing, and the physicians do not induce demand. We assume that the hospital first announces whether it will invest in the testing equipment. Each physician then decides whether he will invest in the testing equipment in his office. In making its decision, the hospital will anticipate how many physicians will subsequently invest if it invests. The physician's adoption decisions will determine the hospital's demand, since physicians who invest will send patients to their own facilities. The hospital will also consider how many physicians will invest if the hospital does not provide testing. This number will determine how many inpatients the hospital receives.

To provide more structure to the analysis, let q_j be the fixed number of patients seeing physician j. The probability that a physician has q_j patients is given by $f(q_j)$ where $0 \leq q_j \leq q^{max}$. The physician knows his or her q_j but the hospital does not; however, the hospital knows f(q,).

[4]We assume that $D_{II} < 0$ and $C_{II} > 0$.

If the hospital invests in the testing equipment, the physician's choice between investing and not investing is made by comparing

$$[p^P - c^P]Dq_j \text{ to } [p^P - c^P]Dq_j + [p^{PF} - c^{PF}]Dq_j - F^P. \tag{6.5}$$

The physician will invest if the second term is larger or, equivalently, if

$$q_j \geq \frac{F^P}{p[p^{PF} - c^{PF}]} \equiv Q^*. \tag{6.6}$$

Physicians with practices large enough that $q_j \geq Q^*$ will invest in the testing equipment, no matter what the hospital does; they find it profitable to operate their own workshop.

If the hospital does not invest in the testing equipment, a physician will invest if

$$\{[p^P - c^P] + [p^{PF} - c^{PF}]\}Dq_j - F^P \geq 0 \tag{6.7}$$

or, equivalently, if

$$q_j \geq \frac{F^P}{D\{[p^P - C'] + [p^{PF} - c^{PF}]\}} \equiv Q^{**} \tag{6.8}$$

This decision reflects the idea that if the hospital does not provide a workshop for diagnostic testing, the physician has nowhere to work unless he or she provides a workshop. If the marginal profit from performing the test (plus follow-up treatments), $p^P - c^P$, exceeds zero then $Q^{**} < Q^*$, meaning that more physicians will invest in testing if the hospital does not invest. Summarizing, physicians never invest if $q_j < Q^{**}$, invest if the hospital does not invest if $Q^{**} \leq q_j < Q^*$, and always invest if $q_j \geq Q^*$.

Given the physician investment decision, the hospital will invest if

$$[p'' - c^H]Q^{TOT} + \pi^{HI}ID\ Q^{NO} - F^H \geq 0 \tag{6.9}$$

where Q^{TOT} is the total demand facing the hospital for tests if the hospital invests and Q^{NO} is the demand facing the hospital from physicians who do not invest if the hospital does not invest, ID Q^{NO} measures the incremental inpatient visits the hospital receives from investing in the testing equipment; Q^{NO} is less than Q^{TOT} because physicians with practices between Q** and Q* will invest, and therefore generate inpatient visits even if the hospital does not invest.[5] The two demand curves facing the hospital are

$$Q^{TOT} = MF(Q^*)D\frac{\int_0^{Q^*} qf(q)dq}{F(Q^*)} = MD\int_0^{Q^*} qf(q)dq \tag{6.10}$$

$$Q^{NO} = MF(Q^{**})D\frac{\int_0^{Q^{**}} qf(q)dq}{F(Q^{**})} = MD\int_0^{Q^{**}} qf(q)dq \tag{6.11}$$

Q^{TOT} equals the number of physicians, times the probability that the physician does not invest if the hospital invests, times the physician's expected patient base, given that the physician does not invest if the hospital invests. Q^{NO} has an analogous interpretation for physicians who never invest.

This analysis highlights the competition between physicians and a hospital to provide ambulatory testing. A hospital's investment decision will be affected by both its own costs and reimbursements and the costs and reimbursements facing physicians. Hospital investment is more likely when the fixed cost of providing a workshop is high (e.g., the hospital itself), then when the fixed cost of a workshop is low (e.g., a physician's office). Applying the model more specifically to testing equipment, hospitals are more likely to invest in expensive equipment like MRIs than physicians. However, policies which increase facility payments to physicians for diagnostic testing

---

[5] In addition, no matter what it does, the hospital-receives inpatients from the physician who always invests in testing.

equipment will erode the demand for tests facing the hospital. An increase in the reimbursement for physicians, p^P, will also lower the probability that the hospital invests by increasing the'number of physicians who invest if the hospital does not invest.

Physician investment depends on whether or not the hospital invests. While we can perform comparative statics on Q* and Q**, comparative statics per se on physician investment is difficult because the threshold for physician investment drops discontinuously from Q* to Q** if the hospital does not invest.

6.4. Hospital and Physician Decisions with Inducement

The physician's inducement problem will be affected by whether the physician installs testing equipment or uses testing equipment at the hospital. Let I^0 be the optimal level of inducement when the physician uses the hospital testing equipment and I' be the optimal level when the physician owns equipment. From (4) the physician-owner will induce more than the non-owner ($I' > I^0$) as long as $p^{PF} - c^{PF} > 0$. If the hospital invests, the physician will invest if

$$\{[(p^P - c^P) + (p^{PF} - c^{PF})]D(I') - C(I')\}q_j - F^P \geq$$

$$\{[p^P - c^P]D(I^0) - C(I^0)\}q_j \tag{6.12}$$

or, equivalently, if

$$q_j \geq \frac{K^P}{[p^P - c^P][D(I') - D(I^0)] + [p^{PF} - c^{PF}]D(I') - [C(I') - C(I^0)]} \tag{6.13}$$

As in the previous section, we call the right-hand side Q*. In a similar way, physicians will invest if the hospital does not invest if

$$q_j \geq \frac{K^P}{\{[p^P - c^P] + [p^{PF} - c^{PF}]\}D(I') - C(I')} \equiv Q^{**}. \tag{6.14}$$

Inducement increases the probability that physicians will invest in testing, even if the hospital invests.

The hospital's investment decision is still governed by (9), but Q^{TOT} and Q^{NO} change slightly to

$$Q^{TOT} = MD(I^{o})\int_{0}^{Q*} qf(q)dq \tag{6.15}$$

and

$$Q^{NO} = MD(I^{o})\int_{0}^{Q**} qf(q)dq. \tag{6.16}$$

These changes alter the effect of p^{P} and c^{P} on hospital investment, because the level of demand inducement (I^{o}) depends on these variables. Differentiating,

$$\frac{\partial Q^{TOT}}{\partial p^{P}} = M\frac{\partial D}{\partial I^{o}}\frac{\partial I^{o}}{\partial p^{P}}\int_{0}^{Q*} qf(q)dq + MD\ Q*f(Q*)\frac{\partial D*}{\partial p^{P}}. \tag{6.17}$$

On the one hand, physicians who still come to the hospital for testing induce more tests if their reimbursement rises, causing Q^{TOT} to rise (the first term). On the other hand, more physicians find it profitable to invest in the equipment, causing hospital demand to fall (the second term), The net result of p^{P} is ambiguous. The effects of p^{P} on Q^{NO} and of c^{P} on Q^{TOT} and Q^{NO} are ambiguous for analogous reasons.

6.5. Hospital Marketing

Until now, the hospital has competed passively with physicians for testing. The hospital builds its testing facility and hopes that physicians and patients come, or, equivalently, that the physician will not invest in testing capacity. In practice, however, a hospital may offer positive inducements to convince physicians to come to the hospital for testing. We call these efforts marketing because they may take a variety of forms including quality enhancements, nonmonetary inducements like free parking and office space within the hospital, or even monetary payoffs,. Let Z denote the hospital's marketing effort. The physician's per patient benefit is $\phi(Z)$, with $\phi_Z > 0$ and $\phi_{ZZ} \leq 0$, while c(Z) is the hospital's cost of marketing, with $c_Z > 0$ and $c_{ZZ} > 0$. We assume that physicians do not induce demand.

We assume that the hospital initially decides whether to invest in testing equipment and how much marketing to engage in if it invests. Given the hospital's decision to invest and provide Z, the physician will earn $D[p^P - c^P + \phi(Z)]q_j$ with no investment and $D\{[p^P - c^P] + [p^{PF} - c^{PF}]\}q_j - F$ if he or she invests. Consequently, the physician will invest if

$$q_j \geq \frac{F}{D[p^{PF} - c^{PF} - \phi(Z)]} \equiv Q^*(Z) \tag{6.18}$$

Note that Q* rises with Z: the more marketing the hospital does, the less likely are physicians to invest. Marketing does not affect Q**.

The hospital's problem will now be to choose Z to maximize

$$\{[p^H - c^H] + ID\pi^{HI}\}Q^{TOT}(Z) + [ID\pi^{HI}]Q^{NO} - c(Z) - F^H \tag{6.19}$$

where

$$Q^{TOT}(Z) = MD\int_0^{Q^*(Z)} qf(q)dq.$$

Let Z* solve this problem. To see if hospital investment occurs, we then insert Z* in (19) and evaluate whether hospital profits exceed 0.

Relative to no marketing, marketing increases the probability that the hospital will invest, and lowers the probability and extent of physician investment. Marketing represents a transfer from the hospital to physicians which is paid because physicians control where their patients receive treatment. Comparative statics for the other exogenous variables remain the same when marketing is introduced in the model.

6.6. Marketing with Competition Between Hospitals

Marketing becomes especially important when we introduce competition between hospitals into the model. In most markets, price competition allocates customers between firms. Price competition may not allocate Medicare patients for testing, however, because the patients pay low coinsurance rates and are referred by their physicians to testing sites. In this section, we assume that patients are allocated among N identical hospitals on the basis of each hospital's share of total marketing shares. Physicians receive per patient benefits that increase with Z, the total level of hospital marketing. We assume that each hospital chooses whether to invest and how much to market under the assumption that its actions have no effect on other hospitals' behavior.[1] For simplicity, physicians do not induce demand.

Given that at least one hospital invests, the physician compares his or her profits from not investing to the profits from investing. The profits from not investing are $D[p^P - c^P + \phi(Z)]q_j$, while the profits from investing are $D\{[p^P - c^P] + [p^{PF} - c^{PF}]\}q_j - F^P$. The physician will invest in testing equipment if

$$q_j \geq \frac{F^P}{D[p^{PF} - c^{PF} - \phi(Z)]} = Q*(Z). \tag{6.20}$$

This condition is identical to (18), so again

$$Q^{TOT}_{(Z)} = MD\int_0^{Q*(Z)} qf(q)dq.$$

[1]This produces a Nash equilibrium.

We assume that at least one hospital invests in testing equipment. This assumption eliminates Q** from the problem since that variable previously measured the threshold where physicians invested if a hospital did not invest.

Hospital i's problem is to choose Z_i, its level of marketing, to maximize

$$\pi_i^H = \frac{Z_i}{Z} Q^{TOT}(Z)[p^H - c^H + ID\pi^{HI}] - c(Z_i) - F \tag{6.21}$$

where

$$Z = \sum_{i=1}^{n} Z_i$$

and n is the number of hospitals in the market who invest.

The first order condition for the problem is

$$\left[\frac{(n-1)Z_i}{Z^2} Q^{TOT} + \frac{Z_i}{Z} Q_Z^{TOT}\right][p^H - c^H + ID\pi^{HI}] - C_{Zi} = 0 \tag{6.22}$$

The first term is the marginal revenue from marketing, while the second term is its marginal cost. Marketing has two effects on marginal revenue. The first term in the first set of brackets shows how marketing gives the hospital a bigger piece of the demand pie. The second term shows that a firm's marketing affects the overall size of the pie. Assuming a symmetric equilibrium among investing hospitals, (22) reduces to

$$\left[\frac{(n-1)}{Z_i} Q^{TOT} + \frac{1}{n} Q_Z^{TOT}\right][p^H - c^H + ID\pi^{HI}] - c_{Zi} = 0 \tag{6.23}$$

An additional complication arises because the number of hospitals investing in equilibrium is endogenous. To find the equilibrium, we first solve (23) to find the optimal level of marketing when n = 1. We repeat for n = 2, n = 3, and so on; denote the optimal marketing level as $Z_i^*(n)$ and the resulting profits as $\pi_i(Z_i^*(n))$. The equilibrium number of hospitals investing is n*, where either $\pi_i(Z_i^*(n)) \geq 0$ and $\pi_i(Z_i^*(n + 1)) < 0$ or all hospitals in the market invest.

