KRASNER, MELVIN ISAAC

AN ECONOMETRIC ANALYSIS OF THE PRODUCTIVITY AND DISTRIBUTION OF HEALTH MANPOWER

City University of New York PH.D. 1980

AN ECONOMETRIC ANALYSIS OF THE PRODUCTIVITY AND DISTRIBUTION OF HEALTH MANPOWER

by

MELVIN I. KRASNER

A dissertation submitted to the Graduate Faculty in Economics in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

1980

This manuscript has been read and accepted for the Graduate Faculty in Economics in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

Jan 29, 1980
date

Michael Grossman
Chairman of Examining Committee

January 29 1980
date

Robert Pollak
Executive Officer

Professor Michael Grossman
Professor Charlotte Muller
Professor Harold Hochman

Supervisory Committee

The City University of New York

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CHAPTER I

INTRODUCTION AND OVERVIEW

As medical science has advanced in its ability to identify disease and alleviate the suffering and discomfort of illness, the availability of effective medical services has become a subject of widespread interest and growing concern. Much of this concern has been focused on the adequacy of the supply of physicians in the United States, which stimulated many reports on physician manpower over the past few decades.[1] In addition, recent years have witnessed a substantial amount of research on physician supply and distribution. For the most part, however, studies of physician manpower dealt with broad categories of physicians and paid insufficient attention to the unique characteristics of individual specialties.

Because most physician services in the United States are provided by specialists and this characteristic of American medical care is likely to persist for some time, better understanding of specialty services is essential. The purpose of the present

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[1]For a concise review of the issues and recent reports, see Physicians for the Future: Report of the Macy Commission (New York: Josiah Macy, Jr. Foundation, 1976).

study, is to provide an understanding of the production and geographic distribution of physicians' services, that recognizes the distinct professional features of different specialties. A single medical specialty is analyzed in this report, but the study is intended to provide general insights for national policy on physician manpower.

Although all physicians share many professional attributes, they also differ markedly by specialty. Each specialty obviously has its own purview, but specialties also differ in many ways related to the production and geographic distribution of medical services. For example, the degree of specialization and the ability of patients to travel should play a role in evaluating the geographic distribution of physicians. Similarly, the amount of time required for the average visit and the type of equipment and setting used for patient care are closely related to the production process. All such factors should be identified and taken into account in analyzing the current situation and in formulating policy.

For the present study, dermatology was selected as a clearly defined specialty that could form the basis of an econometric analysis of the production and geographic distribution of specialty services. Dermatologists form a relatively small, fairly homo-

geneous professional group, whose patients are almost always cared for in an office setting. This specialty has also conducted and cooperated with a number of health manpower assessment efforts, which resulted in the collection of a variety of data that made possible the present empirical analysis.

Overview

The characteristics of this specialty, its practitioners, and the patients afflicted with diseases of the skin, hair, and nails are described in chapter 2. Although dermatologists use a variety of diagnostic tools, simple visualization of an abnormality is the major method of diagnosis. Almost all dermatological care is provided on an ambulatory basis, and the average duration of a visit is quite short. Acne accounts for about 25 percent of all visits to dermatologists, and psoriasis, infections, and skin cancer also figure prominently in the specialist's patient population. Dermatologists, however, handle only about a third of all visits to physicians for skin problems. The demand for dermatologists' care varies substantially by age, income, and education. For every one thousand persons, less than 100 visits per year are made to dermatologists, but about 161 visits per thousand persons are made among families with incomes of $25,000 or more; similarly,

relatively high rates of utilization are found among the more highly educated and among persons aged 15 to 24. Auxiliary personnel employed by dermatologists can perform a wide variety of routine duties, as they can in most physician practices. However, the superficial nature of most dermatological complaints and the rarity of emergencies and life-threatening situations in dermatological practice are reasons to expect greater delegation of responsibilities to adjuvant personnel. Nevertheless, dermatologists as a group have expressed reluctance to delegate many tasks.

A description of the information that forms the basis of the present study and a discussion of the purpose and conceptual framework of the study constitute chapter 3. The empirical analysis is based on information from a variety of sources. Information on the outputs, inputs, and other characteristics of dermatologists' practices comes from a University of Southern California survey of about 300 practices, of which about 150 observations form the basis of the empirical analysis of production. Information on the local supply and national distribution of dermatologists was provided by the American Academy of Dermatology; demographic and economic information on local areas was obtained from the U.S. Census; and local physician fee levels were derived from the Medicare program. An important

part of assembling the information was organizing the data on the basis of Zipcode Sectional Areas, which appear to be especially appropriate geographic units for analyzing dermatologists' services.

The latter half of the chapter is a discussion of the policy issues and the analytic questions that motivated the present study. The general issues of access to health services, medical specialization, and the geographic distribution of physicians have been mentioned earlier and are widely discussed. Particularly interesting questions are whether physicians vary output in response to local demand pressure, how is output varied, and to what extent does the variation in output mitigate the uneven geographical distribution of physicians. Other items discussed include the nature of the market for physicians' services and characteristics of the physician, his practice, and its location that may influence output.

Chapter 4 is a brief discussion of the problems involved in defining and measuring the output of physicians. The ultimate output of medical services is health, but this eludes accurate measurement and is influenced by many other variables. The use of an intermediate output such as visits, however, is consistent with the state of the art, and it is in conformity with modern theories of consumption that regard all

goods and services produced in the marketplace as merely inputs into the household production of utility. Thus, the dermatologist visit is the basic unit of output used in the empirical analysis, but minor refinements of this measure are discussed and used in the analysis.

Descriptive information on the output and characteristics of dermatologists' practices is presented in chapter 5. Output per physician is inversely related to the local supply of dermatologists relative to population, which is consistent with a priori expectations and the findings of earlier studies. The effects on output of other measures of local demand pressure are examined. Output rises initially with the age of dermatologists but declines eventually, as one would expect, and board-certified physicians had substantially greater output than their uncertified colleagues. The effects of form of remuneration and level of local physician fees are also examined, but the findings can only be regarded as generally suggestive.

The econometric analysis of the production of dermatologists' services is described at length in chapter 6. The form of the production function used for the empirical analysis is more appropriate than the form of the conventional Cobb-Douglas production function for analysis of physicians' services, and it permits the marginal products and elasticities to

vary freely over the production surface. Because of a lack of data on capital services and consumable supplies used in dermatologists' practices, only labor inputs are included in the present analysis. Fortunately, in analyzing this labor-intensive production process, the three categories of labor input involved provide a rich basis for empirical analysis.

The basic unit of output is the patient visit, but a number of alternative methods were used to weight each visit. Unfortunately, all of the results were highly intercorrelated, which implies that the refinements contributed little to measuring output. After converting the production function to logarithmic form, its parameters were estimated using ordinary least squares regression. The coefficient of multiple determination (R^2) of the regression equation was .49, which is not unexpectedly low when dealing with individual cross-sectional observations. All of the coefficients had the expected signs, and only one was not significant at the 5 percent level. The production functions were also estimated separately for dermatologists in solo, partnership, and group practice. The addition of a variable reflecting the local per capita supply of dermatologists did not make much difference, but a dummy variable equal to one if the dermatologist was board certified was highly significant.

Because the empirical findings of this analysis may be sensitive to the functional form selected, the data (after making some necessary modifications) were also used to estimate the parameters of a Cobb-Douglas production function. For the most part, the input and scale elasticities were similar for both functional forms at the sample means, but they diverged substantially at input values greatly different from the sample mean, as one would expect. Using the original production function parameters, the marginal products of physician time and auxiliary staff time were calculated and graphed. Because the marginal productivity of auxiliary staff seemed extremely low, a production function was estimated on the basis of a selected sample, with an apparent improvement in the results. At the sample mean, the marginal product of physician time was about 3.8 visits per hour, and the marginal products of the two categories of auxiliary time were about .7 and .4 visits per hour. The marginal rates of substitution between the inputs and the shadow price of dermatologist time were derived; although the results were not quite as expected, they were definitely plausible.

Chapter 7 is an exploratory examination of the geographic distribution of dermatologists. Because an extensive literature on physician distribution already exists, the emphasis of the present study is on

characteristics of the specialty and the identification of an appropriate geographic unit of observation. The supply of dermatologists, the supply per capita, and the change in supply between 1967 and 1977 are the three dependent variables studied. Each equation presented is estimated on the basis of the following geographic units: states, Zipcode Sectional Areas, and Zipcode areas consolidated on the basis of their economic integration. The variables that are associated with the supply of all physicians, such as size, education, and income of the population, figured prominently in the supply of dermatologists, and--given the limitations of the data--only a few specialty-specific determinants of distribution, such as the proportion of the population aged 15 to 24 and the number of residency positions in dermatology, could be examined. The analysis, however, strongly suggests that consolidated areas are very appropriate, and perhaps superior, geographic units for studying the services of dermatologists or similar medical specialists.

The accomplishments and limitations of the present study are briefly reviewed in chapter 8, and directions for future analysis are outlined.

CHAPTER II

A PROFILE OF THE SPECIALTY

Characteristics of the specialist

A dermatologist is a physician who specializes in the diagnosis and treatment of diseases of the skin, hair, and nails. Dermatologists are also trained to be expert in recognizing the cutaneous manifestations of systemic (i.e., generalized) disease, and in that capacity may serve as diagnostic consultants to other physicians. Most of the initial visits made to dermatologists, however, are at the initiative of the patient rather than the result of physician referral;[1] the patient readily notices an abnormality on the skin, and he will often bypass the family physician or general practitioner and seek specialty care directly.

Because of the extensive training and experience of the dermatologist in the superficial manifestations of disease, simple visual inspection of the abnormality is often sufficient for diagnosis. This is probably the reason for the short duration of dermatologists' visits.

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[1]Robert C. Mendenhall et al., "A Study of the Practice of Dermatology in the United States," Archives of Dermatology 114 (October 1978): 1458.

According to the National Ambulatory Medical Care Survey, visits to dermatologists take an average of less than 12 minutes, the shortest period among major specialty groups (table 2-1). The dermatologist, however, does routinely employ a number of diagnostic techniques, including biopsy, culture, and special lighting. The average dermatologist devotes about 39 hours per week to professional activities, which is substantially less than other specialists, and handles approximately 140 patient visits per week.[1]

In 1975, there were about 4,400 dermatologists in the United States principally engaged in patient care, including over 600 physicians in training. This amounts to about 1.4% of all doctors of medicine whose primary professional activity is patient care.[2] As is the case for other specialists, dermatologists tend to be disproportionately concentrated in metropolitan areas. Training in this specialty required for certification by the American Board of Dermatology generally involves four years of postgraduate work after medical school, of which three years must be in an approved dermatology residency program.[3] Almost all residency positions in

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[1]Ibid., p. 1457.

[2]Louis J. Goodman and Henry R. Mason, Physician Distribution and Medical Licensure in the U.S., 1975 (Chicago: American Medical Association, 1976), p. 37.

[3]Directory of Medical Specialists, (Chicago: Marquis Who's Who, Inc., 1975), pp. 137-140.

TABLE 2-1

AVERAGE AMOUNT OF TIME SPENT BY PHYSICIANS IN DIRECT CONTACT WITH PATIENTS, PER VISIT, BY PHYSICIAN SPECIALTY, UNITED STATES, 1975

Specialty	Average Duration of Physician Contact in Minutes
General and family practice	12.6
Internal medicine	18.2
Obstetrics and gynecology	13.1
Pediatrics	12.1
General surgery	12.7
Ophthalmology	20.3
Orthopedic surgery	14.5
Otolaryngology	13.6
Psychiatry	46.9
Dermatology	11.9
Urology	15.0
Cardiovascular diseases	21.5
Neurology	35.5
All specialties	15.0

SOURCE: U.S. Department of Health, Education, and Welfare, Public Health Service, National Center for Health Statistics, Ambulatory Care Rendered in Physicians' Offices: United States, 1975, Advance Data from Vital and Health Statistics of the National Center for Health Statistics, no. 12, October 12, 1977.

the specialty are filled (relatively few by graduates of medical schools outside the United States and Canada), which attests to dermatology's desirability as a career choice among medical graduates (table 2-2). More than half of all dermatologists are in sclo practice, with only about twenty percent employed in partnership and group arrangements combined.[1]

Purview of the specialty

Although dermatology is (with some justification) often regarded as a cosmetic specialty because improved appearance is the objective of many therapeutic measures, dermatologists are also called upon to diagnose and treat many life-threatening conditions. Cancer of the skin is the most common form of cancer in the United States, but, fortunately, most cases are readily curable with expert dermatological care.[2] In addition, skin disease accounts for substantial economic loss; it is generally recognized as the most prevalent form of occupational illness.[3]

The most common illness treated by dermatologists is acne, a disease of the sebaceous glands generally

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[1]Mendenhall, "Practice of Dermatology," p. 1457.

[2]U.S. Department of Health, Education, and Welfare, Public Health Service, National Institute of Health, Progress Against Cancer of the Skin, DHEW Publication No. (NIH) 75-310, revised 1974.

[3]Gerald A. Gellin, Occupational Dermatoses (Chicago: American Medical Association, 1972) p.1.

TABLE 2-2

NUMBER OF ACCREDITED RESIDENCY POSITIONS AND PERCENT FILLED, BY SPECIALTY, 1974

	Total Positions Offered Sept. 1974	Percent Filled	Percent Filled by U.S. & Canadian Graduates	Percent Other Graduates in Filled Positions
Anesthesiology	2,260	90	41	54
Child psychiatry	744	77	53	31
Colon and rectal surgery	34	88	59	33
Diagnostic radiology	2,300	90	76	16
Dermatology	788	97	90	8
Family practice	3,342	80	74	8
General practice	333	86	11	87
Internal medicine	11,353	97	71	27
Neurological surgery	645	94	75	20
Neurology	1,124	93	66	29
Nuclear medicine	129	73	47	36
Obstetrics and gynecology	3,652	94	63	33
Ophthalmology	1,579	99	92	8
Orthopedic surgery	2,454	97	86	11
Otolaryngology	1,049	95	79	17
Pathology	3,404	83	40	52
Pathology, forensic	60	47	30	36
Neuropathology	66	61	42	30
Pediatrics	4,988	96	66	31
Pediatric allergy	135	84	67	20
Pediatric cardiology	142	87	61	30
Physical medicine	507	78	24	70
Plastic surgery	422	94	76	19
Psychiatry	5,012	87	60	36
Radiology	900	80	38	52
Surgery	7,802	94	64	32
Therapeutic radiology	484	77	45	41
Thoracic surgery	318	93	61	35
Urology	1,156	97	76	21

SOURCE: Directory of Accredited Residencies, 1975-76 (Chicago: American Medical Association, 1976) p. 8.

limited to adolescents and young adults. Visits for this condition constitute about one-quarter of the average dermatologist's work-load. Other prominent categories of cutaneous disease treated by dermatologists include psoriasis, infections (viral, bacterial, and fungal), various forms of cancer, allergic skin reactions, and ill-understood inflammations of the skin.[1]

Most of dermatologists' time is spent handling patients with chronic disease, for which the underlying causes are unknown but which are, nevertheless, responsive to various therapies. More than 95 percent of all patient visits occur in an ambulatory setting, and very little use is made of hospital inpatient facilities. The dermatologist's office, however, is often the setting for a great deal of skin surgery, performed for such varied purposes as hair transplantation and excision of malignant lesions.[2]

Of all visits to physicians for skin problems, only about one-third are made to dermatologists. General and family practitioners handle a little more than a third of the visits, and the remainder is handled by

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[1]U.S. Department of Health, Education, and Welfare, Public Health Service, National Center for Health Statistics, Office Visits to Dermatologists: National Ambulatory Medical Care Survey, United States, 1975-76, Advance Data from Vital and Health Statistics of the National Center for Health Statistics, no. 37, August 29, 1978.

[2]Mendenhall, "Practice of Dermatology," p. 1461.

internists, general surgeons, pediatricians, obstetrician-gynecologists, and other specialists.[1] As shown in table 2-3, the proportion of visits handled by dermatologists varies substantially according to the particular condition being treated. Some what surprising is the fact that, of all the conditions presented, dermatologists have the largest share of physician visits for acne, which is an easily-recognized, self-limiting condition. Most cases of this condition are readily responsive to topical and systemic drug therapy that can be easily managed by a general practitioner. Apparently, the technical requirement of the medical problem is not the most important factor encouraging patients to seek the care of a specialist. Unfortunately, the most serious and complex cutaneous diseases are not presented individually in the table because of their rarity; consequently, the role of specialty expertise in the care of these illnesses cannot be readily determined.

Patient population

The demand for dermatologists' services varies substantially by a number of economic and demographic factors. The variation may reflect differences in the quantity of medical care sought by individuals or dif-

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[1]U.S. Department of Health, Education, and Welfare, Public Health Service, National Center for Health Statistics, National Ambulatory Medical Care Survey, (unpublished data).

TABLE 2-3

PROPORTION OF ALL VISITS FOR DERMATOLOGICAL PROBLEMS HANDLED BY DERMATOLOGISTS, U.S., 1972

	Dermatologists' Share of All Physician Visits
Acne	84%
Infectious warts	33%
Dermatitis	14%
Eczema	43%
Psoriasis	67%
Seborrheic dermatitis	67%
Keratoderma	54%
Lichenification and lichen	43%
Dermatosis	72%
Diseases of hair follicles	47%
Unspecified infections of skin	19%
Erythematous conditions	39%

SOURCE: "The Dermatologist in Private Practice," NDTI Review (Ambler, Penn.), September 1973, p. 9.

ferences in quality, i.e., the substitution of a specialist's care for the care of a general practitioner. For example, the high rates of visits per person per year at the upper level of income and education shown in table 2-4 and table 2-5 undoubtedly reflect increased consumption linked to the ability to pay for care; but increased sophistication in seeking specialists' care may also be an important factor underlying these data.

Another important variable in the demand for dermatologists' care is age of the population. As shown in table 2-5, the rate of visits per person per year is substantially higher for persons between the ages of 15 and 24 than for the rest of the population; this is undoubtedly related to the high prevalence of acne for this age group. In studies of general physician manpower, the peculiar effect of population age on demand may be obscured, because each specialty may serve a predominantly different age group. It obviously is desirable to tailor the population age characteristic used in any analysis to the particular specialty under study, rather than rely upon the commonly-employed breakdown based only upon 65 years of age. (See chapter 7.) The distribution of visits between the sexes, however, is similar for all physicians and dermatologists, with 60 percent of visits made by females.[1]

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[1]U.S. Department of Health, Education, and Welfare, Office Visits to Dermatologists, p. 4.

TABLE 2-4

NUMBER OF VISITS TO DERMATOLOGISTS AND NUMBER OF VISITS PER PERSON PER YEAR, BY INCOME LEVEL, UNITED STATES, 1974-1975

Annual Family Income in Dollars	Visits in Thousands	Visits Per Person
Under 3000	1,140	.076
3,000 - 4,999	982	.056
5,000 - 6,999	1,198	.060
7,000 - 9,999	1,245	.046
10,000 - 14,999	3,605	.073
15,000 - 24,999	4,669	.099
25,000 and over	3,144	.161
All persons*	16,829	.080

SOURCE: Melvin Krasner et al., "Dermatologists for the Nation," Archives of Dermatology 113 (October 1977): 1370.

*Includes unknown income.

TABLE 2-5

NUMBER OF VISITS TO DERMATOLOGISTS AND NUMBER OF VISITS PER PERSON PER YEAR, BY EDUCATION AND BY AGE, UNITED STATES, 1974-1975

	Visits in Thousands	Visits Per Person
Education		
Less than 8 years	1,414	.058
8 - 11 years	3,203	.059
12 years	4,517	.066
13 or more years	7,501	.124
Age in years		
Under 15	2,060	.038
15 - 24	4,727	.123
25 - 44	4,437	.085
45 - 64	3,901	.090
65 and over	1,703	.081

SOURCE: Melvin Krasner et al., "Dermatologists for the Nation," Archives of Dermatology 113 (October 1977): 1370.

Emergency situations that require a dermatologist's expertise are extremely rare, which is an attractive feature to women physicians with family responsibilities and other individuals in circumstances that require restricted professional activity. This characteristic of dermatological care and the fact that virtually all dermatologists' patients are ambulant, are important considerations in planning accessible services on a local basis.

Auxiliary personnel in dermatology practice

The use of auxiliary personnel in physicians' practices is new neither in concept nor in practice,[1] but it has attracted a great deal of attention in recent years. The evolution of new categories of health workers, who have slowly but steadily earned the necessary legal and cultural recognition, has substantially expanded the range of feasible staffing arrangements for producing physicians' services.[2] Nurse-practitioners and physician's

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[1]For example, see C. Rufus Rorem, Private Group Clinics (Chicago: University of Chicago Press, 1931; reprint ed., New York: Milbank Memorial Fund, 1971), p.35.

[2]Henry K. Silver and James A. Hecker, "The Pediatric Nurse Practitioner and the Child Health Associate: New Types of Health Professionals," Journal of Medical Education 45 (March 1970): 171-176; Robert D. Coye and Marc F. Hansen, "The Doctor's Assistant," Journal of the American Medical Association 209 (July 28, 1969): 529-533; Judith R. Lave, Lester B. Lave, and Thomas Morton, "The Physicians Assistant: Exploration of the Concept," Hospitals 45 (June 1, 1971): 42-51; and Frederick L. Golladay, Marianne Miller, and Kenneth R. Smith, "Allied Health Manpower Strategies: Estimates of the Potential Gains from Efficient Task Delegation," Medical Care 11 (November-December 1973): 457-469.

assistants now assume duties and responsibilities traditionally reserved for the physician, and conventional nursing personnel are being widely enlisted to help provide personal medical services in physicians' offices. The secretary-receptionist is an almost indispensible part of every medical practice, and expanding biomedical technology has made the employment of various technicians fairly commonplace.

In dermatology practices, ancillary staff handle many administrative tasks that are common to all physicians' practices, such as billing and bookkeeping, maintaining supplies and equipment, and controlling patient flow. Similarly, ancillary personnel perform a variety of functions more closely related to patient care, including sterilizing surgical instruments, instructing patients, and handling clinical photography. As the training and experience of auxiliary personnel increases, such personnel can assume greater responsibility for patient care.

The formal classification of auxiliary personnel, especially the categorization of nurse practitioners and physician assistants, does not accurately delineate the level of responsibility or the breadth of functional competence for any particular aide in a dermatologist's practice. A relatively small set of dermatological problems and their related diagnostic and therapeutic procedures constitute the bulk of dermatology practice;

thus, a relatively small amount of training--either in a structured format or on the job--can develop important skills useful in handling a majority of dermatologists' patients. In most dermatology practices, this circumscribed area of technical competence is more valuable than the broad knowledge and skills taught in general physician assistant programs.

The Board of Medicine of the National Academy of Sciences classified physician's assistants by level of independent judgement and specialization: Type A assistants have broad knowledge and skills and are qualified to exercise a degree of independent judgement; Type B assistants do not possess knowledge and skills related to the entire range of medical care, but they have exceptional skill in a particular specialty; Type C assistants have a wide range of skills, but do not possess the depth of knowledge nor the capacity for independent judgement that Type A assistants have.[1] The Type B assistant would, therefore, be someone who performs technical, rather than analytic or interpretive, tasks often performed by physicians, and it is this kind of assistant that appears to be the most useful in the

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[1]Alfred M. Sadler, Jr., Blair L. Sadler, and Ann A. Bliss, The Physician's Assistant: Today and Tomorrow, 2nd ed. (Cambridge, Massachusetts: Ballinger Publishing Co., 1975), pp. 8-11.

practice of dermatology.[1] Many practitioners, however, might feel more comfortable training and delegating responsibility to individuals with general formal training and credentials.[2]

Despite a widespread recognition of the usefulness of a specialized assistant, there are currently no formal civilian training programs. This may simply indicate that on-the-job training is less expensive or more beneficial, i.e., more efficient than formal instruction. An alternative explanation may be related to ownership and financing difficulties for the development of this form of human capital, i.e., employers may be reluctant to finance the training because they have no assurance that the benefits and returns of their investment will accrue to them, and employees may be reluctant to finance training for which there is a small and uncertain market. The on-the-job setting for training makes the skills more specific (and less portable) and provides the employer and employee with a reasonable expectation of continued

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[1]Stanford I. Lamberg, "Physician's Assistants in Dermatology," Archives of Dermatology 104 (September 1971): 227-230; and Donald O. Hayen, "Socioeconomic Pressure for New Methods of Health Care Delivery," Archives of Dermatology 106 (September 1972): 421.

[2]David G. Welton, "Physician Support Personnel in Office Practice," Archives of Dermatology 105 (January 1972): 42-45; and Marie-Louise T. Johnson, Dermatology and the Physician's Assistant (Evanston, Illinois: National Program for Dermatology of the American Academy of Dermatology, 1974), p. 8.

employment. Therefore, both may be willing to share the financing of the human capital investment, provided they both share in the returns. The United States Navy has operated a Dermatology Technician School since 1957, which includes substantial classroom instruction.[1] The apparent long-term success of this formal program suggests that financing difficulties play a role in determining the locus of training in the civilian sector.

Irrespective of the setting of training and regardless of other general training or credentials, there are a number of specialized tasks that a dermatology assistant is usually expected to perform. The diagnostic procedures that a trained assistant could routinely handle include potassium hydroxide preparation (for microscopic identification of fungi), patch testing (for identifying allergenic agents), Wood's light examination, bacterial slide preparation, and mycologic cultures. Among the therapeutic techniques that an assistant could handle are ultraviolet light administration, acne surgery, incision and drainage of abscesses, cryotherapy of warts, assisting at more complicated surgical procedures, and instructing patients in the application of topical medications and

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[1]Warren W. Epinette and Richard G. Davis, "The Navy Dermatology Technician," Archives of Dermatology 107 (May 1973): 687-688.

dressings.[1] The extent to which these tasks are delegated will, of course, depend on the ability of the assistant, the attitude of the physician, and, at least to some degree, the preferences of patients. In situations where physicians are unavailable, skilled mid-level practitioners have been able to manage--independently and effectively--a substantial proportion of dermatological complaints.[2] Nevertheless, many dermatologists have expressed a reluctance to delegate a variety of tasks tc auxiliary personnel.[3]

In summary, dermatology is a medical specialty with a number of distinct characteristics. Virtually all patients are ambulant, and the majority of patient complaints do not involve a threat to life and limb. Although a relatively small number of conditions account for the bulk of a dermatologist's workload, dermatology encompasses many individual diseases, some of which are

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[1]Ibid., p. 688; Hayen, "New Methods of Health Care Delivery," p. 421; and Johnson, Dermatology Assistant, pp. 107-115.

[2]Kasha Barnove et al., "Round Table Discussion: Skin Diseases in a Rural Practice," Nurse Practitioner 1 (July-August 1976): 11-14.

[3]Melvin Krasner et al., "New Health Practitioners and Dermatology Manpower Planning," Archives of Dermatology 113 (September 1977): 1280-1282.

quite rare. Only about a third of physician visits for dermatological care is handled by dermatologists, most of the remainder going to primary care physicians; in addition, a noteworthy proportion of care may be provided by non-physicians. For example, at least half of the workload of podiatrists involves treatment of the skin of the foot.[1] Similarly, mid-level health practitioners can provide a great deal of dermatological care, but this is customarily done under the direct supervision of a dermatologist. Despite the apparent usefulness of auxiliary personnel in dermatologists' practices, there appear to be barriers preventing realization of the full potential of such personnel.

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[1] "An Assessment of Foot Health Problems and Related Health Manpower Utilization and Requirements," Journal of the American Podiatry Association 67 (February 1977): 102-114.

CHAPTER III

EMPIRICAL BASIS AND CONCEPTUAL FRAMEWORK OF THE PRESENT STUDY

Empirical Basis

The present study is based on a variety of data obtained from different sources, including rosters of practitioners and survey responses provided by the American Academy of Dermatology and a fairly novel disaggregation of demographic information provided by the United States Bureau of the Census; but the most important source of data--which made possible the analysis of the production of dermatologists' services--was the Dermatology Practice Study.

Dermatology Practice Study

Information on the output and inputs of dermatologists' practices was derived from a survey conducted by the Medical Activities and Manpower Project, Division of Research in Medical Education, University of Southern California School of Medicine. The survey, called the Dermatology Practice Study, was one of over twenty studies of different specialties conducted at U.S.C. with the support of the Robert Wood Johnson Foundation and the Bureau of Health Manpower, Health Resources

Administration, U.S. Department of Health, Education, and Welfare. A stratified random sample of dermatologists was selected from the AMA Physicians Masterfile, which is based on self-reported information for all physician characteristics including specialty status. The stratification is based on five categories of physicians, based upon practice arrangement and involvement in patient care.

The survey instrument is a lengthy and detailed log-diary consisting of three major parts. Part I is a summary of the physician's patient encounters and professional hours per day, for an assigned seven-day period. Part II elicits more detailed information for an assigned three-day recording period. The first section of part II is a record of the physician's professional and non-professional activities by 15-minute intervals. The second section is a detailed log of telephone conversations with patients. Of major interest is the third section of part II, which is a detailed description of patient visits including patient characteristics, diagnosis, procedures, and disposition. The last section of part II is a record of the respondent's teaching and research activities during the study period. Part III elicits information on the respondent's professional characteristics, the nature of his practice, and items related to the location of the practice.

The survey was conducted in April of 1976, with the endorsement of the American Academy of Dermatology. Extensive measures were taken to enlist participation in the complex and time-consuming survey. Of a total sample of 597, seventy-one percent responded. On the basis of general demographic characteristics of the respondents, it appeared unlikely that substantial sampling bias was introduced by the non-respondents. The data were reviewed for completeness and consistency, coded, and placed onto a computer file by the U.S.C. survey staff. To make the present research possible, the U.S.C. staff prepared a summary file of information on approximately 150 dermatologists in solo, partnership, or group practice for whom acceptable responses were received. The data on patient visits made available for the present analysis are based on the three-day survey period during which detailed information was collected. The detailed description of the visits permitted some refinement of gross visit volume as a measure of output (see chapter 4).

In addition to detailed information on the output (i.e., patient visits) of dermatologists' practices and the amount of time the practitioner devoted to patient care, the survey also elicited information on characteristics of the respondent, the organization of his or her practice, and its location. Specifically, the informa-

tion provided for the present analysis includes the following:

1. The number and type of personnel employed in the practice

2. The number of years since the respondent completed medical school

3. Whether the respondent has been certified by the American Board of Dermatology

4. Whether the respondent is working in a solo, partnership, or group practice

5. Whether the principal form of remuneration for professional services is fees

6. The number of days a patient must wait for a scheduled appointment

7. The respondent's opinion on whether there is an oversupply or undersupply of dermatologists in the area.

8. The respondent's opinion on whether there is an oversupply or undersupply of other physicians in the area.

Each practice is, of course, also identified by its geographic location according to Zipcode Area, county, and state.

Delineation of medical market areas

For a number of analytic purposes, it appeared advisable to identify a geographical unit that was particularly appropriate for studying dermatologists' services. The Zipcode Sectional Area seemed to approximate the market area for dermatologists' services, and its superiority over conventional geopolitical units for studying the services of physician specialists is described in a separate paper.[1]

Zipcode Sectional Areas, identified by the first three digits of the five-digit Zipcode number, were designated by the United States Postal Service for the management of mail distribution. They were established on the basis of local transportation patterns and thus, in most cases, approximate economic trading areas.[2] It appears reasonable to assume that geographic patterns of health services utilization largely conform to those for goods and services in general, and this has been verified empirically in a recent study.[3]

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[1]Melvin Krasner, David L. Ramsay, and Peyton E. Weary, "Physician Distribution Analysis Based on Zip Code Areas Applied to Dermatologists," American Journal of Public Health 67 (October 1977): 974-977.

[2]Martin Baier, "Zip Code Areas: What They Are and How to Use Them as Marketing Units," Zip Code Atlas (Chicago: Rand McNally & Company, 1975) pp. 4-13.

[3]John M. Leyes et al., The Delineation of Economic and Health Service Areas and the Location of Health Manpower Education Programs (Laramie, Wyoming: Division of Business and Economic Research, College of Commerce and Industry, University of Wyoming, 1973).

There are between 393 and 521 such areas after the areas have been consolidated in alternative ways on the basis of their economic integration, and their size and number appear intuitively consistent with the market area for many specialists, including dermatologists. Although Zipcode Areas do not cross state lines, areas in adjacent states can be readily consolidated to form an integrated economic trading area. Since the overwhelming majority of patients treated by many specialists are ambulant, a fairly large service area is appropriate. Because Zipcode Areas roughly delineate economic activity, they are superior to states and counties for analytic purposes; unfortunately, much pertinent information is not as readily available by Zipcode Area as by conventional geopolitical units. Nonetheless, a substantial amount of important information can be assembled on this basis.

Basic demographic information by Zipcode Sectional Area is available on magnetic tape as part of the Fifth Count of the 1970 Census. The data selected for the present analysis include the following population characteristics:

1. Count of persons by age, sex, and race
2. Income of families and unrelated individuals
3. Residence (urban; rural, non-farm; farm)
4. Years of schooling for population 25 years of age or older

5. Value of owner-occupied units and rent of renter-occupied units

6. Employment (farm or non-farm)

A tabulation of the supply of dermatologists in 1975 by Zipcode Area was provided by the American Academy of Dermatology. This listing, based in part on the American Medical Association Physician Masterfile, includes all active dermatologists (members and non-members) whose principal professional activity is patient care. Physicians are designated dermatologists if they report that the major portion of their professional time is spent in this specialty area. Individuals engaged in residency training in dermatology are identified as such; the average resident provides much less patient care than the average practitioner, and this is taken into account in the present analysis.

The 1967 and 1977 rosters of the American Academy of Dermatology was also made available for the present study. Although the rosters include only members of the Academy, this information serves as a basis for estimating the change in supply and distribution of dermatologists over the past decade. Because roughly ninety percent of dermatologists are members of this specialty society, the information should be a fairly reliable indicator of the situation for all dermatologists.

An effort was also undertaken to obtain information on local fee levels. The Medicare program assembles data

on prevailing physician fee levels on a local basis (in most cases, separately for generalists and specialists), but, unfortunately, these data include all specialists in a single category, and the localities used--based on local insurance carrier discretion--do not conform to established health planning or economic trading areas. Since better data were unavailable, the prevailing fees under the Medicare program for initial and follow-up visits to a specialist were adopted as general indicators of fee levels for dermatologists.[1] Fee levels for Medicare localities were assigned to Zipcode Areas using two principal assumptions: (a) dermatologists are likely to be located in the larger communities within an area and (b) contiguous areas are expected to have reasonably similar prevailing fees. In a number of areas, prevailing physician fees were not presented separately for specialists and general practitioners; consequently, the fee levels for these areas are based upon combined data.

Conceptual Framework

The fundamental issue underlying the present study is the availability of physicians' services in the United States. An adequate supply of physicians has been a matter of concern for decades, but this issue has achieved

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[1] U.S. Department of Health, Education, and Welfare, Social Security Administration, Bureau of Health Insurance, Division of Contractor Operations, Medicare Directory of Prevailing Charges, FY 1976.

national prominence in recent years, as medical knowledge and specialization have advanced. Many segments of the population perceived a shortage of physicians, despite an aggregate national supply of practitioners that seemed adequate for meeting the health care needs of Americans. Closer examination of the situation suggested that the perceptions of physician shortage was only a reflection of the inaccessibility of medical services, often attributed to an uneven geographic and specialty distribution.

This stimulated a great deal of research on geographic location and specialization. Many studies identified a shortage of "primary care" physicians, especially in inner-city and rural locations, but the definition of primary care and the identification of physician categories that provide such care are issues that are far from resolution. In general, primary care physicians are thought of as being responsible for the total well-being of an individual or family over a long period of time, someone who would coordinate a patient's need for specialty and hospital care and other medical services. General and family practitioners would clearly fit the description of primary care physicians, and many pediatricians, general internists, and (perhaps to a lesser extent) obstetrician-gynecologists could also be included in this category. Some observers, however, argue that the principal role of primary care is to serve as the portal of entry into the health care system; under

this definition, such specialists as dermatologists and ophthalmologists (because patients immediately associate the symptom with the appropriate specialty) would be considered providers of primary care. The present study, however, does not attempt to deal with the many issues involved in medical specialization; in particular, the fundamental question of what constitutes an optimal level of specialization is not addressed. The present analysis assumes that present levels of specialization are generally appropriate, and it examines the production and distribution of the services of physician specialists.

Many earlier studies of physicians' services that examined productivity and geographic distribution seldom gave sufficient consideration to the unique features of individual specialties. The present study was, therefore, undertaken as an attempt to provide an analysis of the supply of physicians' services that paid particular attention to characteristics of specialty care and the availability of such services on a local basis. With the growing importance of medical specialization and the dwindling number of general practitioners serving the population, access to at least a limited spectrum of specialty services for the majority of Americans is a reasonable health policy objective.

The original intent of the present study was to analyze the supply of dermatologists' services as an example of medical specialty services that may not be

optimally distributed on a geographic basis. The geographic units of observation to be used in the analysis were to reflect patterns of transportation and economic activity and thus serve as approximations of medical service areas. The study began with ambitious plans to identify all the correlates of dermatologists' output and to use econometric models to analyze output and determine whether it was responsive to indicators of the demand and requirements of local communities. Although this is clearly an important national health policy issue, limited data and resources did not permit full exploration of all the various aspects involved in this issue. For pragmatic reasons, therefore, the present empirical analysis is limited to two distinct aspects of the supply of services: an analysis of the production of dermatologists' services and an analysis of the geographic distribution of dermatologists. Nevertheless, it may be useful to review briefly the analytic development of the policy question as originally conceived.

Output and local demand

As mentioned, an intriguing policy question is whether and to what extent the output of dermatologists is responsive to indicators of the demand and requirements for services in the practitioner's community. Examination of the relationship of output and demand in this manner departs somewhat from conventional economic

analysis, which generally assumes that either (a) the producer faces a perfectly elastic demand for his product at the market price, or (b) he can freely influence prices by varying supply. The market for medical services, however, differs substantially from textbook models, because of a number of reasons including consumers' lack of pertinent information, especially a tendency to associate quality with price level, and the pervasiveness of third-party payment, which seriously weaken the role of price competition. Physicians may, in fact, face a relatively inelastic demand for their services particularly if price variation is greatly constrained by the characteristics of the market for physicians' services; therefore, the possible existence of substantial excess supply cannot be ignored. For example, many studies suggest that greater efficiency in physicians' practices could be realized by employing additional auxiliary personnel (see chapter); without sufficient demand, however, increased staffing could adversely affect physicians' income and professional satisfaction.

The relationship between output and demand obviously has important policy implications. A recent study found that patients located in areas apparently in short supply of physicians (measured primarily by the ratio of physicians to population) seem to have

little difficulty in obtaining an early appointment to see a doctor.[1] This suggests that individual physicians have a great deal of flexibility in the volume of patients they handle, and they try to meet local demand for care. The adverse effects of the uneven distribution of physicians might thus be mitigated by variation in their output.

Indicators of demand

The data described above suggest a number of possible indicators of the demand that the individual dermatologist faces. A frequently used measure is the supply of physicians relative to the population, generally calculated on a statewide basis for lack of better data. Fortunately, the data described earlier permit the determination of the ratio of dermatologists to population for more appropriately delineated market areas, i.e., Zipcode Sectional Areas. Other area characteristics, such as per capita income, educational attainment, and the age distribution of the population, which may substantially influence demand, are also available for this analysis.

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[1]U.S. Department of Health, Education, and Welfare, Public Health Service, Health Resources Administration, Physician Capacity Utilization Surveys: Project Summary, DHEW Publication No. (HRA) 79-17, 1978.

The physician's judgment regarding the existence of a shortage or an excess of dermatologists in the area is another important demand variable that may influence the output of the practice. In addition, because dermatologists handle only one-third of all skin complaints seen by physicians, the respondent's opinion on the local supply of non-dermatologist physicians may also reflect the demand faced by the dermatologist and may affect his or her output. Similarly, the amount of time a patient must wait to get an appointment may be a factor to which the dermatologist is responsive in terms of output.

A related variable that may have an important influence on demand is the age of the practitioner. Age has been studied principally as it affects productivity directly, i.e., younger and elderly physicians may practice slowly and cautiously. However, it appears that physicians develop a patient following over the course of many years,[1] and younger physicians who do

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[1] In some specialties the aging of physicians may be accompanied by an aging cohort of patients developing illnesses of advancing age, which increases demand for the physician's services. In obstetrics-gynecology, for example, young practitioners' practices are often dominated by obstetrics and routine gynecological care, while older physicians, who have an older cohort of patients, spend more time performing gynecologic surgery, a more intellectually challenging and more easily scheduled activity. In other specialties, such as dermatology, the effect of the physician's age on demand may simply reflect developing a reputation among patients and referring physicians and agencies (and perhaps improving skills and knowledge through experience, which may also increase demand).

not join an established practice may face insufficient demand for their services; this may strongly influence observed output.

Sources of output variation

The natural extension of this analysis is to examine the sources of the variation in output. An obvious source is variation in the amount of time individual physicians devote to patient care, which may reflect a number of possible situations or a combination of these factors:

1. Individual physicians may face different marginal revenue curves, and some may work less than they would like to because of insufficient demand.

2. Differences exist among physicians in the relative valuation of the income and professional satisfaction from medical practice, on one hand, and the pleasures of leisure activity, on the other, which may be influenced by local fee levels and recreational opportunities.

3. Some physicians altruistically increase their patient care activities beyond the workload they ordinarily prefer, in response to perceived community needs.[1]

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[1]See the definition of a "charitable" seller, in Roy J. Ruffin and Duane E. Leigh, "Charity, Competition, and the Pricing of Doctors' Services," Journal of Human Resources 8 (Spring 1973): 212-222.

A more analytically intriguing source of variation in output is productivity. Productivity is defined in general as output per unit of input, which in this instance is patient visits (or, as discussed, an index of patient visits) per physician-hour. Although the productivity of any of the inputs involved in producing physician's services, such as office equipment or paramedical labor, could be analyzed, physician time is the relatively scarce and expensive factor and therefore is the principal focus of many productivity studies.