It can be shown that an individual hospital's marketing falls as the number of hospitals investing increases., However, overall marketing ($Z = \sum Z_i$) rises. The increase in marketing-increases the overall demand facing hospitals because physicians are less likely to invest in testing capacity. Physicians are better off than they would be in the absence of marketing; it pays to have something hospitals want, namely patients Other factors affect hospital investment in predictable ways. Increases in hospital reimbursement for testing, the indirect demand for inpatient visits, the profit from inpatient visits, or the fixed or marginal costs of physician testing increase the probability of hospital investment, while increases in the hospital's fixed or marginal costs of testing or physician reimbursement lower the probability of hospital investment.

Inducement can easily be introduced into the market. Physicians will induce more demand when they benefit from marketing on a per patient visit. As in Section D, increases in p^p (or decreases in c^p) will have ambiguous effects on hospital investment.

CHAPTER 7: DATA BASES

7.1. Overview

This chapter describes data bases suitable for analyzing the issues identified in this research design report. We emphasize parts of the data bases most relevant to the issues addressed in this report, and the years 1980-1990. Several data bases come from states. We focus on data from three states: California, Florida, and Tennessee. Appropriate data are available from these states. Each state data base has strengths and weaknesses. Other states collect cost reports and discharge abstracts from hospitals and make such data available as public use tapes. The National Association of Health Data Organizations maintains a list of states that make such data available (Appendix B). Final choice of data sets will depend in part on which of the specific aims listed in Chapter 1 are pursued.

7.2. Medicare Cost Reports

Medicare Cost Reports are available for hospital fiscal years beginning in 1982 and ending in 1989; thus, there is only one pre-PPS year. MCRs are unique in providing national hospital-level data on revenue, Medicare and Medicaid shares and investment. The following revenue information is available: gross revenue (divided into inpatient and outpatient), net revenue, charges for specific ancillary services (unfortunately, not divided into inpatient vs. outpatient) and revenue from outpatient services rendered on an inpatient basis and vice versa (which will be useful in determining the extent to which hospitals are developing dedicated outpatient facilities). Medicare and Medicaid shares of inpatient days can also be computed. Using information on the capital costs of specific items (for example, diagnostic and therapeutic radiology, nuclear medicine, respiratory, physical and occupational therapies and outpatient clinics) we can compute some service-specific investments if several assumptions are made. MCRs also contain information on fixed assets; by differencing values for two adjacent years and subtracting depreciation, we can obtain an estimate of net investment.

7.3. American Hospital Association's Annual Survev of Hospitals

We have public use tapes going back to 1969, but for purposes of this study, we will only use information from 1980-90. Annual Surveys provide information on diffusion of specific technologies (Table 2). There is also a breakdown on surgical utilization, inpatient versus outpatient for all years. For 1980-81, there is information on output levels for open-heart surgery, cardiac catherization, CT scanning, megavoltage radiation therapy and physical therapy. There are data on capital expenditures from 1980-85: land, buildings and improvements, fixed and movable equipment (separate), and construction in progress, whether a CON approval was received during the year and the amount of the capital authorization. From 1980 on, there is information on whether the hospital had a contract with an HMO. Since 1984, hospitals were asked about contracts with PPOs.

7.4. Medicare Beneficiary-specific Data

Abt Associates (1989) has compiled a beneficiary-specific data base for 1981-86. The advantage of this data base is that it includes inpatient, outpatient, and physician charge data for beneficiaries, both before and after implementation of PPS. This data set is available

Table 2. Technologies Covered in AHA Surveys

Technology	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Cardiac Cath Lab	X	X	X	X	X	X	X	X	X	X
Open Heart Surgery	X	X	X	X	X	X	X	X	X	X
Chrnc Obstr Pulm Dis				X	X	X	X	X	X	X
ESW Lithotripter						X	X	X	X	X
Megavoltage Rad'n Th	X	X	X	X	X	X	X	X	X	X
Radioactive Implants	X	X	X	X	X	X	X	X	X	X
Therapeutic Radioisot	X	X	X	X	X	X	X	X	X	X
X-Ray Radioation Th	X	X	X	X	X	X	X	X	X	X
CT Scanner	X	X	X	X	X	X	X	X	X	X
Diag Radioisotope	X	X	X	X	X	X	X	X	X	X
Diagnostic X-Ray						X	X	X	X	X
MRI				X	X	X	X	X	X	X
Ultrasound		X	X	X	X	X	X	X	X	X
OP/Ambulatory Surg	X	X	X	X	X	X	X	X	X	X
Organ Transplant	X	X	X	X	X	X	X	X	X	X

through HCFA. The data's major limitation is that there are many missing values on specific outpatient and physician office procedures. This precludes using information on outpatient and physician office-provided services, such as on diagnostic procedures, and linking them to inpatient use for these years. However, one can examine, for a specific case type, (e.g., open heart surgery), whether reductions in inpatient diagnostic and therapeutic procedures after PPS was implemented resulted in higher spending for care in ambulatory locations.

For 1986 through 1990, HCFA can produce linked files for five percent of beneficiaries. This is not a public use tape, and we are requesting that HCFA make these data available to us for purposes of this project. The linked files combine HISKEW, Medpar, Outpatient, and BMAD data.

The HISKEW data contain information on the beneficiary: demographic information; other payment sources (Medicaid, Medigap); whether. person had Part B; and whether or not person died during the year. The Medpar data contain a record on each hospital discharge, including: diagnoses (five); procedures (three); length of stay; total and covered charges; DRG; and charges by hospital revenue center. There is a record of each outpatient visit. The following information on outpatient services received by the beneficiary is provided: demographic information; ZIP code of residence, diagnoses (five) and procedures (three); number of visits to clinics, emergency rooms; and charges for a number of cost centers; other sources of payment (Medicaid, Medigap). Information on physician-provided care on BMAD is based on individual bills. Therefore, there is information on every procedure billed, and aside from the procedure code, there are data on type of service, specialty of provider, place of service, and charges submitted and allowed.

7.5, California Data

California is a good state for research purposes because there are cost reports for the -entire period, 1980-90, and discharge abstracts for 1983-90. There have been no major changes in the instrument since 1986. Before then, the report was slightly less detailed.

We focus here on items not publically available from national sources which are on the 1986+ instrument. For both total and for ambulatory surgery, there is'information on the number of operating minutes as well as numbers of procedures. Data are provided on the numbers of cardiac caths and open heart surgeries, numbers of diagnostic and therapeutic radiology and nuclear medicine RVS units, number of CT procedures, and physical, occupational, and inhalation therapy treatments by payment source (Medicare, Medi-Cal, and other) and location (inpatient-outpatient). Revenue information is provided by payment source and location for the hospital as a whole and for the services just listed. There is detailed balance sheet information on original cost of land, buildings, leasehold improvements, equipment, accumulated depreciation on plant and equipment, and construction in progress. Contractual arrangements with payers (such as PPOs and HMOs) and number of patient days and outpatient visits supplied to each are given. It is possible to derive the private insured patient share from data on patients days and discharges provided publically insured and no-pay patients.

California discharge abstracts contain information on hospital ID, age, sex, race, ZIP code of patient residence, length of stay, admission date, five diagnoses, five procedures, disposition of patient, source of payment (Medicare, Medi-Cal, Workers' compensation, Title V, other government, Blue Cross-Blue Shield, commercial insurer, HMO-PPO, self-pay, no charge, other no pay), total charges, and DRG.

7.6. Florida Data

Florida has the advantage of being a large state with a high Medicare share, numerous distinct markets, and cost reports dating to before 1980. While discharge abstract information is only available since 1988, Florida began to collect ambulatory surgery abstracts from hospitals and freestanding clinics in the fourth quarter of 1990. Although the state plans to release the ambulatory surgery data to the public, release is being held up, at least temporarily, by a lawsuit filed by providers against the state.

Hospital cost reports contain information on inpatient versus outpatient revenue and total units for surgery, diagnostic radiology, therapeutic radiology, nuclear medicine, CT, MRI, respiratory and physical therapy, cardiac cath, open heart surgery (units only), and lithotripsy. Inpatient days and admissions are disaggregated by self-pay, Medicare, Medicare-HMO, other government, insurance charge-based, other charge-based, commercial HMO-PPO, and other discounted. Contracts with HMOs and PPOs are identified and specific payment arrangements with each payer are described (per diem, discount from charges, per admission, capitation, per diagnosis or DRG, per service, per product, other). Balance sheet information is provided on land, buildings, fixed equipment, leasehold improvements, movable equipment, and construction in progress by balance beginning of period, capital acquisitions and disposals, accumulated depreciation, and depreciation expense during the year. Detailed capital expenditure information is provided for amounts above $250,000 or 1.5 percent of net plant assets.

Discharge abstracts are the same as California's with these exceptions: there is detailed source of admission; the payer information is less specific--only Medicare, Medicaid, private pay, and other, including other government and self-pay; and only three procedures are listed. Ambulatory surgery abstracts include information on patient age, sex, race and ethnicity, ZIP code of residence, five diagnoses and five procedures, as well as facility fees for each procedure. Charge information is provided on total as well as for specific components, anesthesiology, radiology, laboratory and pathology, and recovery room. Source of payment is divided into Medicare, Medicare HMO, Medicaid, private insurance, HMO, PPO, Workers' compensation, self-pay, other, and no pay.

7.7. Tennessee Data

There are no discharge data for Tennessee, but Joint Annual Reports collected by the state provide some fairly unique information. Reports will be available for our analysis for 1983-90. There is information on utilization and charges separately for inpatient and outpatient units for (1) lithotripsy, (2) services to cancer patients (units only)--separately for chemotherapy, cobalt therapy, hemotology, hyperthermia, and megavoltage radiation therapy, (3) CT, (4) MRI (number of machines), (5) other diagnostic radiology, nuclear medicine, radium therapy, other therapeutic radiology, and ultrasound (units only), (6) services to cardiac patients (units only)--cardiac caths (and number of labs), angioplasties (PTCA), streptokinase infusion, and open heart surgery (and number of dedicated ORs). There is detailed information on gross and net revenue source (Medicare inpatient, Medicare outpatient, Medicaid inpatient, Medicaid outpatient, other government, self-pay, Blue Cross/Shield, commercial, and other nongovernment). Balance sheet information includes gross and net plant -and equipment assets.

CHAPTER 8: EMPIRICAL ANALYSIS PLAN

8.1. Introduction

This chapter provides a framework for empirical analysis on the topics identified in Chapter 1. This design is not comprehensive. Rather its goal is to indicate basically how the work could be done and the data sources that might be used. The chapter is organized around (1) provider-level analysis and (2) beneficiary analysis. The hospital is the natural observational unit for analysis of investment and technology adoption decisions. These decisions are made at this level subject to various constraints the hospital faces. By performing some analysis at the beneficiary-level, it is possible to identify specific illness episodes and exploit the detailed information available on types and amounts of care provided for various conditions. In particular, it will be possible to observe the relationship between inpatient and outpatient care during the course of an episode of illness.

8.2. Provider-Level Analysis

8.2.1. Investment. In this and the next section, we describe empirical analyses to implement the first two specific aims as described in Chapter 1. Although much of the hospital investment during the 1980s was on outpatient capacity, such investment is not directly observable. By studying total investment for this period, it should be possible to learn about determinants of outpatient investment as well.

Adoption and investment decisions are made jointly to the extent that capital goods must be purchased to make provision of a new procedure possible. As noted earlier, technologies differ in their capital intensity. Adoption decisions of capital-intensive (e.g., MRI) as well as labor-intensive technologies (e.g., open heart surgery) will be analyzed. In addition, one can compare adoption of technologies used almost exclusively on inpatients (e.g., open heart surgery) and on outpatients (e.g., ambulatory surgery) to see whether recent changes in reimbursement policies have encouraged the adoption of outpatient technologies. Such changes may also stimulate hospital investment to the extent that plant and equipment were added to serve outpatients (Chapter 4).