Apparent differences in productivity among physicians may occur even without corresponding variation in observable features of their practices. Some practitioners may simply elect to see more patients per hour, with a possible sacrifice of some quality.[1] One would expect this kind of increase in productivity to be likely in situations of excess demand. The decrease in quality implied by shorter duration of visits while fee per visit remains unchanged, may be interpreted as a rise in price per unit of physician care, a response

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[1]The loss of quality may be in the realm of biomedical procedures, e.g., inadequate diagnosis and treatment of the medical complaint, but more likely is in the psychosocial aspect of medical care, e.g., failure to convey sympathy or concern. The consumer is obviously a better judge of the latter than the former. From the perspective of national policy, therefore, professional monitoring of the former may be indicated, whereas the latter might be reasonably well-regulated by free market forces.

consistent with traditional economic principles. Handling a greater volume of patients per hour may also require greater intensity of effort on the part of the physician, for which he is rewarded by greater income per hour. Similarly, increased productivity may be attributed to superior professional acumen and talent, which is rewarded by increased hourly remuneration. Unfortunately, many of these characteristics cannot be directly observed or measured; therefore, this aspect of productivity is not a promising area for empirical research.

A more fruitful avenue for empirical analysis of physician productivity is to examine the various input factors that complement the physician in the production of personal medical services. Included in these factors are capital, such as equipment and office space, and consumables such as drugs and disposable supplies; unfortunately, data on these inputs are not available. However, information on the labor input of auxiliary personnel is, fortunately, available, and it forms the basis for the production function analysis discussed in chapter 6.

CHAPTER IV

DEFINITION AND MEASUREMENT OF OUTPUT

The definition and measurement of output is often a problem in studying productivity in service industries, but it is especially troublesome in analyzing physicians' services. The objective of the purchaser of physicians' services and the ultimate output of the medical care industry is improvement of health status, which is extremely difficult to quantify. To some extent, however, this problem is not unique to physicians' services. In recent years, economists have refined demand and consumption theory to distinguish between a commodity or service, on one hand, and the utility engendered by the consumer using the good or service (in combination with time and, possibly, other goods and services), on the other. In an early exposition of this concept, J.R. Hicks pointed out "that we ought to think of the consumer as choosing, according to his preferences, between certain objectives; and then deciding, more or less as the entrepreneur decides, between alternative means of reaching those objectives. The commodities which he purchases are for the most part means to the attainment

of objectives, not objectives themselves."[1] In the automobile industry, for example, we can distinguish between the vehicle produced by a firm, the services it provides for the consumer, and the utility associated with acquiring and using it. Becker[2] and Lancaster[3] further developed the notion of consumption as a process using various combinations of inputs to produce utility. Although ultimate output of economic activity is, of course, utility (i.e., human welfare), the process by which the consumer produces utility generally eludes meaningful observation and quantification. We are compelled, therefore, as in the case of physicians' services, to abandon ultimate output and select a convenient intermediate output for empirical analysis.

Health status, however, is not quite as intangible as utility. Despite formidable obstacles, numerous attempts to measure health status have appeared in

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[1]John R. Hicks, A Revision of Demand Theory (London: Oxford University Press, 1956), p. 166.

[2]Gary S. Becker, "A Theory of the Allocation of Time," Economic Journal 75 (September, 1965): 493-517.

[3]Kelvin J. Lancaster, Consumer Demand: A New Approach (New York: Columbia University Press, 1971).

the literature.[1] Unfortunately, at their present state of development, health status indices or indicators have serious shortcomings as measures of output of physicians' services. Most obvious is the unavoidable imprecision in defining and measuring health status. The health status indices frequently presented in the health services literature are generally based on only broad measures of health status such as mortality, disability, and other major morbidity. The more subtle dimensions of health status toward which substantial resources are allocated remain largely ignored. Furthermore, conventional medical care is by no means the only--and probably not even the major--determinant of health status. Many factors including life style, nutrition, and public health measures, such as sanitation, clearly and substantially affect health. If one were to follow the broad definition of health adopted by the World Health Organization, i.e., "health is a state of complete physical, mental, and social

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[1]U.S. Department of Health, Education, and Welfare, National Center for Health Statistics, Conceptual Problems in Developing an Index of Health, by Daniel F. Sullivan, Publication No. (HRA) 76-1017, Vital and Health Statistics Series 2, No. 17 (first issued May 1966), 1976; Seth B. Goldsmith, "A Reevaluation of Health Status Indicators," Health Services Reports 88 (December 1973): 937-941; and William L. Hightower, "Development of an Index of Health Utilizing Factor Analysis," Medical Care 16 (March 1978): 245-255.

well-being and not merely the absence of disease or infirmity,"[1] a considerable portion, if not most, of our national product can be viewed as contributing to health. Thus, because it is virtually impossible to hold all these other inputs constant, the measure of the output of physicians' services would have to be something considerably more specific than general health status, particularly in the present study of a narrow subset of medical services.

A unit of output that seems to be appropriate for this task and has a great deal of intuitive appeal as a measure of physician's output is a successfully managed episode of illness.[2] This kind of approach has been used in estimating the cost of treating selected diseases.[3] Clearly the objective of medical care is to alleviate, to the extent possible, the suffering and inconvenience accompanying illness. The number of times this goal is achieved is a relatively

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[1]United Nations, World Health Organization, Constitution, May 1976, p. 1.

[2]This would ignore the involvement of physicians in the prevention of disease, which would have to be measured some other way.

[3]Anne A. Scitovsky and Nelda McCall, Changes in the Costs of Treatment of Selected Illnesses, 1951-1964-1971, National Center for Health Service Research, DHEW Publication No. (HRA) 77-3161, 1977.

unambiguous measure of the productive contribution of physicians. Unfortunately, this is not as easily quantifiable as one would imagine. Identifying successful management of illness implies that standards of success for outcomes exist, but until recently, standards of the quality of care were not defined on the basis of outcome. Although the health services literature over the years forcefully reflected widespread concern with the quality of medical care, quality was generally assessed in terms of structure (i.e., the availability of adequate personnel and equipment) or process (i.e., the performance of appropriate diagnostic and therapeutic procedures). The outcome of the patient was not used as a barometer of quality, because generally accepted standards of expected outcome did not exist.[1] Within the past few years, however, there has been considerable work directed toward developing measures of quality based on outcome for selected illnesses, but the work has not progressed to the point where it would permit direct measurement of physicians' output.[2] Such measurement is impeded by (a) the enor-

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[1]Charles E. Lewis, "The State of the Art of Quality Assessment-1973," Medical Care 12 (October 1974): 799-806.

[2]Robert H. Brook et al., "Assessing the Quality of Medical Care Using Outcome Measures: An Overview of the Method," Medical Care 15 (September 1977): Supplement.

mous range in the severity of illness and its responsiveness to treatment, (b) the intangible, but important, psychological dimension of physicians' care, and (c) the prevalence of disease in which total cure is unattainable and the physician's contribution is limited to palliation, which is often difficult to measure.

In dermatological care, identifying a successfully managed episode of illness is particularly difficult. Much of dermatological disease is of a chronic nature, complete cure is frequently elusive, and the effect of physicians' treatment is often confined to mild, temporary improvement. Sometimes the major contribution of the physician is providing some hope for the patient. It is obviously impossible to talk about precisely measured imputs that yield correspondingly measured outputs under these circumstances. A recent survey of dermatologists dramatically demonstrates the nebulous character of the art and science of medicine; the survey revealed tremendous variation in the amount of care recommended for each of a number of dermatological conditions, indicating a lack of standards for care (input) or outcome (output).[1] Thus, it appears

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[1]David L. Ramsay, Peyton E. Weary, and Melvin Krasner, Manpower for Dermatologic Care: An Assessment of Supply, Demand, and Distribution, Evanston, Illinois: American Academy of Dermatology, 1977, pp. 37-70.

that an alternative measure of output, perhaps not as theoretically sound but more practicable for empirical analysis, must be used in the present study.

Patient visits

Perhaps the most widely used measure of physicians' output is the patient visit. The visit may be viewed as an intermediate output of the medical care industry which consumers use as one of a number of inputs in the household production of their personal health. However, because visits vary substantially in their nature and content, they are imperfect measures of output. Patient visits may include extensive history taking, comprehensive physician examination, and lengthy diagnostic and therapeutic procedures, on the one hand, or, on the other hand, they may be brief encounters for follow-up care. Moreover, the quality and appropriateness of the medical services provided during a visit invariably elude meaningful, objective assessment and quantification. Obviously, spreading the services ordinarily provided during a single visit over a number of visits, and recommending and providing additional unnecessary patient visits should not be simplistically considered increased output.

Gross revenue from physicians' practices is often used as an alternative measure of output, because it would tend to reflect differences in the content and

quality of visits. Unfortunately, this measure of output may suffer from substantial bias. In a study of the productivity of solo and group practices, Bailey raises serious doubts regarding the widespread belief that economies of scale exist in the production of physician services.[1] He demonstrated that earlier findings suggesting the existence of such economies resulted from the use of gross revenue as a measure of output, when, in fact, increased revenue per physician merely reflected a shift in the location of ancillary services (e.g., x-rays and laboratory tests) from independent vendors to physicians' practices. Thus, gross revenue figures may reflect differences in the extent to which ancillary services are provided within the practice rather than differences in actual productivity.

Another problem with gross revenue as a measure of output is that it is, of course, dependent on the level and distribution of the individual physician's fees. This would not be a problem if physicians' fees were determined by competitive nationwide market forces; then the fees would generally represent the resource costs involved in producing the service and the value (at the margin) of the service to the consumer. Un-

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[1]Richard M. Bailey, "Economies of Scale in Medical Practice," in Empirical Studies in Health Economics, (Baltimore: Johns Hopkins Press, 1970), p. 263.

fortunately, because of such things as (a) the relative ignorance of the consumer, (b) the general independence of local markets for physicians' services, and (c) the pervasiveness of health insurance, the determination of fees for physicians' services differs substantially from what would exist under competitive conditions. Therefore, fee levels vary greatly among practitioners across the country, and the relative distribution of fees for different procedures also seem to differ substantially among physicians.[1] Since this variation undoubtedly reflects much more than differences in quality, gross revenue would not be a very good measure of output.

The present analysis

In the present empirical analysis of the production of dermatologists' services, the available measure of output is the patient visit. Although this unit of output possesses the shortcomings described earlier, much of the weakness can be minimized. By concentrating on a single, well-defined specialty, one eliminates much of the heterogeneity generally characteristic of the universe of physician visits. To in-

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[1]Uwe E. Reinhardt, Physician Productivity and the Demand for Health Manpower (Cambridge, Massachusetts: Ballinger Publishing Company, 1975),

crease further the homogeneity of the visits under analysis, the small percent of dermatologists' visits to hospital inpatients and the professional time devoted thereto are entirely omitted from investigation, and the analysis is limited to office visits only. Finally, the data permit weighting the visits according to a number of factors. For each visit, information is available on (a) whether the patient had previously been seen by the dermatologist; (b) whether the dermatological problem in question was being presented to the dermatologist for the first time; and (c) the diagnosis of the problem.

On this basis, five alternative measures of output are being used: (1) simple count of visits, and counts of visits weighted according to (2) whether or not the visit was for a new patient; (3) whether or not the visit was for a new problem; (4) whether the visit was for a new patient, an old patient with a new problem, or an old patient with an old problem; and (5) visits weighted according to the diagnosis of the problem. The weights used are the average times spent per visit in each of the respective categories, the average being claculated for all dermatologists taken as a group. Although this weighting scheme is not perfect and the important but intangible dimension of output known as quality has been ignored, the present

definition and quantification of output is entirely consistent with the present state of the art.

CHAPTER V

DESCRIPTIVE FINDINGS ON OUTPUT

Although available data and resources did not permit a rigorous and comprehensive analysis of the determinants of output level, an attempt was made to assemble descriptive information that pertain to some of the conceptual issues discussed in chapter 3. These data are presented and analyzed on the basis of bivariate relationships only, and no attempt was made to control for the effects of other variables that may be involved in any apparent relationship. Nonetheless, these data provide useful insights into the policy questions discussed earlier in this report.

Local supply of dermatologists

The ratio of dermatologists to population is an important variable from the perspective of policy, as discussed earlier, and its relationship to output is reflected in table 5-1. The second column of figures, which represents the average number of patient visits provided by each of the respondents during the three-day study period, displays an interesting pattern.

TABLE 5-1

AVERAGE NUMBER OF VISITS AND NUMBER OF HOURS DEVOTED TO DIRECT PATIENT CARE PER DERMATOLOGIST, AND NUMBER OF VISITS PER DERMATOLOGIST PER HOUR, BY THE NUMBER OF DERMATOLOGISTS PER 100,000 POPULATION IN THE PRACTITIONER'S AREA, 1976

Number of Dermatologists per 100,000 Population	Number of Observations	Average Number of Visits	Average Number of Hours in Patient Care	Average Number of Visits per Hour
Less than 1	10	64.0	14.4	5.3
1 - 1.99	38	89.4	15.8	5.8
2 - 2.99	71	79.8	14.5	5.6
3 - 3.99	41	68.5	13.4	5.0
4 - 4.99	3	60.7	13.3	4.5
5 and over	13	58.2	13.4	4.3
Simple correlation coefficient		-.17	-.11	-.17
Level of significance		.023	.153	.026

SOURCES: Unpublished data from the Dermatology Practice Study, University of Southern California School of Medicine, and the American Academy of Dermatology.

Except for the category of dermatologists practicing in areas[1] with less than one dermatologist per 100,000 population (consisting of only ten respondents), there appears to be a clear inverse relationship between the local supply of dermatologists and the output of the individual practitioner. A similar relationship to the local supply of dermatologists is shown for the average number of hours each practitioner devotes to direct patient care and the number of patient visits handled per hour, respectively (last two columns of table 5-1). The simple correlation coefficients between the supply of dermatologists relative to population and the three output variables (i.e., total visits, hours in patient care, and visits per hour) are -.17, -.11, and -.17, respectively, and the first and last are statistically significant at the .05 level.

These findings are completely consistent with our expectations, and they support the contention that differences in output among dermatologists tend to mitigate the undesirable effects of the uneven geographic distribution of physician specialists. Except for dermatologists practicing in areas having less than one dermatologist per 100,000 persons, there was a difference in output among dermatologists of about 50 percent

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[1]The geographic unit of observation used in the present analysis is discussed in chapter 3 and chapter 7.

between the most-amply and least-amply supplied areas. The results are also in harmony with previous multivariate analysis of physician behavior. Fuchs and Kramer found that about sixty percent of the variation in output per physician across states could be explained by differences in the per capita supply of physicians.[1] Reinhardt also found a generally inverse relationship between physician supply and output per physician using statewide physician-to-population ratios.[2] In a study by Lorant and Kimbell, the local supply of physicians was a statistically significant influence on output for some of the physician categories under investigation.[3] The analysis of Lorant and Kimbell is somewhat similar to the present study in that small area (in Lorant and Kimbell, county, and in the present study, Zipcode Area) physician-to-population ratios are used.

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[1]Victor R. Fuchs and Marcia J. Kramer, Determinants of Expenditures for Physicians' Services in the United States 1948-1968, National Center for Health Services Research and Development, DHEW Publication No. (HSM) 73-3013, December 1972, p. 38.

[2]Reinhardt, Physician Productivity, pp. 163-166.

[3]John H. Lorant and Larry J. Kimbell, "Determinants of Output in Group and Solo Medical Practice," Health Services Research 11 (Spring 1976): 11-17.

To refine the dermatologist-to-population ratio to reflect differences in the age and sex composition of the local population, unpublished information on the utilization of dermatologists' services was obtained from the Division of Health Interview Statistics of the National Center for Health Statistics. On this basis, we calculated a ratio of dermatologists per 10,000 "expected visits" in the local area. Unfortunately, this refinement did not seem to improve the relationship at all (table 5-2). Although the relationship appears similar to that found for the dermatologist-to-population ratio, the correlation coefficients and the corresponding levels of significance turn out to be markedly lower for "expected visits."

A number of other variables that would reflect the need for care among the patient population served by a dermatologist were considered. The respondent's opinion on whether there was a shortage or surfeit of dermatologists in the area was considered an important variable with which to study output responsiveness. Although the subjective information provided by the respondent might not be completely accurate in describing the local situation in general, it does reveal the perception of the respondent, which is probably more important as a determinant of his behavior. The dermatologist's response also undoubtedly reflects the

TABLE 5-2

AVERAGE NUMBER OF VISITS AND NUMBER OF HOURS DEVOTED TO DIRECT PATIENT CARE PER DERMATOLOGIST, AND NUMBER OF VISITS PER DERMATOLOGIST PER HOUR, BY THE RATIO OF DERMATOLOGISTS IN THE AREA TO THE NUMBER OF EXPECTED VISITS, 1976

Number of Dermatologists per 10,000 Expected Visits	Number of Observations	Average Number of Visits	Average Number of Hours in Patient Care	Average Number of Visits per Hour
Less than 1	4	62.8	15.4	5.6
1 - 1.99	25	83.4	15.3	5.6
2 - 2.99	43	89.5	14.6	6.4
3 - 3.99	64	73.7	14.4	5.1
4 - 4.99	24	67.1	13.7	4.9
5 and over	18	59.6	13.6	4.4
Simple correlation coefficient		-.15	-.13	-.09
Level of significance		.046	.065	.224

SOURCES: Unpublished data from the Dermatology Practice Study, University of Southern California School of Medicine; the American Academy of Dermatology; and the National Center for Health Statistics.

needs of the patients ordinarily seeking care from him, which should have greater impact on his output than the general situation in the area. Thus, one would expect that the individual dermatologist's output might be strongly related to his assessment of the local availability of dermatological care. The data presented in table 5-3 show the expected pattern with respect to output (i.e., number of visits), but the differences are not statistically significant. Hours in patient care and visits per hour showed even less of the expected relationship.

Because dermatologists generally handle only about one-third of all visits made to physicians for skin problems, it was expected that the respondent's perception regarding the adequacy of supply of general practitioners in the area might also have an influence on his output. Table 5-3 displays a striking pattern in the direction one would expect for all three of the variables (i.e., visits, patient care hours, and visits per hour), and the differences were found to be highly significant. The interpretation of this finding, however, is far from obvious, especially since the local supply of dermatologists turned out not to have a significant effect.[1] According to unpublished information

[1]Similar data for internists shown in table 5-3, though exhibiting the expected pattern, did not yield statistical significance.

TABLE 5-3

AVERAGE NUMBER OF VISITS AND NUMBER OF HOURS DEVOTED TO DIRECT PATIENT CARE PER DERMATOLOGIST, AND NUMBER OF VISITS PER DERMATOLOGIST PER HOUR, BY THE DERMATOLOGIST'S OPINION ON THE LOCAL SUPPLY OF PHYSICIANS, 1976

Dermatologist's Opinion	Number of Observations	Average Number of Visits	Average Number of Hours in Patient Care	Average Number of Visits per Hour
Supply of Dermatologists				
Shortage	7	84.7	15.3	5.4
About right	106	79.3	14.6	5.5
Excess	36	74.9	14.8	5.0
No opinion	5	41.2	11.7	4.2
Supply of General Practitioners				
Shortage	81	85.8	15.2	5.7
About right	46	71.7	14.5	5.1
Excess	5	40.0	10.1	4.0
No opinion	20	64.3	13.1	5.4
Supply of General Internists				
Shortage	49	83.9	15.0	5.7
About right	73	76.3	14.8	5.2
Excess	12	75.6	14.5	5.0
No opinion	18	63.6	12.2	5.6

SOURCE: Unpublished data from the Dermatology Practice Study, University of Southern California School of Medicine.

from the National Ambulatory Medical Care Survey, however, general and family practitioners as a group handle a greater number of patient visits for skin problems than do dermatologists, and this may be reflected here.

A different aspect of the possible effect of physician supply on medical practice is addressed in table 5-4. The data presented in the table show that, contrary to our expectations, the supply of dermatologists relative to population appears to have no effect on the proportion of the dermatologist's time that is devoted to non-dermatologic care or to the treatment of acne, a self-limiting condition.

Another variable thought to reflect the demand for care faced by the individual pracitioner is the number of days a patient must wait to obtain a scheduled appointment. Dermatologists who enjoyed a great demand for their services as evidenced by a backlog of patients were expected to be motivated by either altruistic or financial considerations to increase their output to meet the demand. This hypothesis is similar to one found in the study by Lorant and Kimbell, and it is weakly supported by their empirical analysis.[1] Therefore, the results shown in table 5-5 are quite surprising.

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[1]Lorant and Kimbell, "Output in Medical Practice," pp. 10-15.

TABLE 5-4

PERCENT OF ALL VISITS TO DERMATOLOGISTS MADE FOR DERMATOLOGIC PROBLEMS AND PERCENT OF DERMATOLOGIC VISITS MADE FOR ACNE, BY THE NUMBER OF DERMATOLOGISTS PER 100,000 POPULATION IN THE AREA

Number of Dermatologists Per 100,000 Population	Number of Observations	Visits for Acne as a Percent of All Dermatologic Visits	Visits for Dermatologic Problems as a Percent of All Visits to Dermatologists
Less than 1	10	32.4	96.6
1 - 1.99	37	28.6	99.3
2 - 2.99	70	28.9	97.4
3 - 3.99	42	29.6	96.2
4 - 4.99	3	35.8	99.6
5 and over	13	22.1	98.2

SOURCE: Unpublished data from the Dermatology Practice Study, University of Southern California School of Medicine; and the American Academy of Dermatology.

TABLE 5-5

AVERAGE NUMBER OF VISITS AND NUMBER OF HOURS DEVOTED TO DIRECT PATIENT CARE PER DERMATOLOGIST, AND NUMBER OF VISITS PER DERMATOLOGIST PER HOUR, BY THE AVERAGE NUMBER OF DAYS PATIENTS MUST WAIT FOR A SCHEDULED APPOINTMENT, 1976

Average Wait for a Scheduled Appointment (in Days)	Number of Observations	Average Number of Visits	Average Number of Hours in Patient Care	Average Number of Visits per Hour
Less than 3	44	77.9	14.6	5.4
3 - 5.9	30	80.1	14.8	5.5
6 - 8.9	63	77.0	14.1	5.7
9 - 19.9	30	80.5	15.2	5.2
20 and over	11	44.5	12.5	3.7
Simple correlation coefficient		-.19	-.05	-.20
Level of significance		.009	.472	.008

SOURCE: Unpublished data from the Dermatology Practice Study, University of Southern California School of Medicine.

Both the number of visits and visits per hour are negatively correlated with the length of the wait, and the correlations are highly significant. Furthermore, the inverse relationship between wait and output was also found to be significant after controlling for the effects of other variables.

It is difficult to think of a reason why the duration of wait should have a negative effect on output, but one can imagine that a low level of output could lead to a long waiting time. For example, a dermatologist may serve a large patient population that either does not have or does not look to alternative sources of care; if this dermatologist has a low level of output for any reason, a backlog of patients waiting for visits would tend to develop. Moreover, the backlog would be exacerbated if patients were especially attracted to this particular physician because of his low apparent output. As our data show, the low output is associated with fewer visits per hour, implying more physician time per patient and more attentive care, perhaps. This could obviously be perceived as a desirable characteristic of care, and, ceteris paribus, could lead to greater demand for this physician's care. In any case, this variable should not be considered a determinant of output, and, consequently, it has been excluded from the multivariate analysis of output in chapter

The number of years that an individual physician has been in practice is often considered an important factor in productivity. As mentioned earlier, age may reflect a number of different practice and physician attributes. The information in table 5-6 generally follows the expected pattern, i.e., a rapid rise in output during the early years in practice, followed by a general levelling-off in the middle years, and finally a decline in output accompanying the arrival of old age. This finding is consistent with the expectation of previous investigators, who often found only weak empirical support.[1] The clear pattern exhibited here may reflect the selection for study of only physicians in office practice of a particular specialty.

Other characteristics

The output of dermatologists certified by the American Board of Dermatology is substantially greater than the output of practitioners who have not been certified, and this difference has a very high level of statistical significance. Board-certified specialists also handled about thirty-five percent more visits

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[1]Reinhardt, Physician Productivity, pp. 162-171; Lorant and Kimbell, "Output in Medical Practice," pp. 10-13; and John H. Lorant, "Physician Age in Relation to Practice Characteristics and Performance," in The Profile of Medical Practice (Chicago: American Medical Association, 1972), pp. 89-94.

TABLE 5-6

AVERAGE NUMBER OF VISITS AND NUMBER OF HOURS DEVOTED TO DIRECT PATIENT CARE PER DERMATOLOGIST, AND NUMBER OF VISITS PER DERMATOLOGIST PER HOUR, BY THE NUMBER OF YEARS SINCE THE PHYSICIAN COMPLETED MEDICAL SCHOOL, 1976

Years Since Medical School	Number of Observations	Average Number of Visits	Average Number of Hours in Patient Care	Average Number of Visits per Hour
Less than 10	21	64.2	15.0	4.3
10 - 19	75	77.3	14.4	5.5
20 - 29	40	79.6	13.7	5.8
30 - 39	28	81.7	15.6	5.2
40 and over	14	69.3	13.3	5.5

SOURCE: Unpublished data from the Dermatology Practice Study, University of Southern California School of Medicine.

per hour than non-certified physicians (table 5-7).

The organization of practice also appears to have a very strong relationship to output and productivity. As shown in table 5-7, solo practitioners have an average of 67 visits during the study period at a rate of 4.7 visits per hour, while the corresponding figures for dermatologists in a partnership arrangement were 94 and 6.4 respectively. Dermatologists practicing in a group setting handled 74 visits at a rate of 5.3 per hour. Extreme caution, however, is necessary in interpreting these findings. Other variables, such as the employment of auxiliary personnel, are undoubtedly related to the organization of practice; therefore, the output relationships shown in table 5-7 may reflect the influence of variables for which organization is only acting as a proxy.

The principal form of remuneration for dermatologists' services has a statistically significant relationship with output in the expected direction, i.e., dermatologists paid on a fee-for-service basis handle a greater volume of patient visits at a higher rate of visits per hour than dermatologists paid by salary or capitation (table 5-8). The level of physician fees in an area also appears to have a strong relationship

TABLE 5-7

AVERAGE NUMBER OF VISITS AND NUMBER OF HOURS DEVOTED TO DIRECT PATIENT CARE PER DERMATOLOGIST, AND NUMBER OF VISITS PER DERMATOLOGIST PER HOUR, BY BOARD CERTIFICATION AND BY PRACTICE ARRANGEMENT, 1976

Certified by Board	Number of Observations	Average Number of Visits	Average Number of Hours in Patient Care	Average Number of Visits per Hour
Yes	144	80.9	14.5	5.7
No	34	57.2	13.8	4.2
Practice Organization				
Solo	67	64.9	13.7	4.7
Partnership	50	94.3	15.1	6.4
Group	61	74.2	14.6	5.3

SOURCE: Unpublished data from the Dermatology Practice Study, University of Southern California School of Medicine.

TABLE 5-8

AVERAGE NUMBER OF VISITS AND NUMBER OF HOURS DEVOTED TO DIRECT PATIENT CARE PER DERMATOLOGIST, AND NUMBER OF VISITS PER DERMATOLOGIST PER HOUR, BY FORM OF PROFESSIONAL REMUNERATION AND BY LOCAL FEE LEVELS, 1976

Principal Form of Remuneration	Number of Observations	Average Number of Visits	Average Number of Hours in Patient Care	Average Number of Visits per Hour
Professional Fees	134	79.7	14.7	5.5
Other	22	61.1	12.4	5.0
Estimated Level of Physician Fees				
$ 5 - $9.99	46	85.9	15.5	5.8
$10 - $14.99	108	76.9	14.3	5.5
$15 - $19.99	22	52.7	12.6	4.0
Simple correlation coefficient		-.27	-.18	-.22
Level of significance		.001	.016	.004

SOURCES: Unpublished data from the Dermatology Practice Study, University of Southern California School of Medicine; and U.S. Department of Health, Education, and Welfare, Medicare Directory of Prevailing Charges, FY 1976.

to output.[1] As shown in table 5-8, a statistically significant negative correlation was found between fee levels, on the one hand, and output, hours spent in patient care, and visits per hour, respectively, on the other hand. Economic theory does not attempt to predict a priori whether the relationship between the rate of earnings and the number of hours devoted to labor market activity will be direct or inverse. Two competing forces are operative in this kind of situation: a price effect and an income effect. If the hourly remuneration of a worker (or physician) is high, the price of leisure is high (i.e., the individual must give up a large amount of income for leisure). However, the high level of hourly remuneration also implies that the individual enjoys a relatively high level of income; therefore, he would tend to consume more leisure. The observed relationship between earnings and hours worked thus depends on the relative strength of these two forces. The inverse relationship shown in table 5-8 is often referred to as the backward bending supply curve of labor, since the traditional supply curve for goods generally has a positive slope. At the level of income

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[1]Fee levels in the dermatologist's area were estimated on the basis of Medicare data, as described in chapter III.

enjoyed by most physician specialists, this inverse relationship is completely plausible.[1] Fuchs and Kramer also found an inverse relationship between fee level and output per physician, but they did not express much confidence in this finding.[2] Obviously, the bivariate relationship shown for dermatologists cannot be regarded as conclusive evidence of a fundamental inverse relationship between fees and output.

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[1]The inverse relationship between fee level, on one hand, and the quantity of output of physicians' services and input of physician time, on the other hand, appears to be more readily interpretable as a backward bending supply curve rather than as a demand relationship. The data on fees used in the present analysis is an estimate of general levels of physician fees in a geographic area and therefore can be regarded as exogenous to the individual practitioner's input and output decisions. The alternative interpretation of the relationship, i.e., that higher fees result in smaller quantity of services demanded by the population, seems to be an inference that is less justified on the basis of the data.

The empirical inverse relationship between fees and output is also consistent with a number of previous studies of the market for physicians' services. Some analysts have attributed this finding to target-income behavior, as opposed to profit maximizing behavior, on the part of physicians. The direction of causality in this model is the reverse of the causality implied by the backward bending supply curve. In the target income model, an abundant supply of physicians (which may have been caused by a variety of factors) results in a relatively light workload for each individual practitioner, who responds by raising fees to maintain a high income level.

[2]Fuchs and Kramer, Expenditures for Physicians' Services, p. 38.

CHAPTER VI

EMPIRICAL ANALYSIS OF THE PRODUCTION PROCESS

Specification of the production function

Dermatologists' services are produced by a combination of various inputs including dermatologists' time, ancillary personnel time, office space and equipment, and consumable supplies. The technological relationship between the inputs and output is expressed in mathematical terms in a production function. Consideration must be given to the a priori specification of the production function, since it may embody mathematical properties that can constrain or distort the empirical results. In the present study, for example, use of the popular Cobb-Douglas function in its conventional form could be inappropriate, because that specification constrains output to zero when any of the inputs are zero. In the case of physicians' services, however, output can obviously be positive when the input of auxiliary personnel is zero. In contrast, positive output does necessarily imply (at least according to current medical practice codes) some input of physician time.

In the present analysis, therefore, we have, in

general, adopted a production function developed by Uwe Reinhardt specifically for studying physicians' services.[1] The Reinhardt function is a modification of the Cobb-Douglas form that incorporates the structural elements of medical practice discussed above and introduces greater flexibility. For example, the Reinhardt function allows for increasing and decreasing marginal productivity for all the inputs, it permits variation in the elasticity of substitution between inputs over the production surface, and it can accomodate increasing or decreasing returns to scale. The general form of this function is

$$Q = A \prod_{j=1}^{m} \left(X_j^{a_j} e^{b_j X_j} \right) e^{g(X, L; c)}$$

where X represents inputs essential to achieve positive rates of output and L denotes inputs that can be omitted from the production process. For simplicity of analysis, cross products of essential and non-essential inputs are omitted, but the non-essential inputs, as well as the essential inputs, are specified as non-linear to allow increasing and decreasing marginal products for these inputs. Thus, $g(X,L;c)$ can assume the algebraic form $\sum c_i L_i + d(\sum L_i)^2 + u$. Disaggregation of the squared term would be superior in principle, but it can create serious multicollinearity and diffi-

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[1] Reinhardt, Physician Productivity, pp. 121-129.

culties in estimation. Because the empirical findings of the present study may be substantially influenced by the a priori specification of the production function, a traditional Cobb-Douglas function is also employed for a comparative analysis later in this report.

Empirical limitations of the analysis

Ideally, one would incorporate all input factors, such as capital, all kinds of labor, and other resources, into the production function analysis, but unfortunately, no information was available on capital (such as office space and equipment) or other resources (such as disposable supplies) used in dermatologists' practices. The analysis is, therefore, limited to survey information on labor input factors, i.e., the time devoted to patient care in the office by the physician and three levels of non-physician personnel (subsequently collapsed to two categories in most cases to achieve more reliable estimates). However, because dermatologists' services are highly labor-intensive, the omission of non-labor inputs does not appear to be a serious shortcoming. The analysis, thus, implicitly assumes that non-labor inputs are utilized in direct proportion to the labor inputs, i.e., each category of labor is complemented by a similar quantity of capital services and consumables; consequently, the present study necessarily ignores the potential of non-labor inputs to

influence labor productivity.

As discussed earlier, the definition and measurement of output are important issues on both conceptual and practical levels. The data under study permitted specification of five alternative measures of output described earlier, but because all these measures use patient visits as the fundamental unit of output, they all suffer similar weaknesses. It was, however, hoped that weighting the visits by a number of factors would help identify a better measure of output. Empirical analysis, unfortunately, revealed that the alternative weighting methods did not make much difference. As shown in table 6-1, the five alternative measures of output are highly intercorrelated. The output measures shown are as follows: OUTPUT-1 is a simple count of visits; OUTPUT-2A, OUTPUT-2B, OUTPUT-3, and OUTPUT-5 represent visits weighted, respectively, according to whether or not the patient was previously seen; whether or not the problem was previously seen; whether the visit was made by a new patient, an old patient with a new problem, or a patient returning for follow-up care of an existing problem; and the specific disease receiving attention at the visit. As described earlier, the weights utilized were the average amounts of time the physician spent per visit in each of the categories, the average calculated for all of the respondents taken

TABLE 6-1

CORRELATION MATRIX OF THE ALTERNATIVE OUTPUT MEASURES (IN LOGARITHMIC FORM) USED IN THE ANALYSIS OF DERMATOLOGISTS' PRODUCTIVITY

	OUTPUT 1	OUTPUT 2A	OUTPUT 2B	OUTPUT 3	OUTPUT 5
OUTPUT-1	1.000	.998	.997	.998	.997
OUTPUT-2A	.998	1.000	.998	.996	.999
OUTPUT-2B	.997	.998	1.000	.996	.999
OUTPUT-3	.998	.996	.996	1.000	.996
OUTPUT-5	.997	.999	.999	.996	1.000

as a group. As a consequence of the intercorrelation among the output measures, the estimated production functions were not sensitive to the alternative specification of the output, and the corresponding coefficients are very similar in all of the equations (see table 6-2, discussed below).

Estimation of the production function

The basic algebraic form of the production functions estimated in the present study is

$$Q = a H^{b_1} e^{b_2 H} e^{c_1 L_1 + c_2 L_2 - d(L_1 + L_2)^2}$$

where

Q represents output measured in terms of patient visits or a weighted index of visits;

H denotes the number of hours the dermatologist devoted to office based patient care;

L_1 and L_2 are measures of the time devoted to patient care by two categories of auxiliary personnel;

e is the numerical base of the system of natural logarithms; and

a, b_1, b_2, c_1, c_2, and d are the parameters to be estimated.

The parameters of the production function have been estimated using ordinary least squares (OLS) regression. Although a number of writers have questioned the appropriateness of OLS estimates of production

TABLE 6-2

ESTIMATED PRODUCTION FUNCTION COEFFICIENTS FOR DERMATOLOGISTS' PRACTICES, USING ALTERNATIVE MEASURES OF OUTPUT

	Measure of Output				
	1	2A	2B	3	5
Log of MDHRS	1.4790 (3.90)	1.5229 (4.10)	1.5070 (4.03)	1.4080 (3.79)	1.5070 (4.05)
MDHRS	-.0379 (-1.43)	-.0411 (-1.58)	-.0387 (-1.48)	-.0336 (-1.30)	-.0392 (-1.51)
DERMASSTS	.0040 (3.90)	.0038 (3.78)	.0038 (3.75)	.0040 (3.98)	.0038 (3.74)
OTHSTAFF	.0014 (2.31)	.0015 (2.49)	.0014 (2.33)	.0014 (2.39)	.0015 (2.44)
$(DERMASSTS_2 \& OTHSTAFF)^2$	-.0000015 (-2.99)	-.0000015 (-3.08)	-.0000015 (-2.95)	-.0000016 (-3.12)	-.0000015 (-3.04)
R^2	.48	.49	.49	.49	.49
N	150	150	150	150	150

NOTE: Figures in parentheses are t values.

functions, Reinhardt and others have adopted single equation estimation, despite the possibility of introducing some bias into the estimates. Reinhardt, in particular, goes to great length to justify the use of OLS in estimating a production function of a nationwide sample of physicians' practices, and he argues convincingly that any bias introduced by using single equation estimation would probably not be serious.[1] Moreover, the inadequacy of the data and analytical difficulties generally inherent in simultaneous equations estimating procedures militate against the use of multi-stage-least-squares in the present study.

Thus, most of the production function estimates described in this report are based on the Reinhardt functional form presented above. When converted to logarithmic form, the function is transformed into $\log Q = \log a + b_1 \log H + b_2 H + c_1 L_1 + c_2 L_2 - d(L_1 + L_2)^2$ which conveniently lends itself to linear regression estimation.

Empirical results

The five regression equations shown in table 6-2 display the estimated coefficients of the basic production function using five alternative measures of output. As mentioned, all of the equations are pretty much the

[1] Ibid., p. 136.

same because the alternative output measures turned out to be almost perfectly correlated. For the remainder of the report, the output measure used in the regression equations is patient visits weighted by whether the visit was for a new or a previously-seen patient. Included in the equation are three different labor inputs: physician time, physician assistant time, and other staff time. MDHRS (corresponding to H in the equation discussed earlier) is the amount of time the dermatologist spent in direct patient care and directly related administrative activity. DERMASSTS (which corresponds to L_1) is an estimate of the amount of time spent in the practice by new health practitioners and similar personnel (i.e., nurse-practitioners, physician assistants, graduates of MEDEX programs, or an assistant specially trained in the physician's practice). OTHSTAFF is an estimate of the input of all other personnel employed in the practice including nurses, clerical staff, technicians, and community health aides. Although the original survey questionnaire elicited data on about ten different kinds of non-physician personnel and the information made available for the present study was categorized by three ancillary staff classifications, the analysis was simplified and the results apparently improved by combining the staff into two broad categories. Since auxiliary personnel in

physicians' practices often perform a wide range of tasks regardless of their training, using broad categories of personnel also seems to be intuitively more appropriate than using narrowly-defined staff titles. The relatively small size of the sample also made collapsing the personnel categories a prudent step.

A number of interesting results are reflected in these production function equations. First, the time dermatologists devote to patient care and the estimated effort of auxiliary personnel account for about half of the observed variation in output about its sample mean (R^2 = .49). Although this leaves a great deal of unexplained variation, this is to be expected in a cross-sectional analysis of survey data on individual dermatologists. All of the variables in the equation had the expected signs, i.e., those representing inputs had a positive association with output, and those reflecting the effect of diminishing returns had negative coefficients. All of the coefficients, with the exception of MDHRS, were significant at the .05 level, and the positive effects on output of the time devoted to patient care by dermatologists and their specially-trained assistants were statistically significant even at the .001 level. The overall statistical significance of the estimated equations also exceeded the .001 level.

The production function analysis was also applied separately to each of the three practice arrangements under study: solo, partnership, and group.[1] As shown in table 6-3, the equations for dermatologists in solo practice had coefficients of multiple determination of about .60. All of the variables in equation A had the expected signs, and those with positive coefficients were statistically significant at the five percent level. The negative coefficient of MDHRS was significant only at the ten percent level, and the squared term for all auxiliary personnel was not significant even at that level. Equation B demonstrates the effect of deleting the least significant variable , on the coefficients of the remaining variables. All the variables in this equation were significant at least at the ten percent level. The higher R^2 obtained for solo practitioners than for the entire sample and the correspondingly greater magnitudes obtained for the coefficients of the adjuvant personnel variables probably reflect the ambiguity regarding auxiliary staff in multi-physician practices, discussed below.

The results obtained for physicians in group and

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[1] An attempt was also made to identify the effect of practice organization on output by including organizational dummy variables among the regressors. Unfortunately, this resulted in multicollinearity that adversely affected the significance of the auxiliary staff variables.

TABLE 6-3

ESTIMATED PRODUCTION FUNCTION COEFFICIENTS FOR DERMATOLOGISTS IN SOLO PRACTICE

	Equation A	Equation B
Log of MDHRS	2.198 (3.04)	2.404 (3.37)
MDHRS	-.088 (-1.75)	-.102 (-2.04)
DERMASSTS	.010 (2.19)	.006 (1.73)
OTHSTAFF	.011 (2.24)	.005 (2.50)
(DERMASSTS & OTHSTAFF)^2	-.000034 (-1.36)	--
R^2	.60	.58
N	58	58

NOTE: Figures in parentheses are t values.

partnership practice are, therefore, somewhat inferior. For dermatologists in group practice, only DERMASSTS and the logarithm of MDHRS were significant at the five percent level, and the squared term for all auxiliary staff time was significant only at the ten percent level (table 6-4, equation A). The overall significance of the equation, however, exceeded the .001 level and all the coefficients had the expected signs. Deleting the insignificant variables, as shown in equation B, resulted in a decrease in R^2 from .46 to .41. The lack of statistical significance for many of the variables, though undesirable, must be expected when the analysis is based on small subsamples of the data.

The results obtained in attempting to estimate the parameters of the production function for the 40 dermatologists in partnership practice were apparently not plausible, i.e., some input variables had negative coefficients. Alternative formulations did not immediately yield meaningful results; therefore, separate data on this category of physicians are not presented in the report.