Measures of investment come from balance sheet information or from capital expenditures. Medicare Cost Reports are the only national source of balance sheet data. Some states provide capital expenditure information.

Key to an investment decision is the cost of capital. (See the discussion of Wedig et al. in Chapter 2). To our knowledge, no one has attempted to measure the cost of capital to hospitals since 1982. Since then, payment methods have changed and the outpatient sector has grown. In updating the cost of capital measure, it will be necessary to consider both. PPS has affected the output price, but one must also consider that Medicare and some others continued to pay capital on a retrospective cost basis. It will be important to document limits placed by Medicare on capital payments. These are documented in Commerce Clearing House's Medicare-Medicaid Guide. Medicaid plans are also described in the Guide (see Chapter 3). Blue Cross/Blue Shield maintains a file with plan-specific information. We have not been able to examine these data to date so we do not know how much detail there is on the plans' capital payment policies. Such information was made publicly available in earlier years. Since the commercials pay charges, there is no capital payment policy to study. Payer share information is also needed to compute the cost of capital. The American Hospital Association collects such information, but it does not release it on a hospital-specific basis. The Medicare

Cost Reports contain shares for three broad groups of payers (see Chapter 7). Certain state data bases contain more detailed breaks on payer shares. Focusing on a few states for the investment analysis has the advantage of allowing one to measure shares more precisely. However, much of the variation in payers' capital payment policies is lost.

Another major determinant of investment is competition among hospitals. Alternative methods for defining market areas and for measuring competition among hospitals within a market area are discussed below.

In the simplest investment model, the flexible accelerator model of investment, outputs (differences in outputs between adjacent periods) are taken as exogenous and are interacted with the cost of capital. Output and cost are the only explanatory variables (Jorgenson and Stephenson, 1967). The observational unit would be the hospital-year. With MCR data, it is possible to estimate a model.for 1983-89 with 1982 asset data used to construct investment for 1983. With certain states (e.g., California and Florida), it is possible to analyze a longer time series of cross sections.

The assumption of exogenous output is extreme and ignores competition among hospitals. The most straightforward way to take account of competitive forces is to include some measure of market-wide competition such as the four-firm concentration ratio or a Herfindahl Index. More sophisticated and valid methods take account of the capacity and vintage of the neighboring hospitals. Vintage can be approximated by taking the ratio of total accumulated depreciation to annual depreciation.

8.2.2. Adoption of Technology. In this section, we describe how to estimate how hospital adoption of particular technologies is affected by hospital competition, Medicare reimbursement policy, including the implementation of

PPS, other payers, certificate of need programs, the hospital's initial profitability and costs, and other exogenous variables. The analysis of adoption of particular technologies can be done on a national basis with American Hospital Association Annual Survey data or on a state basis. A richer analysis can be performed on a state basis or with a few states because it would be an overwhelming empirical task to adequately describe market areas for all hospitals. Another disadvantage of a national study is that the only discharge abstract data that can be used to measure market areas is for Medicare. Technology adoption decisions may be driven by nonMedicare payers, however. This discussion therefore describes a state-based analysis which focuses on California, Florida, and Tennessee, states with exceptionally detailed information.

8.2.2.1. Dependent Variables. Adoption of medical equipment and certain medical procedures will first be measured by responses to AHA hospital surveys. Because the adoption of expensive equipment and procedures is of primary interest to HCFA, the analysis could be limited to a subset of the services covered in the surveys; these services, and the years of coverage in surveys between 1988 and 1989 are shown in Table 2. Although the table only covers 1980 to 1989, earlier AHA surveys could be used to study the adoption of CT scanners and other technologies where appropriate. The surveys could be supplemented with data on individual procedures from the state cost reports.

The AHA surveys produce a O-1 measure of adoption; a hospital either adopts or does not adopt. For some types of equipment, the extent of adoption is also important. For example, a hospital may install more than one CT scanner or operate more than one cardiac catheterization lab. Tennessee collects data on the number of MRI units, cardiac catheterization labs, open heart surgery operating rooms, and dedicated outpatient surgery operating rooms in each hospital. Such data could be used where available.

8.2.2.2. Explanatory Variables

8.2.2.2.1. Competition. One of the key goals in the analysis is to carefully examine how technology adoption is affected by hospital competition. Accurate definition of market areas is essential for performing this analysis;. unfortunately, defining distinct market areas within states is both complicated and controversial (see, for example, Morrisey et al., 1988; Baker, 1988; and Werden, 1990).

To test the sensitivity of the findings to the definition of market area, three alternative definitions of market areas should be employed. The strengths and weaknesses of each method should be compared to test whether using the different methods affects the results. Under the first, and simplest, method, hospital market areas correspond to geographic jurisdictions such as counties or MSAs. The second method defines a hospital's market area as the area within a fixed radius of the hospital. For example, Robinson and Luft (1985) define a hospital's market area as the area within 15 miles of the hospital, with the justification that a physician will only admit patients to hospitals located near his or her practice.

The third method for defining market areas relies on the size of patient flows, or shipments, into and out of a market area. Morrisey et al., (1988) define a market area as the smallest area in which 75 (or, alternatively, 90) percent of the patients located within the area receive their treatment and 75 (or 90) percent of the services purchased in the area is sold to area residents. Zwanziger and Melnick (1988) use an alternative form of the shipments method to define procedure-specific market areas that include any zip code where a hospital receives 3 percent or more of its patients for that procedure. The shipments method has the advantage that different market areas can be defined for different procedures and hospitals. For example, the market area for open heart surgery probably extends beyond 15 mile radii and MSA boundaries in many areas while the market area of a major teaching hospital may overlap the separate market areas of several local hospitals. One of the main disadvantages of the shipments method is its computational cost. Moreover, the method requires detailed discharge data which links patient zip codes to hospital locations. This requirement will limit the use of the shipments method; California discharge data are only available from 1983 on, while Florida discharge data is only available since 1988. Tennessee data on patient source is collected on an aggregate basis for all inpatients, allowing one to define overall, but not procedure-specific, market areas for that state. There are also conceptual questions about the shipments method because it produces endogenous market areas that change with hospitals' prices. That is, if one hospital lowers its prices, it may attract patients from outside its original market "area", causing its market to expand. Any factor which affects patient flows will also affect the market area; moreover, patient flows will inevitably change as hospitals adopt new technology.

8.2.2.2.2. Paver Shares and Reimbursement Methodology. As described in the conceptual chapters, the reimbursement systems and rates paid by different insurers affect hospital adoption of costly technology. To incorporate these key variables in an empirical analysis, hospital- and market-specific measures of payer share should be developed directly from the state cost reports and/or hospital discharge data. The state cost reports contain data on the number of Medicare, Medicaid, and "other" discharges. "Other" discharges in Florida are further classified by the type of reimbursement system used by the payer (self-pay, charge-based, commercial HMO/PPO, and other discounted), while "other" discharges in Tennessee are classified by payer type (self-pay, Blue Cross/Blue Shield, commercial insurance, and other). California's discharge records contain more complete information on "other" payers than the cost reports; this data can be used to calculate the types of payers facing each hospital in that state, including HMOS and PPOs. HMO and PPO shares can be calculated for geographic areas within Tennessee using various issues of the HMO/PPO Directory.

In order to completely specify explanatory variables on reimbursement policy, one must have state-specific, time-varying data on the reimbursement systems used by Medicaid, Blue Cross, and commercial insurers. Information on the type of reimbursement mechanism (cost- or charge-based) used by each of these plans through 1982 was computed for the Wedig et al. study. As part of another study, we have already collected data on state Medicaid reimbursement policies. We have requested data from the Blue Cross/Blue Shield Association on plan enrollments (including HMO and PPO shares), type of reimbursement mechanism (cost-based, charge-based, or prospective payment), capital payment policies, and utilization review programs in California, Florida, and Tennessee from 1980 to 1990. Because of the multitude of commercial insurers, state-wide information on these payers' policies is difficult to obtain. However, we have requested the Health Insurance Association of America's Employer Surveys for the years 1988 to 1990. These surveys contain data from employers on the extent of conventional charge-based, PPO, and HMO coverage and utilization review (with separate indicators for preadmission certification, concurrent utilization review, and surgical second opinions) in the employer's health plan. Statewide averages for the larger states are available, while regional averages are available for other states. The analysis will probably have to rely on national estimates of commercial insurer policies for years prior to 1988.

Medicare changed from a cost-based system to PPS in 1983; testing whether this change affected adoption of technology will be a major objective of the study. Three variables to measure the impact of PPS on hospital adoption of technology can be included. First, a dummy variable will be set equal to one for periods when PPS is in effect. Second, the hospital's share of Medicare patients can be included. The third variable to be included is a hospital-specific variable which measures the effect of PPS on the hospital's reimbursement relative to the hospital's pre-PPS base year cost. This variable, which has been created for several studies (e.g., Hoerger, 1991), will allow one to test whether "winners" under PPS were more likely to adopt technology than losers.

8.2.2.2.3. Certificate of Need Programs. Certificate of Need (CON) programs may prevent some hospitals from adopting certain types of technology. Between 1975 and 1986, state CON programs were required to provide review of capital expenditures, substantial changes in services, and addition of beds by health care facilities. CON laws differed significantly from state to state. For the study's purposes it is useful to note that services such as open heart surgery and cardiac catheterization have traditionally been covered by CON legislation. Strong criticism of the CON program during the early 1980s combined with the Reagan administration's support for deregulation of the health care industry led to the discontinuation of the federal CON program requirement in October of 1986 (Gross, 1988).

For another study, we have created a file documenting the existence of Certificate of Need programs in each state for years through 1990. California allowed its CON legislation to lapse on January 1, 1987, while Florida and Tennessee chose not to repeal their CON laws.

8.2.2.2.4. Profitability and Costs. This analysis will test whether hospitals that have high profits or costs prior to the technical innovation are more or less likely to adopt the technology. Later, the analysis of market dynamics will study whether adoption causes profits or costs to change. The source for both profitability and cost will be the hospital's state cost report. A hospital's initial profitability will be defined as its net revenue in the year before the technology first becomes available. Cost will be defined for a similar period; in addition, total costs can be divided by admissions to derive the hospital's cost per admission.

8.2.2.2.5. Other Variables. Other hospital-specific and demographic variables can be included from the AHA surveys and the Area Resource Files, respectively. The hospital-specific variables include bedsize, ownership, membership in the Council of Teaching Hospitals (COTH), and the specialty composition of the hospital medical staff. Of these, hospital size and COTH membership will probably have the strongest effect on adoption of technology. Demographic variables include area population and the ratio of physicians-to-population. To see whether hospitals treating more resource-intensive patients are mbre likely to adopt new technology, two alternative casemix variables can be included. The first variable is the hospital's Medicare Casemix Index (MCI). Because the MCI only applies to Medicare admissions,-the hospital's patient discharge records can be run through the Medicare Grouper program to create a casemix index for the full hospital.

8.2.2.2.6. Characterization of Innovations. Separate estimates should be run for each technology. Evaluating differences before and after PPS and between diagnostic and therapeutic procedures on the basis of different technologies will necessarily involve careful and; ultimately, subjective interpretation. To assist this interpretation, a small technical panel of physicians should be convened to characterize when a technology became commercially available, which old technologies it replaced, whether the new technology reduced costs, and whether the technology can be used on an outpatient basis. The panel will also match diagnostic radiology procedures with related inpatient diagnoses and therapeutic procedures. This will be important in the next analysis, which examines how the volume of related inpatient procedures within a market is affected by the adoption of technology. Finally, the panel will review the radiological services included in Table 1 to identify the services undergoing major technological innovations and growth; the other services would be eliminated from the analysis. To assist the panel, a review of the medical literature could be conducted prior to the panel meeting.

8.2.2.3. Estimation. A hazard model can be used to estimate the probability that a hospital adopts a particular technology during period t. 'Hazard models were developed to deal with the special problems associated with duration data. These models have been used extensively to study the length of employment and unemployment spells, strike durations, time until failure of machinery, and patient survival time. The length of time between technological innovation and hospital adoption of a technology will be estimated. The central concept of a hazard model is to estimate the conditional probability of an event because, conceptually, this is simpler to analyze and the results may be easier to interpret than an estimate of the unconditional probability of an event. Thus, the model will estimate the probability that a hospital adopts a technology at time t, given that the hospital has not adopted the technology prior to that time.

In estimating the hazard model of technology adoption, three potential complications must be addressed. First, the data may be left-censored for certain technologies due to the lag between a technological innovation and its inclusion within the AHA surveys. The technical panel and reviews of the medical literature can be used to determine when the technologies became commercially available. In cases of left-censoring, other sources can be consulted to determine when hospitals adopted the technology. For example, one may contact hospitals that report the technology during the first year of the data and ask when the hospital adopted the technology. Second, hazard models can be estimated using a number of assumptions about the distribution of the conditional probability. The usual basis for distribution selection is a combination of theoretical implication and technical feasibility. The choice can be made after constructing graphical plots of duration time. Third, many of the key variables in the analysis, such as the number of competing hospitals with the technology and the PPS time dummy, will vary over time. While this added complexity is relatively simple to incorporate into the theoretical model, empirical estimation typically requires numerical maximization of the log-likelihood function (Kiefer, 1988). In addition, the time paths of the explanatory variables must vary in order to identify separate effects of the passage of time and the variation of the explanatory variables. This should not‘be a problem in the analysis since the time path of explanatory variables will vary across separate markets.

8.2.3. Market Dynamics: The Effect of Adoption on Patient Flows. This task will analyze how a hospital's adoption of technology affects patient volumes throughout the hospital's market. Both case studies and regression analysis can be used to examine how adoption affects individual hospitals within markets over time. The analysis will test whether adoption increases the patient volume of the adopting hospital primarily by lowering other competitors' volumes or by increasing overall volume in the market. Decreases in competitors' volumes are consistent with Robinson and Luft's (1985) story of a "medical arms race" in which hospitals use nonprice competition to compete for a relatively fixed patient population. On the other hand, adoption may primarily satisfy previously unfilled patient demand: overall market demand would rise with little negative impact on other hospitals, Both types of effects could occur during the course of technology diffusion. Early adoptions could be associated with growing market volume, while later adoptions produce patient flows between hospitals but little overall growth. By looking at individual markets over time, it will be possible to observe both effects. Medicare patient flows can also be studied to see whether adopting hospitals attract large shares of Medicare patients. If they do, Medicare expenditures could rise, although the increase would be less direct than it would have been prior to PPS. If the adopted technology is diagnostic, increased utilization by Medicare patients may lead to greater inpatient utilization as more cases needing treatment are identified. If the new technology is therapeutic and more expensive than the old technology, increased Medicare utilization would eventually lead to an increase in the procedure's casemix index and therefore to a higher reimbursement rate for the procedure.

8.2.3.1. Denendent Variables. The dependent variables in this analysis will be market- and hospital-specific volumes and changes in volume for each service or piece of equipment. The variables will be calculated in two ways. First, the state cost reports contain information on the number of procedures performed in each hospital for many of the procedures in Table 1. These include: cardiac catheterizations (CA, FL, TN), CT scans (CA, FL, TN), MRI (FL, TN), nuclear medicine (CA, FL, TN), radiation therapy (CA, FL, TN), lithotripsy (FL, TN), outpatient surgeries (CA, FL, TN), and open heart surgeries (CA, FL, TN). Second, the technical panel will identify inpatient therapeutic procedures which are associated with diagnostic radiology. For example, an MRI may be used to identify patients requiring back surgery. Therapeutic procedures are relevant to the analysis because the opportunity to detect and perform additional therapeutic procedures may be a major motive guiding a hospital's adoption of diagnostic equipment. Each hospital's volume of related therapeutic procedures from hospital discharge data will be calculated. This analysis will be limited to California, since that state's discharge data begins in 1983.

Once hospital-specific volumes are calculated, market volumes will be created by summing across the hospitals within each market. As in the first analysis, three alternative definitions of market area will be used. The shipments definition poses two special complications. First, if the hospital's market area is based on shipments to the hospital, individual hospitals' market areas may overlap. That is, hospital A may compete with B in one market area while B competes with C in a second market area, but A and C may not compete with each other. Since market areas are not mutually exclusive, the sum of patient volumes across all markets will exceed the sum of patient volumes across all hospitals. This complication will not appreciably affect the analysis, as long as one does not try to sum volumes across markets.

The second complication arises because market areas are endogenous under the shipments method. As mentioned before, the changes in patient flows which will result from technology adoption will change the definition of a hospital's market area. This change provides an opportunity to study how market areas evolve as additional hospitals adopt a technology. The form of evolution may have important implications for policymakers. For example, if a teaching hospital initially adopts an expensive piece of diagnostic equipment, it may be socially optimal if the next adopting hospital is located at the opposite end of the market area, since that location minimizes transportation costs. If nonprice competition is strong, however, the next adopting hospital may be located near the first hospital.. One can document how market areas, as measured with the shipments method, change as adoption proliferates.

How hospital profits and costs are affected by adoption will also be tested. Increased profitability is one of the more obvious reasons why a hospital would adopt a new technology. One can also examine whether adoption has significant effects on hospital costs. Profitability and costs will be defined as in the previous analysis.

<u>8.2.3.2. Explanatory Variables</u>. Market volume will be a function of its population, the number of hospitals offering the service, payer shares, time, and other market demographic variables. Market volume will increase with population. Reimbursement policies will affect volume through the adoption decision if there is initially unfilled patient-demand in the market. The relatively high reimbursement rates of commercial insurers and Blue Cross will encourage adoption, causing market volume to rise. Population will be

obtained from the Area Resource File, while payer shares will be determined as in the previous analysis.

The number of hospitals offering the technology will increase market volume if there is initially unfilled demand; however, the magnitude of this effect may fall as additional capacity is installed. Thus, the number of hospitals will enter the estimation in a nonlinear fashion. Market demand for a new procedure or test may increase as physicians become more accustomed to its performance and new indications for its use are discovered. This effect may become less important, however, as the period since the introduction of the technology to the market lengthens. Therefore, nonlinear estimation to account for the effect of time will also be used.

A hospital's volume will be affected by the market's population, the number of competing hospitals with the technology, time, the hospital's payer mix, its bedsize, and other hospital-specific variables such as teaching status and ownership. When the first measure of hospital volume is used, only hospitals that have adopted the technology will report positive volume levels. The second measure of volume, the number of potentially-related therapeutic procedures, can be positive for both adopting or nonadopting hospitals. When this measure is the dependent variable, one should also include whether or not the hospital has adopted the technology and the total number of hospitals in the market as explanatory variables. Adoption should increase demand.

Market population, payer mix, and time will affect hospital demand in much the same way as they affect market demand. The number of other hospitals with the technology should lower an individual hospital's demand. The effect may not be linear if demand exceeds capacity when the first hospitals adopt the technology. After the excess capacity is absorbed, further entry will produce larger patient flows between hospitals.

Bedsize will probably increase hospital volume but its effect will depend on how market volume is divided when more than one hospital performs a procedure. For example, if a large and a small hospital adopt a technology, physicians may be indifferent between sending patients to either hospital. Probably, however, factors which cause the large hospital to receive a greater share of the volume for all services will also cause it to receive a greater share of the volume for the adopted technology.

8.2.3.3. Estimation

8.2.3.3.1. Volume. Multivariate regression analysis will be used to test how adoption affects volume in the market and in individual hospitals. Separate equations for market and hospital volumes will initially be estimated. The equations will then be estimated jointly to account for the fact that volumes in individual hospitals must add up to the market volume.

8.2.3.3.2. Cost and Profitability. One can use panel data analysis to test whether adoption affects the hospital's costs or profits. Accounting for hospital-specific, time-invariant factors requires the use of a generalized least squares random effects estimator to estimate the cost and profit equations (Hsiao, 1986; Hoerger, 1991, provides an application to hospital profit functions). The basic profit equation which will be estimated is

$$\pi_{it}=\mu+\lambda_t+Z_i\gamma+X_{it}\beta+\alpha_i+u_{it},$$

where π_{it} is hospital i's profit in year t, μ is a general intercept term, λ_{it} is a year-specific intercept, Z_i is a vector of observed hospital-specific time-invariant characteristics, X_{it} is a vector of variables that vary across hospitals and over time, α_i is a hospital-specific error term, and u_{it} is an independent error term. The cost function will be estimated in similar fashion. In both equations, a dummy variable signifying adoption and a variable measuring the number of other hospitals in the market with the technology will be included in X_{it}. These variables should be significant if adoption effects overall profitability or costs.

<u>8.2.3.4. Case Studies</u>. Although regression analysis provides a convenient way to understand behavior across a number of individual markets, it may obscure insights which can be gained by studying a few markets in greater depth. To retain these insights, a case study of technology adoption can be performed within an individual market in each state. The case studies will produce a better understanding of how competition between hospitals evolves following adoption of technology. How each hospital's total, inpatient, and outpatient volume of the new procedure, overall admissions, profits, and costs change after the technology is introduced will be studied. One can examine whether the hospital which first adopts the technology retains a dominant market share. The study will also analyze whether adoption patterns within an individual market are similar for different technologies. This analysis may provide some indication of differences in adoption rates for pre- and post-PPS and for inpatient and outpatient technologies. For example, were MRIs (post-PPS) adopted at different rates than CT scanners (pre-PPS)? The study may also uncover differences between states. To maximize comparability, the markets selected should be similar across states; each technology in the market can be studied to see whether there are different patterns for different technologies or periods.

8.2.4. Diffusion to Outvatient Settings. This section of the project will examine how technology diffuses from inpatient to outpatient settings. The analysis will answer the following questions. Does technology diffuse from inpatient to outpatient settings in a predictable fashion? Has that pattern changed since implementation of PPS? Does competition affect the movement from inpatient to outpatient settings? Do outpatient procedures replace inpatient procedures, or are. they incremental to inpatient services?

8.2.4.1. Dependent Variables. Dependent variables in the analysis are the shares and levels of outpatient and inpatient procedures for each technology. The variables will be measured in two ways, depending on the type of data contained in the state cost reports. The Tennessee cost report contains the actual number of procedures performed on inpatients and outpatients for lithotripsy, radiation therapy, CT scans, MRIs, and cardiac catheterizations. The California and Florida cost reports contain less direct measures of the inpatient and outpatient mix. These states collect data on inpatient and outpatient revenue from the following revenue centers: cardiac catheterization, diagnostic radiology, CT, MRI (Florida only), therapeutic radiology, nuclear medicine, and lithotripsy (Florida only). For these states, outpatient shares will be defined as outpatient revenues divided by total revenues. The variables will be defined for individual hospitals; marketwide figures will also be computed.

8.2.4.2. Explanatory Variables. Many of the explanatory variables from the previous analyses will be included in the study of outpatient diffusion. The conceptual model suggests that diffusion from inpatient to outpatient settings will be faster when there is more competition, PPS is in effect, the share of Medicare patients is larger, utilization review is stronger, and the technology is diagnostic. Explanatory variables measuring each of these effects will be included. Other explanatory variables include the number of competitors who have adopted the technology, teaching status, time since the technology was first introduced into the market, and ownership type. An additional factor which may affect the mix of inpatient and outpatient procedures is the number of years since the hospital first adopted the technology. Hospitals may initially install equipment in their inpatient departments, because severely ill inpatients benefit more from the procedure than outpatients. Later, as the hospital installs more capacity or competition lessens the demand facing the hospital, the hospital may increase its share of outpatient procedures.

8.2.4.3. Empirical Analysis. The first analysis will simply show how inpatient, outpatient, and total procedures (revenues) change with the time since the technology was adopted. This descriptive analysis will be performed at both the hospital and market level. A nonlinear time function should be used to allow the rate of growth in each setting to vary with the length of time since adoption. Second, the level of outpatient procedures will be estimated as a nonlinear function of the total number of procedures. This descriptive analysis will provide some evidence about whether outpatient procedures replace inpatient procedures. If the marginal effect of total procedures is greater than one, the growth in outpatient procedures crowds out some inpatient procedures. The nonlinear function allows the marginal effect to depend on the level of total procedures.