Non-input variables

Because the regression equations shown in table 6-2 account for only about half of the variation in the output of dermatologists, a number of variables that are not strictly inputs were added to the equation. The

TABLE 6-4

ESTIMATED PRODUCTION FUNCTION COEFFICIENTS FOR DERMATOLOGISTS IN GROUP PRACTICE

	Equation A	Equation B
Log of MDHRS	1.7944 (3.15)	.9525 (5.48)
MDHRS	-.0660 (-1.64)	--
DERMASSTS	.0034 (2.45)	.0031 (2.24)
OTHSTAFF	.0013 (1.52)	--
(DERMASSTS & OTHSTAFF)^2	-.0000013 (-1.99)	-.0000004 (-1.87)
R^2	.46	.41
N	50	50

NOTE: Figures in parentheses are t values.

inclusion of such variables in the estimation of production functions is consistent with earlier studies by Reinhardt,[1] Eisenberg,[2] and Lorant and Kimbell.[3] For considerations of practicality in obtaining meaningful and statistically significant coefficient estimates, these non-input variables have been specified a priori to affect simply the intercept or constant term rather than each of the input coefficients. Thus, although theoretically the non-input variables may affect the productivity of each of the input variables in a different direction and to a different extent, all the inputs have been assumed a priori to be similarly affected by the non-input variables.

A number of non-input variables including physician age, type of practice, and the respondent's perception regarding the local availability of specialty services (which were discussed in a general way earlier in this report) were added to the production function equation to test their explanatory power. Some of these variables turned out not to make a significant contri-

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[1]Ibid., pp. 168-170.

[2]Barry S. Eisenberg, Measurement and Analysis of Physician Productivity in Three Primary Care Specialties (Chicago: American Medical Association, 1975), pp. 35-71.

[3]Lorant and Kimbell, "Output in Medical Practice," pp. 6-20.

bution to explaining the variation in output, others were eliminated for not being conceptually appropriate arguments of a production function, and one seemed to be highly correlated with the auxiliary staff variables, causing unreliable and insignificant input coefficient estimates. Two non-input variables remained that appeared to merit inclusion in the regression equations: (1) DERMPOP, the number of dermatologists per 100,000 population in the respondent's area, and (2) CERTIFIED, a dummy variable equal to one if the respondent had earned the specialty certification of the American Board of Dermatology. As an alternative to DERMPOP, a variable called DERMUTIL was formulated. It was intended to be a refinement of DERMPOP, in that an adjustment for the age and sex composition of the local population is included. DERMUTIL may be considered an estimate of the expected local utilization of dermatologists' services, obtained by applying national utilization rates, by age and sex, to local population groups.

Findings on non-input variables

As shown in table 6-5, although DERMPOP has the expected negative sign, it is not significant even at the ten percent level in this equation. CERTIFIED, however, is highly significant and possesses substantial magnitude. The coefficient of multiple determination

TABLE 6-5

ESTIMATED COEFFICIENTS OF PRODUCTION FUNCTION EQUATIONS
INCLUDING NON-INPUT VARIABLES

Log of MDHRS	1.4575 (4.08)	1.4586 (4.08)	1.5082 (4.06)
MDHRS	-.0381 (-1.53)	-.0381 (-1.53)	-.0407 (-1.57)
DERMASSTS	.0034 (3.45)	.0034 (3.44)	.0034 (3.84)
OTHSTAFF	.0014 (2.34)	.0014 (2.35)	.0014 (2.35)
(DERMASSTS & OTHSTAFF)^2	-.0000013 (-2.79)	-.0000013 (-2.79)	-.0000013 (-2.79)
DERMPOP	-.0026 (-1.57)	--	--
DERMUTIL	--	-.0020 (-1.52)	-.0016 (-1.19)
CERTIFIED	.3095 (3.59)	.3090 (3.55)	--
R^2	.54	.54	.49
N	150	150	150

NOTE: Figures in parentheses are t values.

(R^2) of the equation rises from .49 to .54 as a result of the addition of these variables.

Because DERMPOP was not significant, DERMUTIL was substituted, as shown in the second column of table 6-5; unfortunately, the results were not any better. The deletion of the insignificant MDHRS term did not improve the performance of either DERMPOP or DERMUTIL, nor did the deletion of CERTIFIED, as shown in table 6-6. However, both of these variables assume significance at the ten percent level when the equations were estimated on the basis of a slightly increased sample size or on the basis of the selected subsample described below; but the magnitude of the coefficients is relatively small in any case.

The positive coefficient of CERTIFIED has substantial magnitude and this variable makes a noteworthy contribution in explaining the variation in output. This finding contrasts sharply with Eisenberg's study of primary care specialties, in which board certification was found to be associated with lower levels of observed output.[1] He attributed this to the likelihood of certified specialists handling a disproportionately large share of complex cases. The results of the present study, however, suggest that any bias toward

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[1]Eisenberg, Physician Productivity, p. 67.

TABLE 6-6

ESTIMATED COEFFICIENTS OF PRODUCTION FUNCTION EQUATIONS
INCLUDING NON-INPUT VARIABLES

Log of MDHRS	.9292 (10.47)	.9292 (10.48)	.9441 (10.24)	.9441 (10.24)
DERMASSTS	.0034 (3.46)	.0034 (3.46)	.0039 (3.86)	.0039 (3.86)
OTHSTAFF	.0012 (2.13)	.0012 (2.12)	.0013 (2.12)	.0013 (2.12)
(DERMASSTS & OTHSTAFF)^2	-.0000013 (-2.63)	-.0000013 (-2.63)	-.0000014 (-2.81)	-.0000014 (-2.80)
DERMPOP	--	-.0026 (-1.59)	--	--
DERMUTIL	-.0020 (-1.54)	--	-.0016 (-1.21)	--
CERTIFIED	.3127 (3.58)	.3132 (3.59)	--	--
R^2	.53	.53	.49	.49
N	150	150	150	150

NOTE: Figures in parentheses are t values

complex cases in the practices of board-certified dermatologists is overshadowed by the greater professional expertise of these practitioners, which is reflected in higher levels of productivity. It should be noted that the output effects of DERMPOP and CERTIFIED reflected in the equations are independent of the time devoted to patient care by the dermatologist or his assistants; these effects may, therefore, be interpreted as reflecting intensity of effort in response to community need or local excess demand (in the case of DERMPOP) and skill and expertise (in the case of CERTIFIED).

Cobb-Douglas functional form

As discussed earlier, the empirical estimates of the production function may be sensitive to the a priori specification of the function. Therefore, estimates were also obtained using a Cobb-Douglas production function for comparison with the estimates based on the Reinhardt form presented earlier. In addition, the estimated Cobb-Douglas coefficients are easily interpretable in terms of output elasticities and returns to scale, which will be discussed in relation to both functional forms later in this report.

The general Cobb-Douglas production function may be written as:

$$Q = A \prod_{i=1}^{n} X_i^{a_i}$$

which will, in the present study, be applied alternatively to two and three inputs. The specific function to be estimated will therefore be of the form

$$Q = a H^{b} L_1^{c_1} L_2^{c_2}$$

which is linear in logarithms and results in the following regression equation:

$$\log Q = a + b \log H + C_1 \log L_1 + C_2 \log L_2$$

In the Cobb-Douglas function, as mentioned above, output is constrained a priori to zero if any of the inputs are not used in the production process. Since all physicians do not employ staff from each of the two auxiliary personnel categories used earlier, the two categories were collapsed for this analysis into one variable, labeled STAFF. All of the 150 physicians in the sample employed at least some auxiliary personnel, so that the entire sample could be used for this comparison of the Reinhardt and Cobb-Douglas functions.

As presented in table 6-7, both functional forms were able to explain about the same proportion of the variation in output about its mean. Because the MDHRS term in the Reinhardt form was found insignificant at the 5 percent level, it was omitted from the regressions. Thus, the log of MDHRS term was comparable in both forms of the production function, and the coefficients of this term and those for the non-input variables were similar in all the equations. Also, CERTIFIED and

TABLE 6-7

ESTIMATED COBB-DOUGLAS AND REINHARDT PRODUCTION FUNCTIONS FOR DERMATOLOGISTS' SERVICES, WITH ALL AUXILIARY PERSONNEL COLLAPSED INTO A SINGLE CATEGORY

	Cobb-Douglas Form		Reinhardt Form	
Log of MDHRS	.9206 (9.81)	.9307 (10.04)	.9384 (10.05)	.9177 (10.24)
Log of STAFF	.1287 (3.10)	.1130 (2.84)	--	--
STAFF	--	--	.0019 (3.26)	.0017 (3.04)
$STAFF^2$	--	--	-.0000017 (-3.34)	-.0000014 (-3.01)
CERTIFIED	--	.3358 (3.83)	--	.3357 (3.84)
DERMPOP	--	-.0025 (-1.53)	--	-.0017 (-1.37)
R^2	.45	.51	.46	.51
N	150	150	150	150

NOTE: Figures in parentheses are t values.

DERMUTIL roughly accounted for an additional 5 percent of the variation in each of the functional forms. As shown in table 6-8, the inclusion of the MDHRS term (which is significant only at the 10 percent level) leaves the coefficients of multiple determination essentially the same. The output elasticity with respect to physician time also remains virtually unchanged, as discussed below.

Because collapsing the auxiliary personnel categories apparently entails some loss of explanatory power, a comparison of the Reinhardt and Cobb-Douglas forms was also conducted using two separate staff categories. However, the sample under analysis had to be restricted to those physicians that employed at least some staff in each of the two ancillary personnel categories. The estimated regression coefficients, based on 72 observations, are presented in table 6-9. Although the coefficients of multiple determination are consistently higher here than in the equations with collapsed categories, the statistical significance of the individual regression coefficients has suffered. The decline in significance, however, is to be expected, since the sample size was approximately halved while the number of variables in the equation was increased. The estimated equations also exhibit some apparent differences between the Reinhardt and Cobb-Douglas forms that will be examined below.

TABLE 6-8

ESTIMATED PRODUCTION FUNCTIONS FOR DERMATOLOGISTS' SERVICES, WITH ALL AUXILIARY PERSONNEL COLLAPSED INTO A SINGLE CATEGORY

Log of MDHRS	1.5963 (4.26)	1.5329 (4.26)	1.5880 (4.23)	1.5193 (4.23)
MDHRS	-.0474 (-1.81)	-.0435 (-1.73)	-.0473 (-1.81)	-.0433 (-1.73)
STAFF	.0020 (3.48)	.0018 (3.37)	.0020 (3.40)	.0018 (3.25)
$STAFF^2$	-.0000017 (-3.51)	-.0000016 (-3.27)	-.0000017 (-3.44)	-.0000015 (-3.17)
CERTIFIED	--	.3184 (3.66)	--	.3299 (3.79)
DERMPOP	--	--	-.0016 (-0.96)	-.0023 (-1.36)
R^2	.47	.52	.48	.52
N	150	150	150	150

NOTE: Figures in parentheses are t values.

TABLE 6-9

ESTIMATED COBB-DOUGLAS AND REINHARDT PRODUCTION FUNCTIONS FOR DERMATOLOGISTS' SERVICES, USING TWO CATEGORIES OF AUXILIARY PERSONNEL

	Cobb-Douglas Form		Reinhardt Form	
Log of MDHRS	.8897 (7.83)	.9107 (7.94)	1.8389 (4.62)	1.8247 (4.60)
Log of DERMASSTS	.1528 (2.25)	.1568 (2.33)	--	--
Log of OTHSTAFF	.0233 (0.48)	.0124 (0.26)	--	--
MDHRS	--	--	-.0681 (-2.44)	-.0656 (-2.35)
DERMASSTS	--	--	.0034 (3.18)	.0032 (2.97)
OTHSTAFF	--	--	.0008 (1.07)	.0008 (1.05)
$(\text{DERMASSTS} \ \& \ \text{OTHSTAFF})^2$	--	--	-.0000009 (-1.65)	-.0000009 (-1.59)
CERTIFIED	--	.2288 (1.74)	--	.1868 (1.47)
DERMUTIL	--	-.0015 (-1.14)	--	-.0010 (-0.81)
R^2	.50	.53	.56	.58
N	74	74	74	74

NOTE: Figures in parentheses are t values.

Output elasticity of physician time

All of the equations indicate that, as expected, physician time is the most important influence on output. The magnitude of that influence can be expressed in terms of the output elasticity with respect to physician time, which is defined as $\frac{\Delta Q}{Q} \div \frac{\Delta H}{H}$. At any given point this may be understood as simply the percent change in output that results from a 1 percent change in the input. The specific algebraic formula for calculating the output elasticity with respect to physician time is obtained by differentiating the production function with respect to H and multiplying by H/Q. In the Reinhardt production function, this elasticity is given by $b_1 - b_2 H$, and in the Cobb-Douglas function it is simply b, the exponent of the input variable.[1]

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[1]The partial derivative of the Reinhardt function with respect to H, $\frac{\partial Q}{\partial H}$, treating $\left[a e^{c_1 L_1 + c_2 L_2 - d(L_1 + L_2)^2}\right]$ as a constant K, is $Kb_1 H^{b_1 - 1} e^{b_2 H} + KH^{b_1} e^{b_2 H} b_2$. Multiplying by $\frac{H}{Q} = \frac{1}{KH^{b-1} e^{b_2 H}}$ leaves $b_1 - b_2 H$.

The partial derivative of the Cobb-Douglas function with respect to H, $\frac{\partial Q}{\partial H}$, collapsing all

In the equations presented early in the chapter, estimated on the basis of the entire sample using the Reinhardt form, the MDHRS variable lacked statistical significance even at the 10 percent level. The estimated values of MDHRS were nevertheless used to calculate the output elasticity with respect to physician time, which invariably hovered in the vicinity of .9 at the mean value of 15.6 hours of physician time during the survey period. For the solo practitioners reflected in table 6-3, the MDHRS variable was significant at the 10 percent level, and the calculated output elasticities are .88 and .84 at the average input of 15.4 hours of physician time during the survey period.

Simple inspection of table 6-7 reveals that the output elasticity of physician time is roughly equal to .9 regardless of the particular functional form used. This result is expected because the insignificant MDHRS term is omitted from the Reinhardt-form equations and the input of physician time is treated similarly in both functional forms. However, even if the MDHRS term is included, as in table 6-8, the calculated elasticity

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constant and other variable terms in a constant K, is $K\ b\ H^{b-1}$. Multiplying by $\frac{H}{Q} = \frac{1}{KH^{b-1}}$, leaves b.

remains close to 0.9. In contrast, table 6-9 includes the MDHRS term which was significant at the 5 percent level, and the estimated equations based on 74 observations reflect a noteworthy difference in output elasticity between the two functional forms. At the sample mean input of 16.2 hours of physician time, the calculated output elasticities for the two Reinhardt equations are .74 and .77, somewhat different from the Cobb-Douglas elasticities of .89 and .91.

Regardless of the functional form used, these output elasticities appear high relative to earlier studies of physicians' practices. In Reinhardt's estimated production functions for general practitioners, pediatricians, obstetrician-gynecologists, and internists in private practice, the elasticity of output with respect to physician time (with output measured by office visits) ranged from .56 to .70.[1] These elasticities and most of those calculated in the present study remain constant over the entire range of input, and thus the differences cannot be explained by reference to the level of input. Reinhardt's finding is supported by Kimbell and Lorant who obtained elasticities between .65 and .75 for office visits of general

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[1]Reinhardt, Physician Productivity, pp. 162-178.

practitioners.[1] The unique characteristics of dermatological practice may play an important role here, and it may likewise be a noteworthy consideration in interpreting the findings on ancillary staffing, discussed below.

Aide elasticity of output

In a similar fashion, the output elasticity with respect to auxiliary staff effort may be calculated using the formula $cL - 2dL^2$ for the Reinhardt production function.[2] As implied by the algebraic form of this formula, the auxiliary staff input is collapsed into one category to correspond to the squared sum of auxiliary staff effort (i.e., $L = L_1 + L_2$) in the production function. Ideally, one would prefer to calculate output elasticities separately for each category of auxiliary personnel; unfortunately, that would require a separate squared

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[1]Larry J. Kimbell and John H. Lorant, "Physician Productivity and Returns to Scale," presented at Health Economics Research Organization meeting, New York, December, 1973; and Larry J. Kimbell and John H. Lorant, "Methods for Systematic and Efficient Classification of Medical Practice," Health Services Research 8 (Spring 1973): 46-60.

[2]This formula is obtained by differentiating the production function with respect to L, which results in $\frac{\partial Q}{\partial L} = K e^{cL-dL^2} (c-2dL)$. Multiplying by L/Q yields $cL-2dL^2$.

term for each category, which introduces substantial multicollinearity and seriously complicates the empirical estimation of the production function. For the Cobb-Douglas function, the elasticity of output with respect to any input is simply the exponent of the input variable (or the coefficient of the variable, in logarithmic form), as described earlier.

Using the estimated coefficients presented in table 6-7, the aide elasticities of output for the Reinhardt equations are .17 and .15 at the average value of about 109 hours of auxiliary staffing per week. For the estimated equations based on the conventional Cobb-Douglas functional form, the corresponding elasticities are .13 and .11. The aide elasticity of output remains constant over the full range of input in the Cobb-Douglas function, but the estimated Reinhardt function implies that the elasticity will increase with increasing levels of that input, reaching a maximum of about .25 at an input level of approximately 280 hours per week.

Scale elasticity of output

The definition of the elasticity of output with respect to scale is similar to that of the elasticities just discussed, i.e., it may be thought of as the percent change in output resulting from a 1 percent change in all the inputs. This parameter is often called

economies of scale, but in the present analysis and in similar econometric investigations, this parameter has a very specific meaning, reflecting particular mathematical properties of the estimated production function. In contrast, the term "economies of scale" is often used in the health services literature to generally describe the effect of scale of operation on output and productivity, even if it may involve completely different production processes (i.e., different production functions).

The formula for the scale elasticity is simply the sum of the elasticities for the individual inputs. Thus, for the estimated equation using Reinhardt's functional form, the formula for scale elasticity is $b_1 - b_2H + cL - 2dL^2$. For the conventional Cobb-Douglas form, the scale elasticity is simply the sum of the exponents, i.e., b + c.

On the basis of the calculations for the output elasticities with respect to the individual inputs described earlier, it appears that the scale elasticity is just slightly greater than one. Using the data in table 6-7, the scale elasticity for the Cobb-Douglas form lies between 1.02 and 1.05, and between 1.07 and 1.11 for the Reinhardt form. For all intents and purposes, these figures may be regarded as generally reflecting constant returns to scale.

It should be noted, however, that these elasticities are point estimates and reflect the returns to scale for very small increments in scale at the average scale of operation in the sample. As mentioned earlier, the conventional Cobb-Douglas functional form constrains the estimated function to a constant elasticity of scale over the entire production surface. In contrast, the Reinhardt form permits the scale parameter to vary over the production surface; therefore, the scale elasticity calculated for the sample may not apply for different levels of input.

For the first Reinhardt-form equation presented in table 6-7, the scale elasticity calculated at input levels that are twice the sample average is 1.19. The overall effect of doubling the inputs, which may be called the arc elacticity of scale, is usually different from the two point elasticities, and can be calculated by substituting the different quantities of the inputs into the estimated production function. Using the estimated parameters in table 6-7 and the estimated constant term (4.4), we find that with double the inputs we get two-and-a-quarter times as much output. Thus, the arc elasticity of output with respect to scale would be 1.21.

A totally different picture, however, can be drawn from the estimated equations that include the

MDHRS variable, which reflects diminishing returns to physician time. Using the estimated coefficients presented in column 2A of table 6-2, the output elasticities calculated at the average input level in the sample are .88 for physician time, .23 for auxiliary time,[1] and (adding the two) 1.11 for the scale. In contrast, at input levels twice that of our sample, the scale elasticity falls dramatically to .62. This results from a sharp drop in the output elasticity of physician time to .24, while the aide elasticity rises to .38, as described earlier. The arc elasticity, or the percent increase in output resulting from a doubling of the inputs is .77, somewhere between the two point elasticities. Similar results are obtained for the estimated equations presented in table 6-8, which also include the MDHRS term.

The sharply declining output elasticity with respect to physician time and the concomitant declining scale elasticity are generally consistent with intuitive expectations. The data under analysis reflect the

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[1]The elasticity figure for auxiliary staff time was calculated by averaging the regression coefficients for the two kinds of auxiliary personnel. The hypothesis that there is no difference in the productive contribution of the two levels of personnel could not be rejected on the basis of the empirical evidence; therefore, averaging the coefficients seemed reasonable. The alternative of combining all staff input into one variable was done in the equations shown in table 6-8, and the output elasticity with respect to staff time calculated on that basis was .18.

behavior of individual physicians, and one would expect to encounter declining productivity as the individual's workday was extended well beyond the average. This, however, does not imply that there are diseconomies of scale in medical practice. Most discussions of scale effects in medical practice deal with the questions of solo versus group practice or the optimal size of group practice; increasing the number of physicians in a medical practice rather than increasing the number of hours per practitioner would not involve the kind of decreasing returns reflected in the present study.