While separate descriptive analyses for each technology will be performed, the results will also be compared across technologies. Although such comparisons are necessarily subjective, since different technologies may offer different opportunities for substitution between inpatient and outpatient settings, they may reveal important insights. Of particular interest are comparisons of technologies which primarily diffused before, during, and after implementation of PPS. PPS gave hospitals strong incentives to unbundle diagnostic procedures from inpatient therapeutic episodes by performing the diagnostic procedure on an outpatient basis. This incentive may affect the distribution of CT scans, which were common by 1983, when PPS was implemented. In contrast, MRIs were just beginning to diffuse in 1983.

Next, multivariate analysis will be used to explain the results observed in the descriptive analysis. Special emphasis will be placed on the role of competition between hospitals, the implementation of PPS, and any differences between California, where selective contracting is especially common, and the other states. The latter differences may arise because California hospitals are more likely to compete with one another on the basis of price and less likely to engage in nonprice competition.

Finally, whether hospitals performing more diagnostic tests on an outpatient basis have 'a lower yield of related inpatient treatments than hospitals that usually perform the test on an inpatient basis will be tested. The conceptual model suggests that outpatient testing attracts patients with lower probabilities of illness than inpatient testing. To perform this test, the hospital's yield from diagnostic testing will be calculated as the number of related therapeutic treatments divided by the number of diagnostic tests. One will then estimate how the yield is affected by the percentage of patients tested as outpatients.

8.3. Beneficiary Level Analysis

All parts of the beneficiary level analysis will use linked files created by--Linked A-B File for 1986-90- -or for HCFA--the file developed by Abt Associates for 1981 through 1986 (see Chapter 7). Analysis of these files allows one to create episodes of care and directly measure the interrelationships (complementarity and substitutability) of physician, hospital outpatient, and inpatient services. We propose that Medicare data be used, primarily because HCFA has a direct interest in beneficiary behavior. During the course of our study, we did explore the possibility of using data from other sources. MedStat, a firm located in Ann Arbor, Michigan also has the capacity to produce linked files. MedStat collects billing data from employers in a number of states. The Midwest is especially well-represented. The vast majority of insureds covered in the MedStat data are under age 65.

8.3.1. Use of Inpatient and Outpatient Care During Episodes of Illness Requiring Hospitalization. The overall objective of this task is to determine the extent to which PPS caused substitution of outpatient for inpatient care to occur and, equally importantly, whether the substitution played out in the immediate post-PPS implementation period or whether the adjustment took longer than this. If the former is true, one should observe about equal growth in inpatient and outpatient services for particular types of episodes during the late 1980s. Consequently, the deceleration in the growth of Medicare inpatient expenditures that immediately followed implementation of PPS may provide an overly optimistic picture of future inpatient expenditures. The case for developing episode-based prices would be particularly strong if the adjustment substituting outpatient for inpatient care is still taking place. As seen from the vantage point of an episode of care, two phenomena may occur simultaneously as a result of a policy change, such as implementation of PPS. On the one hand, there are shifts of care among sites. On the other, there are changes in the total service bundle patients receive per episode. Before 1986, the data do not allow one to adequately distinguish between these two phenomena because only aggregate outpatient and physician charges are reported. Data are incomplete on procedures or diagnoses. After 1986, there is sufficient detail to determine, for example, if there have been changes in the proportion of MI patients receiving cardiac caths or if declines in caths on the inpatient side merely reflect shifts to the outpatient sector.

The first step of the empirical analysis is to define an episode of care. An episode would be defined around a hospitalization for a particular set of diagnoses or a procedure. Abt has already created some tracer discharge files for 1981-86: hip replacement; stoke; inguinal hernia; and pneumonia. The distinguishing factor of the procedure/diagnoses selected should be that they require hospitalization at least at some point during the episode. Otherwise, the analysis would be biased because of cases that are treated on an outpatient basis after implementation of PPS. Thus, inguinal hernia and pneumonia may not be satisfactory tracers for this purpose. Other possibilities include coronary bypass surgery, open heart surgery, mastectomy, myocardial infarction, and hysterectomy.

The dates before and after hospitalization which should be included within an episode may be expected to vary by diagnosis/procedure. Abt defined an episode as 60 days before admission and 60 days after discharge. It would be advisable to rely on clinical judgments about this matter and allow the periods to vary in clinically meaningful ways.

The next step is to measure the cost of various services performed in each of the three settings. The hospital record (Medpar) contains a detailed list of charge categories (18). Of particular interest are the ancillary charges because opportunities for substitution may be especially strong there, but, for certain conditions, other types of services merit attention, such as physical and occupational therapy for strokes. Before 1986, only total charges are available for physician and outpatient services. Therefore, one can only tell, for example, whether and the extent to which reductions in ancillary service use on the inpatient side are picked up by increased physician and outpatient charges before and after hospitalization. After 1986, one should use the A-B Linked File to analyze the procedure information from Medpar with the procedure information available for physicians' services (BMAD) and outpatient services (Outpatient Skeleton Record File) as well as charge information available from all three sources; A technical panel should identify families of procedures, and one would compute rates of procedure use by location for particular diagnoses/procedures related to the specific episode of care.

It would be desirable to include some covariates, accounting for their influence either in the form of cross tabs or by using a regression. These covariates include age, gender, number of diagnoses on the hospital record, hospital ownership and teaching status. To accomplish this, it would be necessary to merge the A-B Linked File with a hospital data base. The merge has already been done by Abt for 1981-86.

<u>8.3.2. "True" Substitution between Inpatient and Outpatient Care</u>. This analysis follows from the conceptual work presented in Chapter 4. There we defined "true" substitution as care that could be provided in either inpatient

or ambulatory settings. We noted that changes in reimbursement policy, such as PPS, would change the relative severity of cases treated in both settings. For example, PPS probably caused an increase in demand for outpatient care, causing the relative severity of cases to increase in inpatient settings. An increase in severity has been documented across DRGs (Ginsburg and Carter, 1986; Russell, 1989; Newhouse and Byrne, 1988). Here interest centers on severity within particular DRGs. Severity may be measured by specific comorbidities, the number of comorbidities, and extreme age. Here again, input from a technical panel will be needed.

Before 1986, one cannot directly observe substitution because one only has aggregate charge information for the nonhosital settings. One could measure case severity for particular DRGs to determine whether severity of hospitalized cases within particular DRGs has increased. It would be necessary to deal with the creep problem, using recent studies such as Carter, et al. (1990) or Altman (1990) as a guide.

After 1986, the analysis would be much more conclusive because shifts of particular services can be observed and related to the case severity of beneficiaries served at alternative care sites. Arguably, the creep problem will also have subsided but so may some of the major substitutions attributable to implementation of PPS.

The substitutions may be driven by other forces as well. In particular, pressures from utilization management programs (e.g., PROs) may have driven services out of the hospital. A limited amount of information on these programs is potentially available from national Blue Cross/Blue Shield and from the Health Insurance Association of America's Employer Surveys, the latter only for 1988-90. For the private insurers' programs to have an effect on Medicare beneficiaries' treatment patterns, there would have to be a spillover; judging from evidence from several studies to-date, such a spill-over may be anticipated. To properly measure the effects of other programs on Medicare, it will be necessary to have payer share information. (See Chapter 7 and the discussion above.)

Also, hospital competition may have had an effect on substitution. The model in Chapter 4 indicated that monopolistic hospitals may have an incentive to treat less severe cases as inpatients; however, in more competitive hospital markets, they will compete for patients more aggressively by offering outpatient services, and these will necessarily include many low severity cases. (See the discussion above about how competition can be measured.)

Technological advances can enhance the feasibility of outpatient care. The technical panel should be asked to characterize the nature of various improvements for types of cases selected for analysis. It is important that this be done independently (prior to) of the empirical analysis, lest observed changes be interpreted as "technological change."

8.3.3. The Yield from Diagnostic Testing. The empirical analysis of the yield from diagnostic testing relates to the theoretical discussion in Chapter 5. There, we distinguished between the yield from testing (number of persons receiving tests who also received the treatment divided by the number of persons tested) and the total yield (number of persons receiving treatment divided by the number of persons tested). The distinction is important because improvements in a diagnostic test will both lower the testing thresh-old (some patients for whom treatment was previously postponed are now tested) and increase the treatment threshold (some patients formerly treated will now be tested with negative findings). Also, the severity of patients treated is likely to fall (because some persons are treated as a consequence of a positive finding on a test who heretofore were not treated since their symptoms were insufficiently severe).

In the past, many persons with a given condition will have received treatment (e.g., surgery with no prior testing). These would be patients with serious symptoms which unfortunately cannot be directly observed. What can be observed is both kinds of yields and how they vary over time and market areas. We also expect to find that the yield from testing should be lower on outpatient tests than on inpatient tests. Since outpatient tests are cheaper, at least in terms of nonpecuniary cost, the testing threshold at outpatient locations is lower. We also expect the testing threshold to be lower for patients closer to the diagnostic facility (inpatient or outpatient) because the time price is lower. It would pay to measure distances from place of residences to nearest care sites as precisely as possible.

In areas with substantial competition among hospitals, one may expect to find lower yields from testing because hospitals are anxious to attract the profitable inpatient treatments from the test (see Chapter 6), especially when the Medicare patient share is high. There is appreciable variation among communities in this share.

BIBLIOGRAPHY

Aaron, Henry J. and William B. Schwartz, The Painful Prescription: Rationing Hospital Care Washington D.C.: The Brookings Institution, 1984.

Ackaert, K. S., W.C. Hop, C.A. Heemskerk and F.H. Schroder, "Risk Factors in Outpatient Extracorporeal Shock Wave Lithotripsy," European Urology, Vol. 16, No. 5, 1989, pp. 349-353.

Alder, H.C., Lithotripters: Noninvasive Devices for the Treatment of Kidnev Stones, AHA-012828. Chicago, IL: American Hospital Association, 1985.

Altman, S.H., "Measuring Real Case Mix Change Under Medicare's Prospective Payment System," Journal of Health Economics, Vol. 9, No. 4, 1990, pp. 499-504.

Anderson, Howard J., "Outpatient Planning: Still More Art Than Science?," Hospitals, December 20, 1990, pp. 26-32.

Anderson, Howard J., "Are Hospitals Ready for More Growth in Ambulatory Care?," Hospitals, June 20, 1991, pp. 32-37.

Aronne, L.J., R.L. Braham, R. Riehle, Jr., E.D. Vaughan, Jr. and H.S. Ruchlin, "Cost-Effectiveness of Extracorporeal Shock-Wave Lithotripsy," Urology, Vol. 31, No. 3, March 1988, pp. 225-30.

Baert, L., H. Claes, I. Billiet, M. D'Hallewin, H. Vandeursen and H. Van Poppel, "Second-generation Lithotripsy," Urology International, Vol. 44, No. 1, 1989, pp. 38-40.

Baker, Jonathon B., "The Antitrust Analysis of Hospital Mergers and the Transformation of the Hospital Industry," Law and Contemnorarv Problems, Vol. 51, No. 2, Spring 1988, pp. 93-164.

Bashkoff, E., R.A. Lehrer and B. Saltzman, "Comparison of Extracorporeal Shock-Wave Lithotripsy and Surgical Lithotomy Regarding Patient Satisfaction," Urology, Vol. 33, No. 5, May 1989, pp. 371-9.

Baumgardner, James R., "The Interaction Between Forms of Insurance Contract and Types of Technical Change in Medical Care," Rand Journal of Economics, Vol. 22, No. 1, Spring 1991. pp. 36-53.

Blue Cross and Blue Shield Association, Extracorporeal Shock Wave Lithotripsy: Clinical Assessment, Utilization and Cost Projections. Chicago, IL: Blue Cross/Blue Shield Association, May 1985.

Bunker, John P. and Ralph W. Schaffarzick, "Reimbursement Incentives for Hospital Care," Annual Review of Public Health, Vol. 7, 1986, pp. 391-409.

Center For Health Policy Studies, Replication of 1982 Studv of Resource Costs in 25 Hosoitals: Final Report. Washington, D.C.: Office of the Assistant Secretary of Planning and Evaluation, Department of Health and Human Services, DHHS-100-88-0038, April 6, 1990.

Carter, G.M., J.P. Newhouse and D.A. Relles, "How Much Change in the Case Mix Index is DRG Creep?," Journal of Health Economics, Vol 9., No. 4, 1990, pp. 411-428.

Charig, C.R., D.R. Webb, S.R. Payne and J.E. Wickham, "Comparison of Treatment of Renal Calculi by Open Surgery, Percutaneous Nephrolithotomy and Extracorporeal Shockwave Lithotripsy," British Medical Journal of Clinical Research, Vol. 292, No. 6524, March 29, 1986, pp. 879-82.

Custer, William S., James W. Moser, Robert A. Musacchio, and Richard J. Willke, "The Production of Health Care Services and Changing Hospital Reimbursement: The Role of Hospital-Medical Staff Relationships," Journal of Health Economics, Vol. 9, No. 2, September 1990, pp. 167-92.

Danzon, Patricia M., "Hospital 'Profits': The Effect of Reimbursement Policy," Journal of Health Economics, Vol. 1, 1982, pp. 29-52.

Detmer, Don E. and Dorothy J. Buchanan-Davidson, "Ambulatory Surgery," in Ira M. Rutkow (ed.), Socioeconomics of Suraery. Baltimore: The C. V. Mosby Company, 1989, pp. 31-50.

Dranove, David, "Pricing by Non-Profit Institutions: The Case of Hospital Cost-Shifting," Journal of Health Economics, Vol. 7, 1988, pp. 47-57.

Ellis, Randall P. and Thomas G. McGuire, "Provider Behavior Under Prospective Reimbursement: Cost Sharing and Supply," Journal of Health Economics, Vol. 5, 1986, pp. 129-151.

Gabel, Jon, Steven Fink, Clare Liffert, et al., Trends in Managed Health Care. Washington, D.C.: Health Insurance Association of America, Research Bulletin, February, 1989.

Ginsburg, P.B. and G.M. Carter, "The Medicare Case Mix Index Increase," Health Care Financing Review, Vol. 7, 1986, pp. 51-65.

Gross, Benjamin, "Certificate of Need: Background and Review of Recent Changes in Florida Law," Universitv of Florida Journal of Law and Public Policy, Vol. 2, 1988, pp. 183-210.

Health Insurance Association of America, Source Book of Health Insurance Data 1990. Washington D.C.: Health Insurance Association of America, 1990.

Helbing, Charles and Viola B. Latta, "Use and Cost of Hospital Outpatient Care for Inpatient Care," Health Care Financing Review, Vol. 9, No. 4, Summer 1988, pp. 113-125.

HMO/PPO Directory. Deerfield, IL: Whole World Publishers, 1990.

Hoerger, Thomas J., "'Profit' Variability in For-Profit and Not-For-Profit Hospitals," Journal of Health Economics, Vol. 10, No. 3, 1991, pp. 259-89.

Hoppszallern, Suzanna, Christine Hughes, and Robert A. Zimmerman, MRI: Update on Technology Diffusion and Acquisition. Chicago, IL: American Hospital Association, Hospital Technology Series, Vol. 10, No. 8, April 1990.

Hospitals, "Freestandings Less Expensive to Build," October 5, 1986, p. 1.

Hsiao, Cheng, Analysis of Panel Data. Cambridge, MA: Cambridge University Press, 1986.

Iglehart, John K., "The Debate Over Physician Ownership of Health Care Facilities," New England Journal of Medicine, Vol. 321, No. 3, July 20, 1989, pp. 198-204.

Jackson, Morgan N., Public Health Service Assessment Cardiac Catheterization in a Freestanding Setting. 1989. Rockville, MD: National Center for Health Services Research and Health Care Technology Assessment, U.S. Department of Health and Human Services, DHHS Pub. No. (PHS)89-3446, 1989.

Jorgenson, D. W., and J. A. Stephenson, "Investment Behavior in U.S. Manufacturing, 1947-60, Econometrica, Vol. 35, 1967, pp. 169-220.

Kamien, Morton I. and Nancy L. Schwartz, Market Structure and Innovation. Cambridge, IL: Cambridge University Press, 1982.

Kiefer, Nicholas M., "Economic Duration Data and Hazard Functions," Journal of Economic Literature, Vol. 26, No. 2, June 1988, pp. 646-679.

Klawanski, Sidney and Gary L. Gaumer, Measuring Therapeutic Efficiency of Diagnostic Activity in Medicare: An Exploratory Analysis. Washington, D.C.: Report to the Health Care Financing Administration (500-85-0015), April 1990.

Laudicina, Susan S., State Systems for Hospital Payment. Washington, D.C.: Intergovernmental Health Policy Project, George Washington University, April 1989.

Lazenby, Helen C. and Suzanne W. Letsch, "National Health Expenditures, 1989," Health Care Financing Review, Vol. 12, No. 2, Winter 1990, pp. l-26.

Levin, Richard C., Wesley M. Cohen and David C. Mowery, "R and D Appropriability, Opportunity and Market Structure: New Evidence on Some Schumpeterian Hypotheses," American Economic Review, Vol. 75, No. 2, 1985, pp. 20-24.

Lingeman, J.E., R.M. Saywell, J.R. Woods and D.M. Newman, "Cost Analysis of Extracorporeal Shock Wave Lithotripsy Relative To Other Surgical and Non-surgical Treatment Alternatives for Urolithiasis," Medical Care, Vol. 24, No. 12, December 1986, pp. 1151-60.

Mahrer, Peter R., Charlie Young, and Peter T. Magnusson, "Efficacy and Safety of Outpatient Cardiac Catheterization," Catheterization and Cardiovascular Diagnosis, Vol. 13, 1987, pp. 304-8.

McCue, P., "Going Mobile," Applied Radiolorry, Vol. 18, No. 7, July 1989, pp. 29-32.

McGivney, William T., "Hurdles to Technology Diffusion: What are Expectations for PET?," The Journal of Nuclear Medicine, Vol. 32, No. 4, April 1991, pp. 660-4.

McGuire, Thomas G. and Mark V. Pauly, "Physician Response to Fee Changes with Multiple Payers," Working Paper, April 13, 1991.

Miller, K., G. Fuchs, J. Rassweiler and F. Eisenberger, "Financial Analysis, Personnel Planning and Organizational Requirements for the Installation of a Kidney Lithotripter in a Urologic Department," European Urology, Vol. 10, No. 4, 1984, pp. 217-221.

Mitchell, Janet B., Gerard Wedig and Jerry Cromwell, "The Medicare Physician Fee Freeze," Health Affairs, Vol. 8, No. 1, Spring 1989, pp. 21-33.

Morrisey, Michael A., Frank A. Sloan and Joseph Valvona, "Defining Geographic Markets for Hospital Care," Law and Contemporary Problems, Vol. 51, 1988, pp. 166-194.

Nathanson, Susan, "Ambulatory PPS: More Hospitals Will Track Costs," Hospitals, June 5, 1988, p. 106.

Newhouse, Joseph P., "Towards a Theory of Nonprofit Institutions: An Economic Model of a Hospital," American Economic Review, Vol. 60, March 1970, pp. 64-74.

Newhouse, Joseph P. and Daniel J. Byrne, "Did Medicare's Prospective Payment System Cause Length of Stay to Fall," Journal of Health Economics, Vol. 7, No. 4, 1988, pp. 413-416.

Noether, Monica, Comuetition Among Hosvitals. Washington, D.C.: Federal Trade Commission, Staff Report of the Bureau of Economics, 1987.

Pauly, Mark V., Doctors and Their Workshops: Economic Models of Physician Behavior. Chicago, IL: The University of Chicago Press, 1980.

Peddecord, K. Michael, Edward A. Janon, and Jon M. Robins, "Use of MR Imaging in an Outpatient MR Center," American Journal of Roentgenology, Vol. 148, April 1987, pp. 809-12.

Phelps, Charles E. and Alvin I. Mushlin, "Focusing Technology Assessment Using Medical Decision Theory," Medical Decision Making, Vol. 8, No. 4, October-December 1988, pp. 279-289.

Pope, Gregory C., "Hospital Nonprice Competition and Medicare Reimbursement Policy," Journal of Health Economics, Vol. 8, 1989, pp. 147-172.

Power, E.J., "The Adoption and Use of Extracorporeal Shock Wave Lithotripsy by Hospitals in the United States," International Journal of Technology Assessment in Health Care, Vol. 3, No. 3, 1987, pp. 397-404.

Prospective Payment Commission (ProPAC), Report to Connress. 1989.

Prospective Payment Commission (ProPAC), Report to Congress. 1990.

Prospective Payment Commission (ProPAC), Medicare and the American Health Care Svstem: Report to Congress. Chicago, IL: Commerce Clearing House Supplemental Edition No. 658, June 24, 1991.

Rajagopal, V. and M.J. Bailey, "Mobile Extracorporeal Shockwave Lithotripsy," British Journal of Urology, Vol. 67, No. 1, January 1991, pp. 6-8.

Robinson, James and Harold S. Luft, "The Impact of Hospital Market Structure on Patient Volume, Average Length of Stay and the Cost of Care," Journal of Health Economics, Vol. 4, 1985, pp. 333-356.

Robinson, James and Harold S. Luft, "Competition and the Cost of Hospital Care, 1972 to 1982," Journal of the American Medical Association, Vol. 257, No. 23, June 19, 1987, pp. 3241-3245.

Robinson, Michele L., "Trouble Ahead: PPS Outpatient Radiology Limits," Hospitals, April 5, 1988, pp. 72-73.

Russell, Louise, Technology in Hospitals: Medical Advances and Their Diffusion. Washington D.C.: The Brookings Institution, 1979.

Russell, Louise B., Medicare's New Hospital Pavment Svstem: Is It Working? Washington, D.C.: The Brookings Institution, 1989.

Romeo, Anthony A., Judith L. Wagner and Robert H. Lee, "Prospective Reimbursement and the Diffusion of New Technologies in Hospitals," Journal of Health Economics, Vol. 3, No. 1, April 1984, pp. l-24.

Sabatino, Frank G., "The Diversification Success Story Continues: Survey ," Hospitals, January 5, 1989, pp. 26-32.

Sabatino, Frank G., "As Cardiology Market Matures, Technology's Impact is Clearer," Hospitals, October 20, 1990, pp. 62-68.

Sabatino, Frank G. and Mary A. Grayson, "Diversification: More Black Ink Than Red Ink," Hospitals, January 5, 1988, pp.36-42.

Scherer, F.M., Industrial Market Structure and Economic Performance. 2nd ed. Boston, MA: Houghton Mifflin Company, 1980.

Scherer, F.M., Innovation and Growth: Schumpeterian Perspectives. Cambridge, MA: MIT Press, 1984.

Showstack, Jonathan A., Mary Hughes Stone, and Steven A. Schroeder, "The Role of Changing Clinical Practices in the Rising Costs of Hospital Care," The New England Journal of Medicine, Vol. 313, No. 19, November 7, 1985, pp. 1201-7.

Sloan, Frank A., Joseph Valvona, James M. Perrin, and Killard W. Adamache, "Diffusion of Surgical Technology: An Exploratory Study," Journal of Health Economics, Vol. 5, 1986, pp. 31-61.

Sloan, Frank A., Michael A. Morrisey, and Joseph Valvona, "Effects of the Medicare Prospective Payment System on Hospital Cost Containment: An Early Appraisal," The Milbank Quarterly, Vol. 66, No. 2, 1988, pp. 191-220.

Souhrada, Laura, 'Hospitals Pursue Heart Programs--Despite Pitfalls," Hospitals, October 20, 1989, pp. 40-45.

Souhrada, Laura, "Imaging Devices' Shifting Uses Affect Market," Hospitals, November 5, 1990, pp. 28-33.

Stason, William B. and Harvey V. Fineberg, "Implications of Alternative Strategies to Diagnose Coronary Artery Disease," Circulation, Vol. 66, Supplement III, 1982, pp. 111-80-111-86.