Similarly, the finding of increasing aide elasticity of output seems to indicate that when the number of personnel is increased, the diminishing returns involved in increasing the workload of each person are largely avoided. The expanded pool of auxiliary personnel may allow for more efficient division of responsibilities that permits greater output. It also probably reflects some bias, in that physicians with organizational and managerial skills are likely to (a) generate a greater volume of output and (b) extensively employ auxiliary personnel. In the present empirical analysis, the managerial skills are thus loaded onto the auxiliary personnel variables.

Alternative measure of auxiliary staff

As mentioned earlier, the auxiliary staff variables were specified in a number of alternative ways to obtain a better fit of the data. Unfortunately, most of the experimentation did not yield any improvement in the estimated equations. One specification of the auxiliary staff variables, however, (unlike the equations presented above) did result in statistically significant coefficients (at least at the .10 level) for all of the input variables in the original Reinhardt-form equation, i.e., log of MDHRS, MDHRS, DERMASST, OTHSTAFF, and (DERMASST & OTHSTAFF)^2.

In the equations that yielded significant coefficients for all of the input variables, the auxiliary staff variables represent the number of individuals employed in each category, rather than the number of hours worked in a typical week (the measure used in all the equations discussed earlier). The assumption implicit in this approach is, of course, that the amount of effort devoted to patient care by adjuvant personnel during the survey period would be directly proportional to the number of individuals employed. In the case of part-time auxiliary employees, it is logical to assume that they would work in the dermatologist's practice during office hours; therefore, conversion to full-time equivalence on the basis of the number of hours each

staff member worked per week (as implicitly done in the earlier equations) may not be the most accurate approach. For example, if a dermatologist employs three aides each working twenty-five hours per week, it seems safer to assume that all three aides will be working simultaneously during office hours, rather than to convert the part-time input into the equivalent of two full-time employees and assume that only two aides assist the physician during office hours.

As shown in table 6-10, there is some change in the magnitude of the individual regression coefficients, as expected, but the R^2 (.47) and the elasticities of output with respect to physician time (.82) and auxiliary staff (.22) remain roughly similar to previous results. Thus, although the MDHRS term attains statistical significance at the 10 percent level using this measure of auxiliary staff input, the coefficient of multiple determination does not improve and the estimates of output elasticities do not change much. Therefore, it appeared more appropriate to continue the analysis using flows of personnel services, i.e., hours of aide time (which would be similar to the measurement of physician input), rather than using stocks of employees, i.e., number of aides, as a measure of the auxiliary staff input.

TABLE 6-10

ESTIMATED PRODUCTION FUNCTION COEFFICIENTS FOR DERMATOLOGISTS' PRACTICES, USING THE STOCK OF AUXILIARY PERSONNEL RATHER THAN THE NUMBER OF HOURS WORKED PER WEEK AS THE MEASURE OF AUXILIARY STAFF INPUT

Log of MDHRS	1.6222 (4.29)
MDHRS	-0.0479 (-1.81)
DERMASST-S	0.0704 (3.22)
OTHSTAFF-S	0.0215 (1.84)
STAFFSQ-S	-0.000445 (-2.36)
N	150
R^2	.47

NOTE: Figures in parentheses are t values.

Marginal products of the inputs

As mentioned earlier, the Reinhardt form of the production function permits the marginal products of the inputs to both rise and fall over the production surface. The estimated equations presented earlier readily permit the derivation of conventionally-shaped marginal productivity curves for physician hours, but to simplify the exposition and analysis the equation shown in column 1 of table 6-8 will be used for this marginal productivity analysis. This equation is simpler in that all auxiliary staff are included in a single category, and all the coefficients are statistically significant at least at the 10 percent level. The auxiliary staff variable reflected in this table is measured in hours per week (in contrast to the equation presented in table 6-10), and thus both physician input and auxiliary staff input are expressed as flows of personal services (rather than as stocks of personnel, as is the case for the auxiliary staff variables in table 6-10).

Marginal product of physician time

The marginal product of physician time is obtained by differentiating the production function with respect to that input, i.e., $\frac{\partial Q}{\partial H} = \left[\frac{b_1}{H} - b_2 \right] Q$,

where, $Q = aH^{b_1} e^{b_2 H} e^{cL - dL^2}$;

H is physician hours;

L represents auxiliary staff hours; and

a, b_1, b_2, c, and d are the estimated parameters of the production function.

The total product and marginal product of physician time calculated at various levels of physician input and auxiliary staff input are shown in table 6-11. By differentiating the function a second time and setting it equal to zero, one obtains the formula $\frac{b_1 - \sqrt{b_1}}{b_2}$, which represents the point at which marginal productivity is at its maximum. The marginal product of physicians' time attains a maximum at about 7 hours of patient care for the three-day study period, and it declines steadily from that point until its value turns negative at the hypothetical input of 34 hours per three-day period (see figures 6-1 and 6-2).

In comparison with other studies of physician productivity, these points seem to occur rather soon, i.e., diminishing and negative returns set in at relatively low levels of input. Reinhardt, for example, was unable to estimate equations that yielded conventionally-shaped marginal cost curves in many cases; but where he was able to do so, the equations imply that the marginal productivity of physicians remains

TABLE 6-11

TOTAL PRODUCT AND MARGINAL PRODUCT OF PHYSICIAN TIME, AT VARIOUS LEVELS OF PHYSICIAN INPUT AND AUXILIARY STAFF INPUT

Input of Physician Time (in Hours)	No Auxiliary Staffing		Auxiliary Staffing of 100 Hours per Week	
	Total Product	Marginal Product	Total Product	Marginal Product
5	16.11	4.38	19.32	5.25
10	38.45	4.32	46.11	5.18
15	57.96	3.42	69.51	4.11
20	72.40	2.35	86.84	2.82
25	81.59	1.35	97.85	1.61
30	86.14	0.50	103.31	0.61

	Auxiliary Staffing of 200 Hours per Week		Auxiliary Staffing of 300 Hours per Week	
	Total Product	Marginal Product	Total Product	Marginal Product
5	22.38	6.09	25.04	6.81
10	53.41	6.00	59.75	6.71
15	80.52	4.76	90.08	5.32
20	100.59	3.27	112.53	3.65
25	113.35	1.87	126.81	2.09
30	119.67	0.70	133.88	0.78

Fig. 6-1. Marginal Productivity Curves for Dermatologists' Time Devoted to Patient Care in a Three-Day Period, at Two Levels of Auxiliary Staffing.

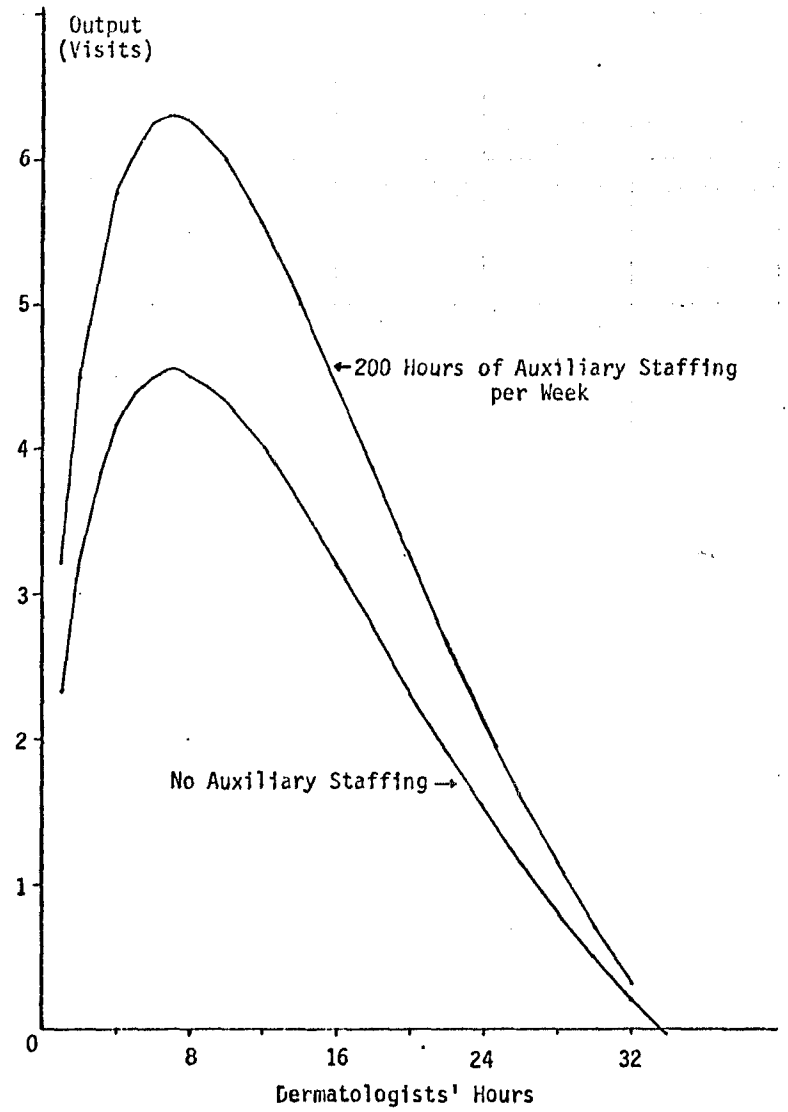
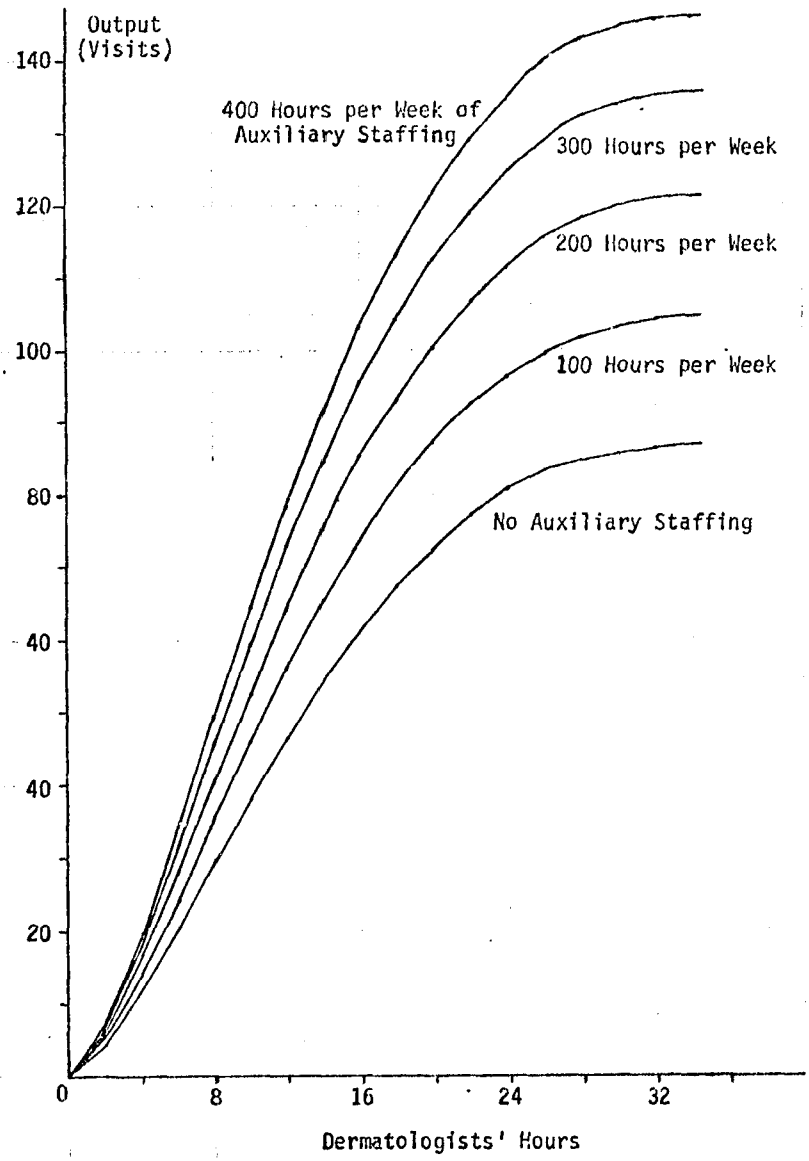


Fig. 6-2. Total Product Curves for Dermatologists' Time Devoted to Patient Care in a Three-Day Period, at Various Levels of Auxiliary Staffing.



positive at substantially greater levels of input.[1] In Reinhardt's estimated equations based on total visits to general practitioners and obstetrician-gynecologists, respectively, the marginal productivities reach their maxima at 25.2 and 25.5 hours of physician time per week and turn negative at 111 and 85 hours per week.[2]

An important distinction, however, between the "primary care" specialties studied by Reinhardt and the dermatologists currently under study may account for the differences found regarding maximum total productivity. All of the specialists studied by Reinhardt, i.e., general practitioners, internists, pediatricians, and obstetrician-gynecologists, are generally considered to be providing "primary care" and were thought to be in short supply relative to other specialists. In addition, these specialists have traditionally devoted more time to patient care than other physician specialty groups. Furthermore, the Medical Economics survey upon which Reinhardt based his study took place about ten years before the USC survey of dermatologists that forms the basis for the present study. During that period, i.e., the mid 1960s, the notion of a severe shortage of

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[1] Reinhardt, Physician Productivity, pp. 175-178.

[2] Since the present study is based on only three days of data, the critical values obtained should be doubled for meaningful comparison with Reinhardt's results.

physicians was widely accepted. The production parameters estimated for the surveyed physicians may thus reflect their reaction to the perceived shortage and the specialties' tradition of devoting long hours to patient care.

In contrast, dermatologists tend to choose a relatively short workweek of less than forty hours of practice, and they generally do not perceive a shortage of practitioners in the specialty. In the USC survey, fewer than 5 percent felt there was a shortage of dermatologists in their community, whereas almost 25 percent felt there was an excess supply. Thus, it seems logical that few dermatologists feel any meaningful professional pressure to work very hard or long hours.

Thus, one may interpret these empirical marginal product curves as reflecting more than the conventional relationships. The behavior of the textbook model of marginal productivity reflects the contribution to output of one factor of production while all other factors are held constant; as increasing units of the variable factor are used, diminishing marginal productivity is encountered. In the present empirical study, however, there are intuitive reasons to expect diminishing marginal productivity of physicians' time even without holding other factors constant. The limited

number of hours per day and the fatigue and boredom that emerge as an increasing number of hours per day are devoted to patient care by a single physician may be important components of the observed diminishing marginal productivity. Similarly, it is likely that the rate of diminishing marginal productivity is influenced by the length and intensity of the typical workweek in each profession, which may account for the difference between the present results and those of Reinhardt.

Marginal product of auxiliary staffing

The marginal productivity of auxiliary staff time may be determined by differentiating the production function with respect to that input. The resulting formula is $MP_L = (c - 2dL)\ Q$, and the total and marginal products calculated at various levels of physician and auxiliary staff input are shown in table 6-12. The maximum marginal productivity is a attained at 36 hours of auxiliary staffing per week, using the formula $L = \frac{c}{2d} - \frac{1}{\sqrt{2d}}$, and marginal productivity does not turn negative until the input of auxiliary staffing exceeds 500 hours per week.

The configurations of the marginal productivity curves shown in figure 6-3 and the corresponding total product curves shown in figure 6-4 are somewhat unexpected, in that marginal productivity remains positive

TABLE 6-12

TOTAL PRODUCT AND MARGINAL PRODUCT OF AUXILIARY STAFFING, AT VARIOUS LEVELS OF PHYSICIAN INPUT AND AUXILIARY STAFF INPUT

Auxiliary Staffing (in Hours per Week)	Physician Input of 5 Hours		Physician Input of 15 Hours	
	Total Product	Marginal Product	Total Product	Marginal Product
0	16.11	.032	57.96	.115
100	19.32	.032	69.51	.114
200	22.38	.029	80.52	.104
300	25.04	.024	90.08	.085
400	27.06	.016	97.33	.058
500	28.23	.007	101.57	.026

	Physician Input of 25 Hours		Physician Input of 35 Hours	
	Total Product	Marginal Product	Total Product	Marginal Product
0	81.59	.163	86.95	.173
100	97.85	.161	104.28	.171
200	113.35	.147	120.79	.157
300	126.81	.120	135.14	.128
400	137.01	.082	146.01	.088
500	142.97	.036	152.36	.038

Fig. 6-3. Marginal Productivity Curves for Auxiliary Staff Time Devoted to Patient Care in a Three-Day Period at Three Levels of Physician Input.

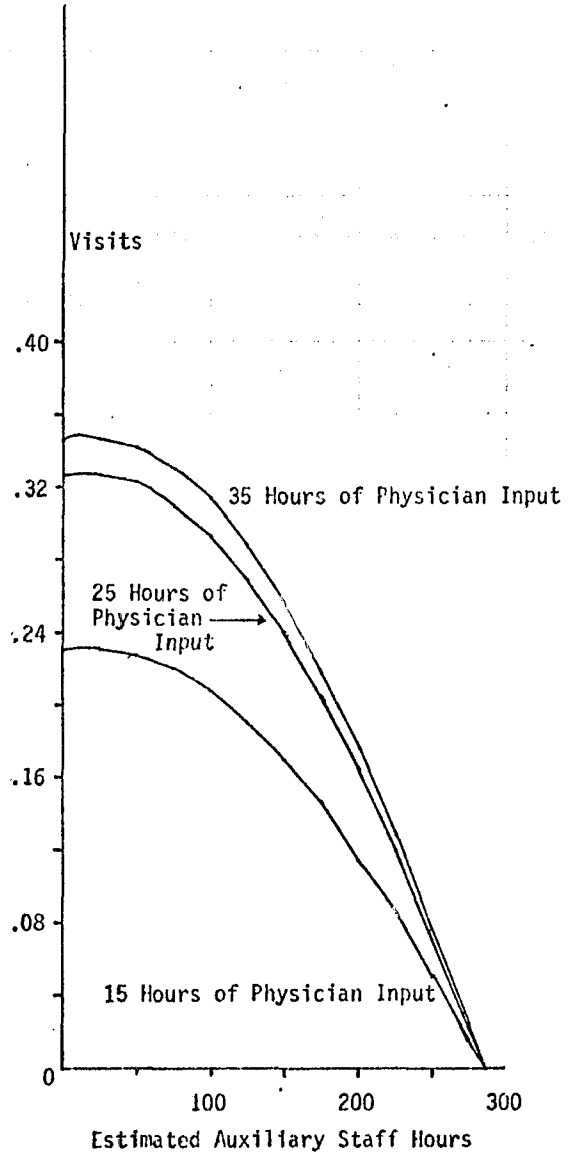
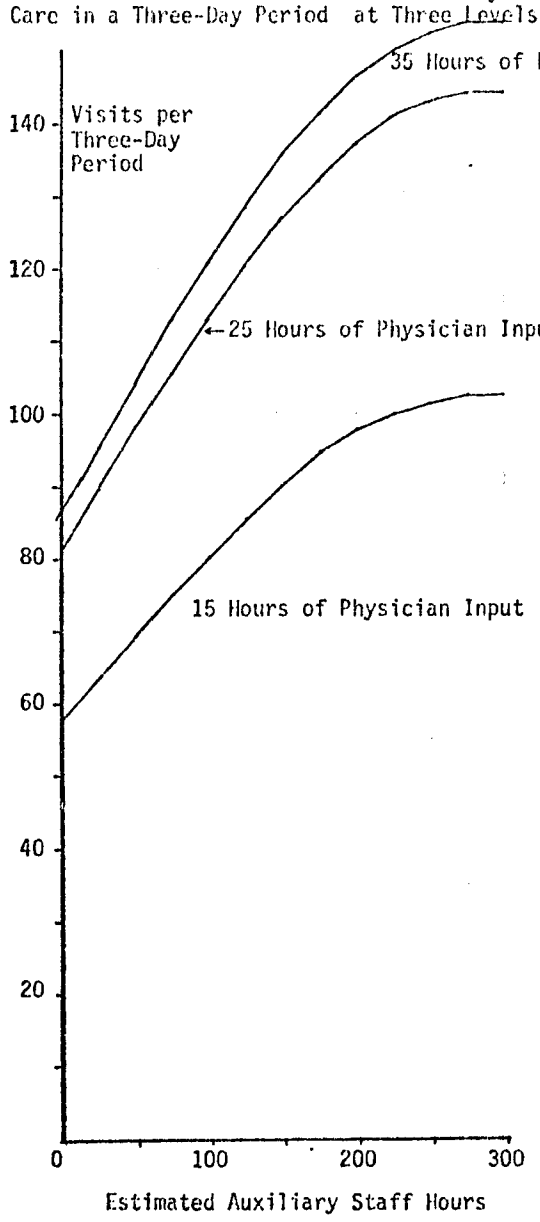


Fig. 6-4. Total Product Curves for Auxiliary Staff Time Devoted to Patient Care in a Three-Day Period at Three Levels of Physician Input.



even at extremely high levels of auxiliary staffing, (roughly 15 aides per physician). In contrast, Reinhardt's study found that the marginal productivity of auxiliary staff turned negative at about five aides per physician. Some of the difference between the present findings and those of Reinhardt may be a result of data inaccuracy, as discussed elsewhere in this report, but the differences in these findings may also reflect actual differences in the parameters of medical practice between the two surveys.

Auxiliary staff in dermatology

As mentioned earlier, there is a gap of about ten years between the two surveys. The Medical Economics survey data analyzed by Reinhardt reflects medical practice in the mid-1960s, when interest in ancillary personnel in physicians' practices was just beginning to gain momentum. It was only a decade ago that the physician's assistant, nurse-practitioner, and MEDEX programs became a reality, and this phenomenon seems to have been accompanied by a renewed interest in all kinds of physician aides. Thus, during the Medical Economics survey period, the development and deployment of mid-level health practitioners had not really begun, and other kinds of adjuvant personnel in physicians' offices were probably not as widely accepted nor as efficiently employed as they have been

more recently. The wide range of positive marginal productivity found in the present study may reflect delegation of many patient care tasks that may not have been regularly delegated in the past.

Another consideration that may be operative in the present study is that it is an analysis of a particular, well-defined specialty. In such a situation, one may expect--on a priori grounds alone--to find auxiliary staff making positive contributions to output even at very high staffing levels. Unlike general practice or the other "primary care" specialties enumerated above, the practice of dermatology is dominated by the care of a few major pathological conditions involving a limited set of diagnostic techniques and therapeutic procedures (see chapter 2). Thus, auxiliary staff can be easily trained to master these techniques and rapidly acquire the requisite experience to handle a substantial proportion of dermatological patient care with relative independence. Moreover, the fact that most of dermatologic disease is not life-threatening, and much of it is self-limiting undoubtedly influences the role of auxiliary personnel in this specialty. In contrast, primary care practices are generally confronted with a broad spectrum of medical complaints, including a large proportion of vague symptoms. In many cases, accurate diagnosis is difficult to establish and the

possibility of a serious threat to life and limb cannot be summarily dismissed. The range of procedures regularly employed in such practices is also much greater than in dermatology. The role of auxiliary personnel in such practices must, therefore, of necessity be circumscribed.

The productivity of ancillary staff in dermatology is perhaps just another example of the benefits attainable through specialization, so brilliantly illustrated in Adam Smith's classic description of the pinmaker.[1] One large prepaid group practice, for example, delegated exclusive responsibility for a routine acne clinic to a nurse, who handled about two-thirds as many patients annually as ordinarily handled by a physician in that setting.[2] A number of busy private practitioners routinely schedule follow-up visits to nurses employed in the practice rather than to a physician. However, there still remains a great deal of reluctance among many dermatologists to delegate responsibilities to auxiliary personnel.[3]

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[1]Adam Smith, An Inquiry into the Nature and Causes of the Wealth of Nations (New York: Random House, Inc., 1937), pp. 4-6.

[2]Krasner, "New Health Practitioners," pp. 1281-1282.

[3]National Program for Dermatology, Joint Committee on Planning for Dermatology, American Academy of Dermatology, 1969, p. 26; Welton, "Physician Support Personnel," pp. 42-45; and 1972 Annual Report, Division of Education and Communication, National Program for Dermatology, 1972, pp. 63-67.

Maximum marginal product

Having presented a lengthy argument--based on a priori reasoning and some empirical evidence--that adjuvant personnel are especially productive in dermatologists' practices, two characteristics of the estimated marginal productivity of adjuvant staff in dermatologists' practices are puzzling: (1) the early decline in marginal productivity and (2) its small absolute magnitude.

As shown in figure 6-3, marginal productivity of auxiliary staff time reaches a maximum at an input level of about 36 hours per week. Although this maximum point is perfectly consistent with Reinhardt's findings on auxiliary staff, the earlier discussion of the relatively high productivity of such staff in dermatologists' practices suggests that increasing marginal productivity would continue at higher levels of input. With the large proportion of patient care responsibilities that can be assumed by auxiliary staff, one may expect increased staffing levels to bring about greater productivity through division of labor, between clerical and laboratory functions, for example. Unfortunately, there does not appear to be a simple explanation for the early decreasing marginal product. As mentioned elsewhere, there is some imprecision in the data on auxiliary personnel, which may lead to the

unexpected finding. In addition, the remaining reluctance among a substantial number of dermatologists to delegate tasks traditionally reserved for the physician may play a role in this finding.

Absolute magnitude of marginal product

A more perplexing finding is the very small magnitude of the marginal product of auxiliary staffing. As shown in table 6-12, at approxinately the average level of physician and auxiliary input in the USC sample (i.e., 15 hours of physician time and 100 hours of auxiliary time) the marginal productivity of auxiliary staff appears to be only about .11; in comparison, the marginal product of physician time at that level of input is about 4.11 (table 6-11). The numbers in table 6-12, however, are somewhat misleading, because the data on auxiliary staffing are expressed in terms of hours per week, whereas output and physician time are given with respect to a three-day period. Therefore, the marginal product per hour of auxiliary staffing is roughly double that shown in the table.

Unfortunately, this simple correction does not resolve the problem. Even after the adjustment is made, the marginal productivity of auxiliary personnel appears quite small: less than a quarter of a visit per hour of auxiliary input, whereas an hour of physician time yields over four visits. This seems to be inconsistent

with the descriptive literature on ancillary personnel in medical practice, particularly in dermatology.[1] Moreover, it implies an extremely high shadow price of physician time (see below).

Much of this finding can be appropriately attributed to ambiguities in the data on auxiliary personnel upon which the present analysis is based. A general weakness of the data is that information on patient visits and the physician-respondent's activities was elicited in a detailed log-diary covering a specified three-day survey period, whereas the data on auxiliary staff was elicited at the end of a lengthy questionnaire among questions about general characteristics of the physician, his practice, and its location. Thus, there is no assurance that the auxiliary staffing reported in the questionnaire was actually involved in providing care for the patients recorded in the detailed log-diary.

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[1]Donald M. Schiff, Charles J. Fraser, and Heather L. Walters, "The Pediatric Nurse Practitioner in the Office of Pediatricians in Private Practice," Pediatrics 44 (July 1969): 62-68; R.E.M. Lees, "Physician Time-Saving by Employment of Expended-Role Nurses in Family Practice," Canadian Medical Association Journal 108 (April 1973): 871-875; Walter O. Spitzer et al., "The Burlington Randomized Trial of the Nurse Practitioner," New England Journal of Medicine 290 (January 1974): 251-256; and Eugene C. Nelson et al., "Impact of Physician's Assistants on Patient Visits in Ambulatory Care Practices," Annals of Internal Medicine 82 (May 1975): 608-612.

A more important shortcoming of the data, however, seems to be the lack of clear identification of the role of auxiliary staff in multi-physician practices. Specifically, in these practices, it was unclear whether the reported number of auxiliary staff were (a) occupied exclusively in providing services to the patients of the respondent dermatologist or (b) involved in the care of the patients seen by all the physicians in the practice. In the analysis presented in this report, the former has been assumed.[1] If in fact a substantial proportion of ancillary staff effort is devoted to the care of patients not recorded in the log-diary, a serious underestimation of the productive contribution of auxiliary personnel would result.

Productivity of aides: a refinement

In an effort to mitigate the data weakness just discussed, a separate analysis was conducted on a subsample of the data. For this analysis, all observations reporting more than one physician in the practice were eliminated, which left 100 cases for study. The parameters of the production function were estimated on the

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[1]The alternative assumption was tried in early stages of the analysis, but it yielded no benefit.

basis of these 100 observations and the coefficients are presented in table 6-13. As can be immediately seen, the magnitude of the regression coefficients of the auxiliary staff variables is substantially greater than what was estimated earlier on the basis of the entire sample (see table 6-2). All the coefficients are statistically significant at the .01 level; the MDHRS term was deleted from the equation because it failed to achieve significance even at the 10 percent level.[1] As shown, this equation maintains the distinction between the two categories of auxiliary personnel, which is particularly important in this attempt to capture the full impact of such personnel on the output of medical practices.

Holding the other two inputs (i.e., physician time and other auxiliary staff time) constant at their sample means, the marginal product of L_1 (i.e., mid-level health practitioners and specially trained dermatologists' assistants) reaches a maximum at about 300 hours per week and then diminishes steadily and turns negative at about 650 hours per week. The maximum absolute magnitude of the marginal product presented in the table is about .6 visits per hour of input,

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[1]The exclusion of this term, however, did not appear to make a noteworthy difference in the magnitudes of the auxiliary staff variables.

TABLE 6-13

ESTIMATED PRODUCTION FUNCTION COEFFICIENTS FOR DERMATOLOGISTS' PRACTICES, BASED ON PRACTICES REPORTING NOT MORE THAN ONE STAFF PHYSICIAN

Log of MDHRS	0.9415 (6.98)
DERMASSTS	0.0059 (2.86)
OTHSTAFF	0.0039 (2.88)
(DERMASSTS & OTHSTAFF)^2	-.0000042 (-3.24)
N	100
R^2	.48

NOTE: Figures in parentheses are t values.

which should be doubled to 1.2 to realistically reflect the marginal productivity of auxiliary personnel, as explained above. At the average input level observed in the USC sample of dermatologists' practices (i.e., 17.2 hours per week), the marginal product of L_1 is almost .7 (after appropriate adjustment).

The marginal product of L_2 (which consists of nurses, clerical staff, and other personnel not included in L_1) is smaller than that of L_1 over the entire range of input level, when holding the other two factors constant at their sample means (see figures 6-5 and 6-6). Marginal productivity attains a maximum of about .4 visits per hour (after adjustment) at an input level of 110 hours per week, with the absolute magnitude of the marginal product varying little to that point. At about 450 hours of L_2 per week, marginal productivity turns negative.

Marginal rate of substitution

The marginal rate of technical substitution between inputs is the rate at which one input can be substituted for another while maintaining the level of output constant. At any given point on the production surface, this is defined as the ratio of the marginal products of the two inputs under consideration.

For the production function estimated on the basis of the 100 observations reporting no more than

Fig. 6-5. Marginal Productivity Curves for Two Categories of Auxiliary Staff Hours Devoted to Patient Care in a Three-Day Period, Holding Other Labor Inputs Constant at Their Sample Means

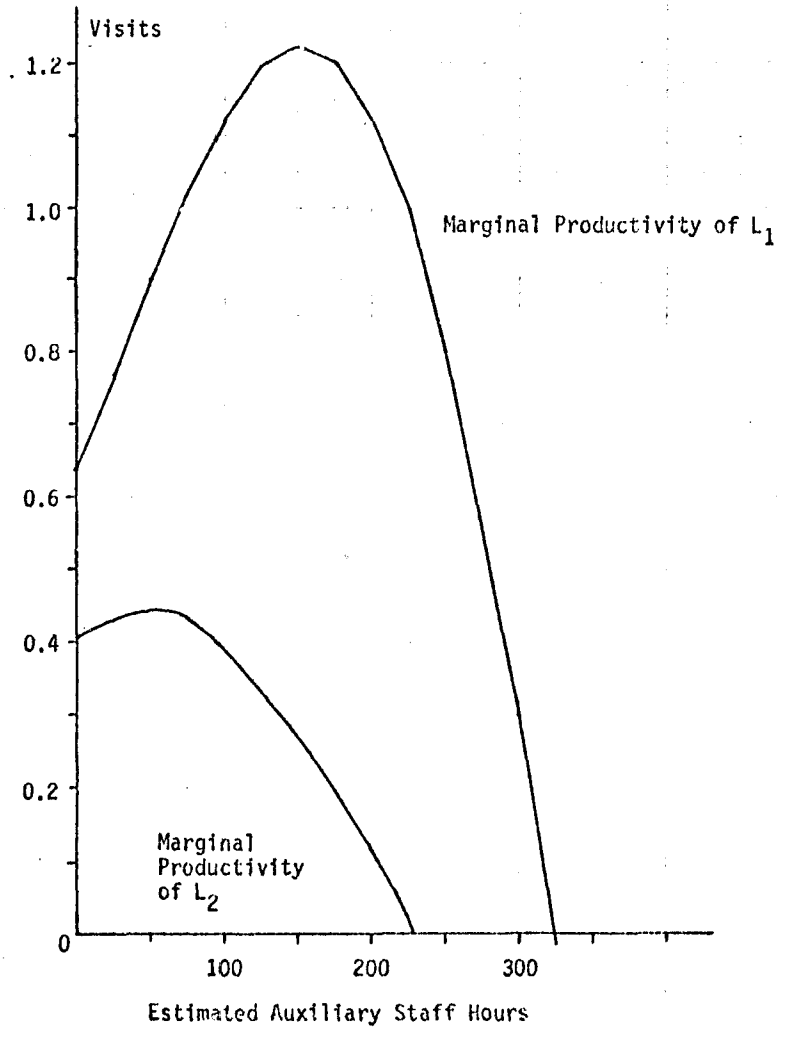
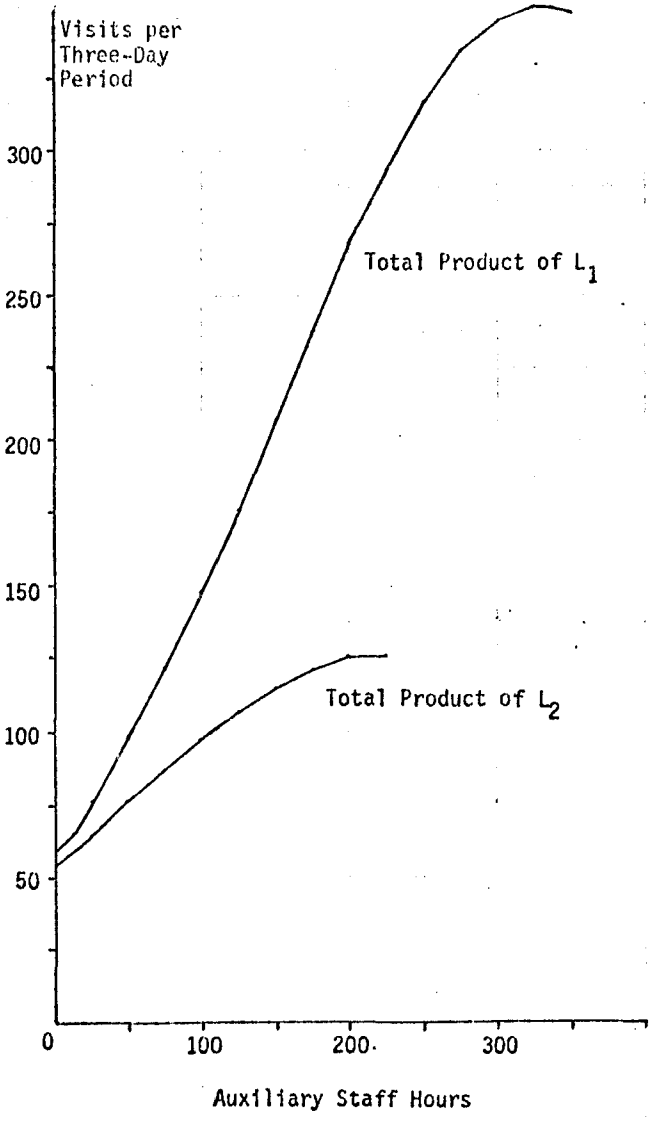


Fig. 6-6. Total Product Curves for Two Categories of Auxiliary Staff Hours Devoted to Patient Care in a Three-Day Period, Holding Other Labor Inputs Constant at Their Sample Means.



one physician in the practice (table 6-13), the marginal product of physician time is approximately 3.8 visits per hour at the average level of input observed in the sample for all three factors. As mentioned earlier, the marginal product of L_1 is about .7 and that of L_2 is about .4, at this level of input. Thus, the marginal rate of substitution between physician time and mid-level practitioner time is about 5.6, between physician time and other staff time is approximately 8.8, and between the two levels of auxiliary personnel is about 1.6 (using unrounded figures for the calculations).

Another economic parameter of interest is the elasticity of substitution, which describes the percent change in the input ratio induced by a given percent change in the marginal rate of substitution. If the earnings of factors of production are proportional to their marginal products, this parameter indicates how the relative share of the product going to each factor would change as a result of a change in relative input prices that would induce corresponding changes in the input ratio and marginal rate of substitution. For the estimated production function presented in table 6-13, the elasticity of substitution between physician time and mid-level health practitioner time is approxi-

mately 5.7,[1] at the average level of all three inputs observed in the study samples. Similarly, the elasticity of substitution between physician hours and auxiliary staff other than mid-level practitioners is about 3.2. This indicates that, on a percentage basis, the marginal rate of substitution changes little relative to changes in the input ratio, at the average input mix in the sample.

Shadow price of dermatologists' time

In order to minimize the cost of producing any good or service, the ratio of marginal products of two inputs should be equal to the ratio of their prices. Another way of saying this is that the marginal product per dollar should be equal for all the inputs; otherwise, production costs could be reduced by substituting more of one input for some of another. The wage rates of auxiliary personnel are generally determined in fairly competitive markets and at least some information on these wages is available; the corresponding (imputed) price of physicians' time, however, must be inferred from their work-leisure decisions, the prices

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[1]The formula used for calculating the elasticities, adapted from Reinhardt, is

$$\frac{b - L_i (c_i - 2dL)}{HL_i \left[\frac{c_i - 2dL}{H} - \frac{2\,db}{c_i - 2dL} \right]}$$

where $L = L_1 + L_2$.

of substitute factors, and the marginal rate of substitution.

Although accurate data on the relative prices of the inputs included in the present study are unavailable, information on nurses' salary levels can be used to approximate the cost of auxiliary staff input. During the survey period, it appears that the average hourly wage for registered nurses was about seven-and-a-half dollars, including fringe benefits. The wage rate for practical nurses seems to be about 80 percent of the wage for registered nurses, or roughly six dollars per hour. The average wage rate for competent secretarial and clerical staff is probably only slightly less. Thus, a figure of about six-and-a-half dollars per hour seems a reasonable, albeit imprecise, estimate of the cost of L_2.[1]

Fragmentary data on the earnings of mid-level health practitioners suggest that such personnel earn substantially more than registered nurses. In 1975, many formally-trained physician's assistants received as much as $20,000 in annual compensation, including fringe benefits, but it appears that the average was

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[1]The figures presented are rough estimates loosely based on U.S. Department of Labor, Bureau of Labor Statistics, Earnings and Supplementary Benefits in Hospitals: New York, N.Y.-N.J. Metropolitan Area, August 1975, Industry Wage Survey (New York: Bureau of Labor Statistics, 1976), pp. 4-14.

closer to $15,000.[1] A 1976 survey of family nurse practitioners and physician's assistants in California revealed an average salary level of about $17,000 per year, but national wage levels are thought to be somewhat lower.[2] The treatment of fringe benefits in these surveys is often unclear, which makes estimating the rate of compensation difficult. Nevertheless, it appears that $17,000 per year is a realistic estimate of the total cost of L_1 (including fringe benefits) during the survey period. Assuming an average of 1600 working hours per year, the hourly wage is about ten-and-a-half dollars.

Although the information on the earnings of mid-level practitioners and other auxiliary staff is admittedly very weak and no firm conclusions should be drawn therefrom, it does provide a basis for crudely estimating the shadow price of physicians' time. The profit-maximizing entrepreneur will employ an input ratio that

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[1]Donald W. Fisher and Susan M. Horowitz, "The Physician's Assistant: Profile of a New Health Profession," in The New Health Professionals, Ann A. Bliss and Eva D. Cohen, eds., (Germantown, Maryland: Aspen Systems Corporation, 1977), pp. 49-52.

[2]Mary O'Hara-Devereaux et al., "Economic Effectiveness of Family Nurse Practitioner Practice in Primary Care in California," in The New Health Professionals, pp. 163-164.

achieves equality between the marginal rate of substitution and the price ratio of the inputs; therefore, multiplying the marginal rate of substitution by the price of auxiliary staff should provide an estimate of the physician-entrepreneur's valuation of his own marginal hour of leisure.

On the basis of each of the two categories of auxiliary personnel, the shadow price of dermatologists' time appears to be close to sixty dollars per hour. For L_1, the estimated wage of ten-and-a-half dollars per hour multiplied by the marginal rate of technical substitution between physician time and L_1 (i.e., 5.6) implies a shadow price of about fifty-nine dollars per hour. Similarly, the estimated wage rate for L_2 (i.e., $6.50 per hour) multiplied by the marginal rate of substitution of 8.8 yields an estimated shadow price of about fifty-seven dollars. These figures may seem a bit high relative to available data on physicians earnings. In 1974, for example, the average net income from medical practice for all physicians was approximately $52,000 per year, which, on an hourly basis, is equivalent to less than half the estimated shadow price of dermatologists' time.[1] However, the dermatologists'

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[1]Sharon R. Henderson, ed., Profile of Medical Practice, (Chicago: American Medical Association, 1977), p. 188.

unique ability to handle a large volume of visits in a relatively short period of time (as discussed in chapter 2), can account for the high hourly earnings potential implied by the high shadow price of his leisure time.

It should be noted, however, that the omission of capital (i.e., physical plant and equipment) from the production function can lead to underestimation of the shadow price of physicians' time. In other words, the relative wage rates described earlier do not take into account the complement of capital services used in conjunction with the labor services. If, for example, the mid-level practitioners observed in the USC survey required additional space for examination and treatment and were, therefore, complemented by capital services valued at an average of two dollars per hour and the dermatologists in the sample employed capital services priced at four dollars per hour, the implied shadow price of physician time would be sixty-six dollars per hour, calculated using the formula,

$$(W_l + C_l)\ (MRS_{l.H}) = W_h + C_H$$

where, W_l is the estimated wage rate for L_l;

C_l is the estimated price of capital services used per unit of L_l;

$MRS_{l.H}$ is the marginal rate of technical substitution of L_l for physician time;

W_H is the shadow price of physician time; and

C_H is the estimated price of capital services used per unit of physician time.