Trajtenberg, Manuel, Economic Analvsis of Product Innovation: The Case of CT Scanners. Cambridge, MA: Harvard University Press, 1990.

U.S. Congress, Office of Technology Assessment, Effects of Federal Policies on Extracorporeal Shock Wave Lithotripsy. Washington, D.C.: US Congress, Office of Technology Assessment, Health Technology Case Study 36, OTA-HCS-36, May 1986.

Wagner, Henry N. and Peter S. Conti, 'Advances in Medical Imaging for Cancer Diagnosis and Treatment," Cancer, Vol. 67, No. 4, February 15, 1991, pp. 1121-1128.

Wedig, Gerard J., Mahmud Hassan and Frank A. Sloan, "Hospital Investment Decisions and the Cost of Capital,' The Journal of Business, Vol. 62, No. 4, October 1989, pp. 517-537.

Werden, Gregory J., "The Limited Relevance of Patient Migration Data in Market Delineation for Hospital Merger Cases," Journal of Health Economics, Vol. 8, No. 4, February 1990, pp. 363-376.

Wickizer, Thomas M., John R. C. Wheeler, and Paul J. Feldstein, "Have Hospital Inpatient Cost Containment Programs Contributed to the Growth in

Outpatient Expenditures? Analysis of the Substitution Effect Associated with Hospital Utilization Reveiw," Medical Care, Vol. 29, No. 5, May 1991, pp. 442-51.

Wilkenson, Richard, "New Technology That Will Change Key Services," Hospitals, May 20, 1988, pp. 56-61.

Yarbro, John W., "Changing Cancer Care in the 1990s and the Cost," Cancer, Vol. 67, No. 6, March 15, 1991, pp. 1718-1727.

Zwanziger, Jack and Glenn A. Melnick, "The Effects of Hospital Competition and the Medicare PPS Program on Hospital Cost Behavior in California," Journal of Health Economics, Vol. 7, 1988, pp. 301-320.

Zweifel, Peter, "Diffusion von Innovationenen und staatliche Regulierung im Krankenhausbereich," in Gerard Gäfgen and Peter Oberender (eds.), Technolozischer Wandel im Gesundheitswesen. Baden-Baden: Nomos Verlag, 1988, pp. 57-87.

APPENDIX A
MEDICAID REIMBURSEMENT POLICIES

MEDICAID INPATIENT HOSPITAL REIMBURSEMENT SYSTEMS
AS OF SEPTEMBER 1, 1990

STATE	DATE OF CCH UPDATE	RETROSPECTIVE PAYMENT SYSTEM	PROSPECTIVE RATE OF INCREASE CONTROLS	PROSPECTIVE CASE MIX SYSTEM	NEGOTIATE/ CONTRACT
ALABAMA	03/89		X		
ALASKA	10/88		X		
ARIZONA	04/89				X
ARKANSAS	07/87		X		
CALIFORNIA	07/88				X
COLORADO	05/89			X	
CONNECTICUT	01/89			X	
DELAWARE	07/89	X			
DC	02/89		X		
FLORIDA	11,881		X		
GEORGIA	07/88		X		
HAWAII	01/89		X		
IDAHO	06/89	X			
ILLINOIS	12/89				X
INDIANA	02,901	x			
IOWA	06/90			X	
KANSAS	07/88		X		
KENTUCKY	06/89		X		
LOUISIANA	03/87	X			
MAINE	12,881		X		
MARYLAND (1)	07/89		X		
MASSACHUSETTS1	08/89		X		

(1) MARYLAND USES A RETROSPECTIVE SYSTEM FOR NON-PARTICIPATING PROVIDERS

MEDICAID INPATIENT HOSPITAL REIMBURSEMENT SYSTEMS
AS OF SEPTEMBER 1, 1990

STATE	DATE OF CCH UPDATE	RETROSPECTIVE PAYMENT SYSTEM	PROSOSPECTIVE RATE OF INCREASE CONTROLS	PROSPECTIVE CASE MIX SYSTEM	NEGOTIATE/ CONTRACT
MICHIGAN	01/90			X	
MINNESOTA	01/90			X	
MISSISSIPPI	01/89		X		
MISSOURI	08/89		X		
MONTANA	07/88			X	
NEBRASKA	04/90		X		
NEVADA	09/89		X		
NEW HAMPSHIRE1	06/90			X	
NEW JERSEY	09/89			X	
NEW MEXICO	01/89		X		
NEW YORK	01/89			X	
N. CAROLINA	01/90		X		
NORTH DAKOTA	02/88			X	
OHIO	09/89			X	
OKLAHOMA	07/90		X		
OREGON	01/88			X	
PENNSYLVANIA	05/89			X	
RHODE ISLAND	07/89				X
S. CAROLINA	07/88			X	
SOUTH DAKOTA	01/88			X	
TENNESSEE	01/87		X		
TEXAS	10,891			X	

MEDICAID INPATIENT HOSPITAL REIMBURSEMENT SYSTEMS
AS OF SEPTEMBER 1, 1990

STATE	DATE OF CCH UPDATE	RETROSPECTIVE PAYMENT SYSTEM	PROSPECTIVE RATE OF INCREASE CONTROLS	PROSPECTIVE CASE MIX SYSTEM	NEGOTIATE/ CONTRACT
UTAH	10/88			X	
VERMONT	07/88		X		
VIRGINIA	07/88		X		
WASHINGTON	04/90			X	
W. VIRGINIA	05/90		X		
WISCONSIN	08/89		X		
WYOMING	01/88	X			

MEDICAID OUTPATIENT HOSPITAL REIMBURSEMENT SYSTEMS
AS'OF SEPTEMBER 1, 1990

STATE	DATE OF CCH UPDATE	RETROSPECTIVE	PROSPECTIVE	FEE SCHEDULE	NEGOTIATED/ RATES
ALABAMA	03/89			X	
ALASKA	10/88		X		
ARIZONA	04/89				X
ARKANSAS	07/87			X	
CALIFORNIA	07/88			X	X
COLORADO	05/89	X			
CONNECTICUT	01/89		X		
DELAWARE	07/89	X			
DC'	02/89		X		
FLORIDA	11/88		X		
GEORGIA	07/88	X			
HAWAII	01/89				X
IDAHO	06/89	X			
ILLINOIS	12/89			X	
INDIANA	02/90	X			
IOWA	06/90	X			
KANSAS	07/88			X	
KENTUCKY	06/89	X			
LOUISIANA	03/87	X			
MAINE	12/88		X		
MARYLAND (1)	07/89		X		
MASSACHUSETTS	08/89		X		

(1) RETROSPECTIVE COST IS USED FOR NAN-PARTICIPATING PROVIDERS

MEDICAID OUTPATIENT HOSPITAL REIMBURSEMENT SYSTEMS
AS OF SEPTEMBER 1, 1990

STATE	DATE OF CCH UPDATE	RETROSPECTIVE	PROSPECTIVE	FEE SCHEDULE	NEGOTIATED RATES
MICHIGAN	01/90	X			
MINNESOTA	01/90	X			
MISSISSIPPI	01/89	X			
MISSOURI	08/89	X			
MONTANA	07/88	X			
NEBRASKA	04/90	X			
NEVADA	09/89			X	
NEW HAMPSHIRE	06/90	X			
NEW JERSEY	09/89				
NEW MEXICO	01/89	X			
NEW YORK	01/89		X		
N. CAROLINA	01/90	X			
NORTH DAKOTA	02/88	X			
OHIO	09/89		X		
OKLAHOMA	07/90		X		
OREGON	01/88	X			
PENNSYLVANIA	05/89			X	
RHODE ISLAND	07/89		X		
S. CAROLINA	07/88			X	
SOUTH DAKOTA	01/88	X			
TENNESSEE	01/87	X			

MEDICAID OUTPATIENT HOSPITAL REIMBURSEMENT SYSTEMS
AS OF SEPTEMBER 1, 1990

STATE	DATE OF CCH UPDATE	RETROSPECTIVE	PROSPECTIVE	FEE SCHEDULE	NEGOTIATED RATES
TEXAS	10/89	X			
UTAH	10/88	X			
VERMONT	07/88	X			
VIRGINIA	07/88	X			
WASHINGTON	04/90		X		
W. VIRGINIA	05/90			X	
WISCONSIN	08/89		X		
WYOMING	01/88	X			

MEDICAID PHYSICIAN SERVICES REIMBURSEMENT SYSTEMS
AS OF SEPTEMBER 1, 1990

STATE	DATE OF CCH UPDATE	FEE SCHEDULE	MEDICARE CUSTOMARY PREVAILING REASONABLE	USUAL CUSTOMARY REASONABLE	NEGOTIATED/ CONTRACTED
ALABAMA	03/89			X	
ALASKA	10/88			X	
ARIZONA	04/89			X(1)	
ARKANSAS	07/87	X			
CALIFORNIA	07/88			X	
COLORADO	05/89			X	
CONNECTICUT	01/89	X			
DELAWARE	07/89			X	
DC	02/89	- -			
FLORIDA	11/88			X(*)	
GEORGIA	07/88	X			
HAWAII	01/89			X(*)	
IDAHO	06/89	X			
ILLINOIS	12/89	X			
INDIANA	02/90			X	
IOWA	06/90	X			
KANSAS	07/88			X	
KENTUCKY	06/89			X(*)	
LOUISIANA	03/87			X	
MAINE	12/88			X(*)	
MARYLAND	07/89			X	

(*) UCR INCLUDES A CAP EQUAL TO THE RELEVANT MEDICARE RATES
(1) MODIFIED BY CAPS AND CONTRACTS WITH PHYSICIANS

MEDICAID PHYSICIAN SERVICES REIMBURSEMENT SYSTEMS
AS OF SEPTEMBER 1, 1990

STATE	DATE OF CCH UPDATE	FEE SCHEDULE	MEDICARE CUSTOMARY PREVAILING REASONABLE	USUAL CUSTOMARY REASONABLE	NEGOTIATED/ CONTRACTED
MASSACHUSETTS)	08/89			X	
MICHIGAN	01/90			X(+)	
MINNESOTA	01/90			X	
MISSISSIPPI	01/89	X			
MISSOURI	08/89			X	
MONTANA	07/88		X		
NEBRASKA	04/90		X		
NEVADA	09/89	X(+)			
NEW HAMPSHIRE1	06/90		X		
NEW JERSEY	09/89			X	
NEW MEXICO	01/89	X			
NEW YORK	01/89	X			
N. CAROLINA	01/90			X	
NORTH DAKOTA	02/88	X			
OHIO	09/89		X		
OKLAHOMA	07/90			X	
OREGON	01/88		X		
PENNSYLVANIA	05/89	X			
RHODE ISLAND	07/89				X
S. CAROLINA'	07/88	X(+)			

(+) RATES DETERMINED USING RELATIVE VALUE STUDY

MEDICAID PHYSICIAN SERVICES REIMBURSEMENT SYSTEMS
AS OF SEPTEMBER 1, 1990

STATE	DATE OF CCH UPDATE	FEE SCHEDULE	MEDICARE CUSTOMARY PREVAILING REASONABLE	USUAL CUSTOMARY REASONABLE	NEGOTIATED/ CONTRACTED
SOUTH DAKOTA	01/88		X		
TENNESSEE	01/87			X	
TEXAS	10/89			X	
UTAH	10/88	X(+)			
VERMONT	07/88			X	
VIRGINIA	07/88		X		
WASHINGTON	04/90			X	
W. VIRGINIA	05/90	X			
WISCONSIN	08/89			X	
WYOMING	01/88		X		

(+) RATES DETERMINED USING RELATIVE VALUE STUDY

MEDICAID LABORATORY AND X-RAY SERVICES REIMBURSEMENT SYSTEMS
AS OF SEPTEMBER 1, 1990

STATE	DATE OF CCH UPDATE	FEE SCHEDULE	MEDICARE CUSTOMARY PREVAILING REASONABLE	USUAL CUSTOMARY REASONABLE	CHARGE BASED	NEGOTIATED/ CONTRACTED
ALABAMA	03/89			L,X		
ALASKA	10/88		L		X	
ARIZONA	04/89		L,X			
ARKANSAS	07/87	L,X				
CALIFORNIA	07/88			L,X		
COLORADO	05/89			L,X		
CONNECTICUT	01/89	L,X				
DELAWARE	07/89			L,X		
DC	02/89	L,X				
FLORIDA	11/88			L(*),X(*)		
GEORGIA	07/88	L,X				
HAWAII	01/89			L(*),X(*)		
IDAHO	06/89		L,X			
ILLINOIS	12/89	L,X				
INDIANA	02/90	L,X				
IOWA	06/90	L,X				
KANSAS	07/88			L,X		
KENTUCKY	06/89	L,X				
LOUISIANA	03/87			L(*),X(*)		
MAINE	12/88			L(*),X(*)		
MARYLAND	07/89			L,X		

L-LABORATORY SERVICES X-X-RAY SERVICES
(*) UCR INCLUDES A CAP EQUAL TO THE RELEVANT MEDICARE RATES

MEDICAID LABORATORY AND X-RAY SERVICES REIMBURSEMENT SYSTEMS
AS OF SEPTEMBER 1, 1990

STATE	DATE OF CCH UPDATE	FEE SCHEDULE	MEDICARE CUSTOMARY PREVAILING REASONABLE	USUAL CUSTOMARY REASONABLE	CHARGE BASED	NEGOTIATED/ CONTRACTED
MASSACHUSETTS	08/89			L(*),X(*)		
MICHIGAN	01/90			L(+),X(+)		
MINNESOTA	01/90			L,X		
MISSISSIPPI	01/89	L(+)X(+)				
MISSOURI	08/89			L,X		
MONTANA	07/88	L,X				
NEBRASKA	04/90	X	L(1)			
NEVADA	09/89	L(+)X(+)				
NEW HAMPSHIRE	06/90		L,X			
NEW JERSEY	09/89			L,X		
NEW MEXICO	01/89	X	L			
NEW YORK	01/89	L,X				
N. CAROLINA	01/90		L,X			
NORTH DAKOTA	02/88		L,X			
OHIO	09/89		L,X			
OKLAHOMA	07/90			L,X		
OREGON	01/88		L,X			
PENNSYLVANIA	05/89	L,X				
RHODE ISLAND	07/89					L,X
S. CAROLINA	07/88	X(+)	L			

L-LABORATORY SERVICES X-X-RAY SERVICES
(*) UCR INCLUDES A CAP EQUAL TO THE RELEVANT MEDICARE RATES
(+) RATES DETERMINED USING RELATIVE VALUE STUDY
(1) ANATOMICAL LAB SERVICES ARE REIMBURSED ON THE BASIS OF A FEE SCHEDULE

MEDICAID LABORATORY AND X-RAY SERVICES REIMBURSEMENT SYSTEMS
AS OF SEPTEMBER 1, 1990

STATE	DATE OF CCH UPDATE	FEE SCHEDULE	MEDICARE CUSTOMARY PREVAILING REASONABLE	USUAL CUSTOMARY REASONABLE	CHARGE BASED	NEGOTIATED/ CONTRACTED
SOUTH DAKOTA	01/88			L,X		
TENNESSEE	01/87			L,X		
TEXAS	10/89			L,X		
UTAH	10/88		L,X			
VERMONT	07/88			L,X		
VIRGINIA	07/88		L,X			
WASHINGTON	04/90		L,X			
W. VIRGINIA	05/90	L(+)X(+)				
WISCONSIN	08/89			L,X		
WYOMING	01/88			L,X		

L-LABORATORY SERVICES X-X-RAY SERVICES
(+) RATES DETERMINED USING RELATIVE VALUE STUDY

MEDICAID AMBULATORY SURGICAL CENTER REIMBURSEMENT SYSTEMS
AS OF SEPTEMBER 1, 1,990

STATE	DATE (OF CCH UPDATE	FEE SCHED	OLD (MEDICARE CPR	USUAL CUSTOMARY REASONABLE	CONTRACT/ NEGOTIATE	PROSPECT- IVE	CHARGE- BASED
ALABAMA	03/89		X				
ALASKA	10/88						X
ARIZONA	04/89		X				
ARKANSAS	07/87					X	
CALIFORNIA	07/88			X			
COLORADO	05/89			X			
CONNECTICUT	01/89	X					
DELAWARE	07/89			X	X		
DC	02/89				X		
FLORIDA	11/88					X	
GEORGIA	07/88					X	
HAWAII	01/89			X(*)	X		
IDAHO	06/89		X				
ILLINOIS	12/89			X			
INDIANA	02/90			X			
IOWA	06/90					X	
KANSAS	07/88				X		
KENTUCKY	06/89			X			
LOUISIANA	03/87	X					
MAINE	12/88			X(*)			
MARYLAND	07/89	X					

(*) UCR INCLUDES A CAP EQUAL TO THE RELEVANT MEDICARE RATES

MEDICAID AMBULATORY SURGICAL CENTER REIMBURSEMENT SYSTEMS
AS OF SEPTEMBER 1, 1990

STATE	DATE OF CCH UPDATE	FEE SCHED	OLD MEDICARE CPR	USUAL CUSTOMARY REASONABLE	CONTRACT/ NEGOTIATE	PROSPECT-IVE	CHARGE-(BASED
MASSACHUSETTS	08/89	X					
MICHIGAN	01/90			X(+)			
MINNESOTA	01/90			X			
MISSISSIPPI	01/89					X	
MISSOURI	08/89	X					
MONTANA	07/88	X					
NEBRASKA	04/90					X	
NEVADA	09/89	X					
NEW HAMPSHIRE	06/90	X			X		
NEW JERSEY	09/89	X					
NEW MEXICO	01/89					X	
NEW YORK	01/89					X	
N. CAROLINA	01/90				X		
NORTH DAKOTA	02/88			X			
OHIO	09/89	X					
OKLAHOMA	07/90	X(*)					
OREGON	01/88	X					
PENNSYLVANIA	05/89	X					
RHODE ISLAND	07/89	X					
S. CAROLINA	07/88	X(*)					

(+) RATES DETERMINED USING RELATIVE VALUE STUDY
(*) UCR INCLUDES A CAP EQUAL TO THE RELEVANT MEDICARE RATE

MEDICAID AMBULATORY SURGICAL CENTER REIMBURSEMENT SYSTEMS
AS OF SEPTEMBER 1, 1990

STATE	DATE OF CCH UPDATE	FEE SCHED	OLD MEDICARE CPR	USUAL CUSTOMARY REASONABLE	CONTRACT/ NEGOTIATE	PROSPECT-IVE	CHARGE-BASED
SOUTH DAKOTA	01/88			X			
TENNESSEE	01/87					X	
TEXAS	10/89					X	
UTAH	10/88			X			
VERMONT	07/88			X			
VIRGINIA	07/88					X	
WASHINGTON	04/90	X					
W. VIRGINIA	05/90	X					
WISCONSIN	08/89			X			
WYOMING	01/88					X	

(+) RATES DETERMINED USING RELATIVE VALUE STUDY

APPENDIX B
BLUE CROSS/BLUE SHIELD REIMBURSEMENT POLICIES IN SELECTED STATES

Blue Cross and Blue Shield of California

Inpatient Hospital: Contracts are negotiated with individual hospitals. Those hospitals who choose to contract are reimbursed in two ways. (1) Fee-for-service pays a percentage of the agreed-upon charge, which is automatically adjusted for inflation. The hospital submits cost reports to Blue Cross to determined allowed charges. Contracts are periodically reviewed on an individual charge basis. (2) PPO and HMO contracts calculate imputed rates using historical data from the office of statewide planning and in-house data. PPOs and HMOs are paid a percentage of allowed charges for outpatient services. Non-contractinghospitals receive a percentage of billed charges based on patient's policy agreement. The percentage can be anywhere from 0 to 75 percent.
Outpatient Hospital: Same as above.
Physicians: Reimbursed on a reasonable cost basis.
Laboratorv and X-Ray Services: Reimbursed on a reasonable cost basis.
Ambulatorv Surgical Centers: Contracting ASCs negotiate individually with Blue Cross. Fee schedules are negotiated for each facility and then the facility is paid a percentage of the allowed charge. Non-contracting facilities are paid a lower percentage of billed charges.

Blue Cross and Blue Shield of Massachusetts. Inc.

Approximate Enrollment: 2.4 million
Inpatient Hospital: Reimbursement levels are determined by the state Rate Setting Commission. An individual hospital's 1981 actual costs are trended for inflation, volume changes, costs beyond the hospital's control and legislative changes (e.g., allowances for labor shortages). Additional allowances are made for capital costs, interest and depreciation, and malpractice allowances. Through a formula, each hospital's allowed charges are calculated. The product of this calculation is defined as the hospital's maximum allowed charge calculation (MACC). The MACC is then increased to a charge level with allowances for working capital, bad debt, and free care to calculate an Approved Gross Patient Revenue Care (GPR) number. Hospitals are paid 93.02 percent of billed charges as long as the total annual amount is less than the GPR. Costs assigned to non-Medicare patient are audited by the Rate Setting Commission to prevent cost-shifting.
Outpatient Hospital: Same as hospital inpatient.
Physicians: UCR reimbursement, with some allowance for specialties.
Laboratorv and X-Rav Services: Free-standing and physician office-based labs are paid with UCR reimbursement. Free-standing imaging centers are also reimbursed on a UCR basis. Hospital labs and X-rays are paid through the hospital system as described above.
Ambulatorv Surgical Centers: Free-standing ASCs are currently paid according to four fee screen categories. Future plans are to expand the number of fee screens to six. Hospital-based ASCs are reimbursed through the hospital system.

Empire Blue Cross and Blue Shield of New York

Hospital Inpatient: Medicare DRG system.
Hospital Outpatient: Fee schedule based on each hospital's cost report.
Ambulatory Surgical Centers: Fee schedule similar to that used for outpatient' services.

Blue Cross of Greater Philadelphia

Approximate Enrollment: 2 million
Inpatient Hospital: Contracts are negotiated with the area hospital association (65 hospitals in 5 counties). Hospitals are reimbursed on a cost per admission basis with allowances and adjustments for casemix variation, capital pass-throughs, and inflation.
Outpatient Hospital: Medicare reasonable costs.
Ambulatory Surgical Centers: Free-standing ASCs are reimbursed on a contractually agreed upon basis. Any ASC associated with a hospital is covered under the hospital contract and is reimbursed as an outpatient facility.

Blue Cross and Blue Shield of Rhode Island

Approximate Enrollment: 624,000
Inpatient Hospital: Prospective cost-based reimbursement. Blue Cross/Blue Shield and Medicaid get together with each hospital to negotiate contracts for that hospital. Hospitals present cost analyses; Blue Cross/Blue Shield and Medicaid jointly establish rates.
Outpatient Hospital: Prospective cost-based reimbursement. Negotiated at the same time and in the same manner as inpatient contracts.
Physicians: The lower of actual or prevailing charges.
Laboratorv and X-Ray Services: The lower of actual or prevailing charges.
Ambulatory Surgical Centers: There is only one ASC in the state. All-inclusive rates for four categories are negotiated annually. Capital payments are negotiated separately.

Blue Cross and Blue Shield of Washington. D.C.

Approximate Enrollment: 1.3 million
Inpatient Hospital: Individual contracts with facilities.
Outpatient Hosnital: Individual contracts with facilities.
Physicians: UCR reimbursement.
Laboratorv and X-Rav Services: UCR reimbursement.
Ambulatorv Surgical Centers: Individual contracts with facilities.

APPENDIX C
PUBLICLY AVAILABLE DATA SETS

APPENDIX C

PUBLICLY AVAILABLE DATA SETS

State	Cost Reports	Patient Discharge Data
Arizona	X	
California	X	X
Colorado	X	X
Florida	X	X
Illinois	X	X
Maine	X	X
Maryland	X	X
Massachusetts	X	X
Nevada	X	X
New Jersey	X	X
New York	X	
Oregon	X	X
Pennsylvania	X	
Rhode Island	X	
South Carolina	X	X
Tennessee	X	
Vermont	X	
Washington	X	X
West Virginia	X	X
Wisconsin,	X	X

Source: National Association of Health Data Organizations, 1991.