If the capital stock used by the physician is basically fixed (i.e., the expenses for the physician's office are constant) regardless of the number of hours per week the physician works, but additional capital expenses are incurred (i.e., more space is needed) with the addition of auxiliary personnel, then C_H at the margin would be equal to zero and the shadow price would be somewhat higher. With regard to the cost of consumable supplies used in the practice, one can safely assume that these costs will be directly proportional to the marginal products, i.e., the use of consumable supplies is probably strictly related to the volume of patients seen; therefore, it should not affect the estimated shadow price.

At this point, it is worth emphasizing that, although an attempt was made to minimize the weaknesses in the data on auxiliary personnel, all problems and ambiguities could not be completely eliminated. Thus, the possibility remains that the productivity of auxiliary personnel has been somewhat underestimated in this empirical analysis; consequently the shadow price of dermatologists' marginal hour of leisure may be overestimated to some degree.

Discussion

Despite weaknesses in the data, the analysis reveals that auxiliary staff make a noteworthy contribution to dermatologists' output. The productivity of auxiliary personnel reflected in the empirical results was less than expected, but the estimates of the various economic parameters were clearly reasonable. The marginal productivity of mid-level practitioners and specially-trained assistants appears substantially greater than the marginal productivity of other ancillary personnel, which is expected. Better-qualified assistants can handle a wider variety of patient-care and administrative tasks, and in physicians' practices, there are relatively few of the distinct functional boundaries that characterize institutional staffing arrangements. Therefore, senior level physician assistants will be able to assume many responsibilities and will generally be more useful than aides with more limited skills.

It should be noted that the estimated production functions presented in this report are not ideal, theoretical relationships between inputs and outputs; rather, they are reflections of the real world in which optimal efficiency is usually not realized. These empirical estimates, therefore, incorporate all of the practical problems and managerial shortcomings involved in the

daily operation of medical practices. Perhaps the unexpectedly small marginal productivity of auxiliary staff is an indication of inefficient deployment of such personnel in the sample of dermatologists' practices; in contrast, earlier studies of new health practitioners and other assistants may have been based on small, select samples of particularly receptive physicians' practices or especially proficient assistants in an attempt to document the maximum productivity that could be achieved. A related issue is that managerial ability may be positively associated with the employment of auxiliary staff; in such cases, the contribution to output made by the unobservable managerial talent will be incorporated into the auxiliary staff variables, which results in an overestimation of the marginal productivity of auxiliary staff.

Another noteworthy finding is that dermatologists appear to be employing at least an optimal level of auxiliary personnel. The implied shadow price of leisure time at the margin is unexpectedly high, especially since the average dermatologist enjoys substantially more leisure than his colleagues in other specialties; this suggests that dermatologists, who employ an average of three aides, may even be employing more than an optimal level of auxiliary staff. In contrast, Reinhardt estimates a dramatically lower

shadow price of physician time, on the basis of 1965-67 data, and infers that employment of auxiliary staff--at two aides per physician--was about half of its optimal level. Coate, however, did not find evidence of suboptimal employment of aides in optometry in 1964.[1]

The relative efficiency of solo and group medical practice is a subject that has attracted widespread interest and some controversy in recent years; unfortunately, the present analysis has not resulted in any definitive conclusions on this question. The group practice dummy variable was highly correlated with the auxiliary staff variables and therefore was omitted from the equations presented in the report. Without controlling for any other variables, however, it appears that dermatologists in group practice devote as much time to patient care as their peers in solo practice and at the same time handle a greater number of patient visits. As described by Newhouse, one would expect the diminution of individual incentive in group practice to discourage physician effort in terms of number of hours practiced and number of visits handled per hour.[2] As

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[1]Douglas Coate, "The Optimal Employment of Inputs in Fee-for-Service, for Profit Health Practices: The Case of Optometrists," Explorations in Economic Research 4 (Spring 1977): 316-330.

[2]Joseph P. Newhouse, "The Economics of Group Practice," Journal of Human Resources 8 (Winter 1973): 37-56.

mentioned, the greater use of auxiliary staff in group practice can easily explain the greater rate of output per hour. The similar amount of practice time for solo and group practitioners may be attributable to the relatively short average workweek in dermatology; the group practice norm may be equal to or greater than the average in this specialty, but less than the average for physicians in general.

As discussed earlier, estimates of the scale elasticity of output developed in the course of this analysis do not really address the policy issue of whether a group of physicians practicing together can provide more services than if each practiced individually. The unit of observation upon which the present analysis is based is the individual dermatologist; the empirical production functions estimated in this report therefore reflect the results of the individual physician increasing his hours of work rather than increasing the number of physicians in the practice. Moreover, even if the sample consisted of medical practices of different sizes, it may be analytically unsound to estimate a single production function on the basis of the entire sample. This would imply that all medical practices operate essentially in accordance with a single production function, whereas solo and group practices may involve distinctly different production processes. (The

scale elasticity of output is clearly the appropriate parameter in examining returns to scale among group practices of various sizes.) Earlier in this report, separate equations were presented for solo and group practice, and these suggest that solo practice is somewhat more efficient in converting inputs into output, while holding the level of the inputs constant at approximately their sample means. However, this cursory examination does not do justice to the complexity of the issue, and further research is needed.

A final point worthy of mention is the inconclusiveness of the variables reflecting the local scarcity or abundance of dermatologists. This finding was particularly disappointing because a rather unique and seemingly appropriate geographical unit, i.e., the Zip-code Sectional Area, was used as the basis for calculating the number of dermatologists relative to population in each respondent's area. The local physician-to-population ratio is undoubtedly only one of many factors that determines whether or not there is excess demand in the local market for medical care generally, and, specifically, among the population served by a particular physician. Thus, a physician's perception of the need for his services may be only remotely related to the physician-to-population ratio in an area. In the case of dermatologists, there are additional

explanations for encountering less responsiveness to the local dermatologist-to-population ratio: (a) only a small portion of dermatology involves threatening or very serious illness and (b) in many areas, primary care physicians may be handling a disproportionately large share of dermatological problems.

One must also recall that inclusion of this kind of variable in a production function equation, results in the variable reflecting only differences in output that cannot be attributed to variation in the inputs. Therefore, it might capture such things as intensity of effort among the practitioner and his staff, but would not reflect responsiveness to excess demand that manifests itself in more hours devoted to patient care by the physician and support personnel. As discussed in the descriptive segment of this report, where the inputs were not held constant, there was a significant inverse relationship between the local supply of dermatologists relative to population and the number of visits per dermatologist during the survey period. Nevertheless, this issue is far from clear and requires further study.

CHAPTER VII

GEOGRAPHIC DISTRIBUTION OF DERMATOLOGISTS

Over the past two decades, widespread concern regarding the availability of medical care to all segments of our nation has stimulated numerous investigations of the geographical distribution of physicians in the United States. At present, the literature on this subject is quite extensive, and it includes studies using a variety of physician categories, geographical units, sources of data, and methodological orientations. In fact a number of extensive reviews of the literature have been prepared, which renders unnecessary another comprehensive review of previous research on this subject.[1] Nevertheless, a brief review of the salient

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[1]U.S. Department of Health, Education, and Welfare, Health Resources Administration, Bureau of Health Resources Development, Factors Influencing Practice Location of Professional Health Manpower: A Review of the Literature, DHEW Publication No. (HRA) 75-3, 1974; Carolynn Steinwald, "Factors Influencing the Distribution and Location of Physicians: Literature Review," in Distribution of Physicians in the U.S., 1971, ed. Gene A. Roback (Chicago: American Medical Association, 1972), pp. 25-30; John McFarland, "Toward an Explanation of the Geographical Location of Physicians in the United States," in Measuring Physician Manpower: Contributions to a Comprehensive Health Manpower Strategy (Chicago: American Medical Association, 1974), pp. 17-36; U.S. Department of Health, Education, and Welfare, National Center for Health

findings of some of the earlier studies puts the current investigation into proper perspective.

The purpose of undertaking further examination of the geographic distribution of physicians in the present study in spite of the extensive research conducted earlier is essentially to refine and extend previous analytic work in two ways: (1) by concentrating on a single, well-defined specialty and (2) by deliberate consideration of the geographic unit of observation used in the analysis (explicitly taking into account the degree of specialization and the extent of the market, as described later) and experimenting with alternative units, including the Zipcode Sectional Area--a new and apparently appropriate unit of analysis. Therefore, in the brief review of earlier research, special attention will be focused on the geographic unit used in the analysis and the extent of differentiation by individual specialty.

Development of medical service areas

Before discussing the relatively recent economic analyses of physician distribution, it is worthwhile to

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Services Research, Models of Physicians' Specialty and Location Decisions, by Jack Hadley, Technical Paper Series No. 6, (n.d.), pp. 22-46; and James R. Cantwell and Barry S. Eisenberg, "The Spatial Distribution of Physicians: A Literature Review," American Medical Association, 1975.

note that the literature on health services includes some very early references to the concept of a medical service area and the need to delineate such areas, just as commercial trading areas are identified. In a paper published in 1943, Ciocco, Davis, and Altman discuss the problems involved in using various geographic units for analyzing the distribution of physicians.[1] The use of states as units of observation obscures enormous intrastate variation; counties are also inappropriate units because of the substantial inter-county movement that takes place in the course of all economic activity. Dickinson reported, in 1949, on the development of a medical service area map of the United States.[2] On the basis of the judgments of secretaries of county medical societies, Dickinson divided the United States into 757 separate areas, more than a fourth of which cross state boundaries. Each area was supposed to be self-sufficient in a variety of medical specialty services. Dickinson's medical service areas are surprisingly similar, in

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[1]Antonio Ciocco, Burnet M. Davis, and Isidore Altman, "Measures of Medical Resources and Requirements," Medical Care 3 (November 1943): 314-326.

[2]Frank G. Dickinson, "A Medical Service Area Map of the United States: A Progress Report," Journal of the American Medical Association 139 (April 1949): 1021-1028.

number, configuration, and purpose, to the Zipcode areas used in the present study. Ciocco and Altman issued a report in 1954 on medical service areas in Western Pennsylvania.[1] They surveyed physicians and households in that region, and delineated service areas on the basis of movement of the population to obtain physician, hospital, and maternity care. Although these areas are aggregations of counties, they are generally consistent with the areas developed by Dickinson.

Studies of physician distribution

One of the earliest economic investigations of the spatial distribution of physicians in the United States was conducted by Rimlinger and Steele.[2] They recognize "the problem of defining the geographic area served by physicians," but they simply adopt convenient county groupings and regions as units of

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[1]U.S. Department of Health, Education, and Welfare, Medical Service Areas and Distances Traveled for Physician Care in Western Pennsylvania, by Antonio Ciocco and Isidore Altman, Public Health Monograph No. 19 (Washington, D.C.: U.S. Government Printing Office, 1954).

[2]Gaston V. Rimlinger and Henry B. Steele, "An Economic Interpretation of the Spatial Distribution of Physicians in the U.S.," Southern Economic Journal 30 (July 1963): 1-12.

observation. Their most salient finding was that the supply of physicians relative to population was closely related to the per capita income of the population. They also infer that "desire for leisure is not a strong motivating force in physicians' choice of location." The authors discern substantial immobility, which includes, however, all non-pecuniary and unmeasured advantages of practicing in a particular place. In a later paper, Steele and Rimlinger report that the per capita income of the population appeared to have little effect on the change in physician location; degree of urbanization and increase in population were most closely associated with changes in the stock of physicians over time.[1]

Benham, Maurizi, and Reder studied the geographic distribution of physicians and dentists, with states as the unit of observation simply "because of availability of data."[2] The dependent variables

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[1]Henry B. Steele and Gaston V. Rimlinger, "Income Opportunities and Physician Location Trends in the United States," Western Economic Journal 3 (Spring 1965): 182-194.

[2]Lee Benham, Alex Maurizi, and Melvin W. Reder, "Migration, Location and Remuneration of Medical Personnel: Physicians and Dentists," Review of Economics and Statistics 50 (August 1968): 332-347.

studied include the absolute number of physicians in each state, the number per capita, and changes in the absolute and per capita supply over time. Population, personal income, number of medical school places, barriers to entry, urbanization, and average income of physicians were the explanatory variables included in the study, which covered the period 1930 to 1960. Consistent with earlier work and a priori expectations, Benham et al. found that the major determinant of physician supply in a state was population, and change in population was the major determinant of change in physician supply. These findings and similar, though weaker, associations found with per capita income, suggest that physicians are, to a great extent, responsive to the effective demand for their services. However, evidence was also found that non-pecuniary factors play a noteworthy role in physicians' location decisions, and the volume of training facilities appears to be positively associated with the per capita supply of medical practitioners.

Joroff and Navarro conducted an analysis of physician distribution that is of particular interest because it (a) uses 299 metropolitan areas as units of observation (which appears to be conceptually more appropriate than using either states or counties) and (b) separates individual specialties, including derma-

tology, for the analysis.[1] The dependent variables studied are components of the stock of physicians relative to population in 1966, and the community characteristics examined for their explanatory power include population size and density, purchasing power and educational attainment of the population, proportion of the population that is white and the proportion 65 years of age and older, number of hospital beds per capita, and the existence of a medical school in the community. The study found that the per capita supply of general practitioners was most strongly associated with the proportion of the population older than 64. For specialists, education of the population and the medical environment of the community seemed to play an important role. Quite puzzling to this writer, however, was the finding that the per capita supply of dermatologists was primarily related to the supply of hospital beds. As indicated in chapter 2, only 3 percent of all visits handled by dermatologists are for care of hospital inpatients, and one would therefore suspect that there is no direct causality between the supply of hospital beds and the supply of dermatologists. However, to the extent that the supply of hospital beds

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[1]Sheila Joroff and Vicente Navarro, "Medical Manpower: A Multivariate Analysis of the Distribution of Physicians in Urban United States," Medical Care 9 (September-October 1971): 429-438.

serves as a proxy measure for the degree of medical specialization and sophistication in an area, one would expect the supply of dermatologists to be positively correlated with bed supply.

Before examining the particular questions involved in the distribution of dermatologists, it would be useful to outline, in a very general way, a conceptual model of physician location choice that underlies all of the studies of physician distribution. Sjaastad's classic work on migration identifies many of the costs and returns involved in selecting a place to live and work.[1] Studies of physician distribution generally focus on the advantages of different locations, and they often attribute differences in earnings and leisure among areas to unobservable compensatory characteristics of some places or unexplained lack of mobility. Following the conventional utility-maximization approach, we can hypothesize that physicians choose their location so as to maximize their utility from market and non-market activities. The utility derived from market activities is most clearly reflected in earnings, but it may very well include non-pecuniary aspects of professional activity in-

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[1]Larry A. Sjaastad, "The Costs and Returns of Human Migration," Journal of Political Economy Supplement (October 1962), pp. 80-93.

cluding intellectual challenge, professional contact with colleagues and patients, and the satisfaction involved in improving the health of the local population. The non-pecuniary aspects of market activity, such as the safety and pleasantness of an occupation, are well recognized in economic analysis and are the basis for compensating differentials in earnings; but, since non-pecuniary professional rewards seem to be a superior good, one would expect these factors to play a greater role in the decisions of physicians than in the decisions of other workers. Similarly, one can expect the non-market attributes of an area, e.g., climate, cultural activities, and educational attainment of the population, to have a greater impact on the location of physicians than on the location of the general population.

Unfortunately, many aspects of this conceptual model do not readily lend themselves to empirical analysis. As is often the case in empirical economic studies, the data necessary for direct verification of the model are simply not available and many of the variables alluded to are not measurable. Therefore, one is compelled to rely on proxy measures of the pertinent variables; many of the widely-used proxies, however, are closely associated with a number of market and non-market advantages of a particular location,

obscuring the unique effect of each conceptual variable; the model, therefore, is substantially distorted in undergoing empirical analysis.

Other limitations of empirical analysis also prevent the examination of conceptually intriguing questions. For example, the independent effects of education and income on behavior are very often difficult to identify, because these two variables are usually highly intercorrelated. In the present study of dermatologists, distinguishing between income and education would be especially useful. The income of the population is a determinant of effective demand for physicians' services, and it has been found to be consistently associated with the supply of physicians. Increased levels of private and public health insurance coverage during the past decades may have weakened somewhat the relationship between income and demand, but a good deal of ambulatory care still remains largely uncovered. Since medical care is generally considered a superior good--and specialists' care even more so--one would expect that upper income groups would make more visits per capita to dermatologists than would the rest of the population, as described in chapter 2 . Increased use of dermatologists' services, however, may also reflect greater sophistication in seeking specialists' rather than generalists' attention,

which may be more a result of educational attainment than of income level.[1] From the perspective of national health manpower policy, distinguishing these two effects may clarify whether increased demand for dermatologists' care reflects principally the indulgence of the affluent in seeking discretionary, perhaps cosmetic, physician care or the selection by a discerning population of efficient and effective physician management of cutaneous disease. Unfortunately, the data do not permit separation of these two factors.

Distribution of a particular specialty

On a conceptual level, it appears superior to attempt an analysis of a particular specialty group, giving consideration to its unique characteristics, rather than to examine the general supply of physicians. Physicians are, at present, a very heterogeneous group, with widely divergent responsibilities, expertise, interests, and methods of practice. Although physician specialty groups have many attributes in common, they also differ substantially in many different ways, including the patient population served, the amount of

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[1]The selection of a specialist reflects the patient's perception regarding the superiority of specialty care for a particular problem, a perception that may not always be correct. However, although the expertise of the specialist may not be required or may not be useful in many circumstances, a specialist will often be routinely selected to avoid the risk of inappropriate treatment in unusual cases.

time required for the average patient visit, and similar factors discussed in chapter 2. By focusing the analysis on a single specialty and by dealing with a roughly uniform professional group, one hopes to evaluate more precisely the arguments of the decision-making function in choosing a location and to identify the characteristics of the specialty that distinguish it from other physician specialties.

The age of the population served by a physician, for example, varies substantially across specialties. In analyzing hospital services or general physician care, analysts often distinguish between persons younger than 65 and the elderly population,[1] but for specialists such as pediatricians, obstetricians, and dermatologists, a different breakdown would obviously be more appropriate. Similarly, the income of the population may be strikingly more important for some specialties, e.g., psychiatry and dermatology, than for others. In addition, the measurement of some of the variables may be tailored to suit the particular group under study, as discussed below regarding the income variable used in the present study.

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[1]Parker G. Marden, "A Demographic and Ecological Analysis of the Distribution of Physicians in Metropolitan America," American Journal of Sociology 72 (November 1966): 290-300.

As mentioned earlier in this report, studying a particular specialty also facilitates the selection of an appropriate geographic unit of observation. Ideally, the geographic boundaries used for the analysis should circumscribe the local market area for the goods or services under study. However, when analysis of the general supply of physicians is undertaken, the definition of an appropriate market area is obscured by the inclusion of different kinds of physicians and various levels of specialization. Medical service areas undoubtedly reflect the hierarchical structure of health services production, and, similar to the markets for all goods and services, different kinds of physicians' services have market areas of different sizes. Obviously, patients of general and family practitioners and those of specialists providing "primary care" tend to come from a relatively local area, whereas highly specialized physicians may draw patients from an entire state or an even larger area. As Adam Smith observed, the degree of specialization is related to the extent of the market.[1] In medical services, three levels of care are generally recognized: primary care, provided by generalists and some specialists; secondary care, provided by most specialists; and tertiary care,

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[1]Adam Smith, The Wealth of Nations, pp. 17-21.

provided by subspecialists, usually in an academic setting. Moreover, even specialties that appear to be parallel in the hierarchy may differ substantially in the actual degree of specialization (i.e., in the extent of the purview of a specialty or in the rarity of illnesses within that purview), and they will, therefore, differ in the size of the area or population served. Thus, it appears desirable to study each specialty or medical service using a geographic unit appropriate to it.

As described in chapter 3, Zipcode Sectional Areas can serve as an appropriate basis for analyzing the distribution of dermatologists. These areas were delineated on the basis of local transportation patterns, and they tend to approximate economic trading areas.[1] A discussion of the conceptual superiority of these units for analytic studies and their advantages for descriptive purposes has been presented in a recent paper.[2] Leyes and colleagues found a close correspondence between the hierarchies of medical service areas and economic trading areas,[3] and Zipcode areas appear

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[1]Baier, "Zip Code Areas," pp. 4-13.

[2]Krasner, Ramsay, and Weary, "Physician Distribution," pp. 974-977.

[3]Leyes, Economic and Health Service Areas.

to be at the ideal level of the hierarchy and are of the proper size for studying dermatologists' services.

The present empirical analysis

As mentioned, the approximately 800 Zipcode areas can be consolidated into between 400 and 500 areas to make them consistent with economic trading areas. In the present analysis, three alternative geographic units are presented: states, Zipcode Sectional Areas, and consolidated Zipcode areas. Three dependent variables are also studied: the number of dermatologists located in each area, the per capita number, and the change in the absolute number between 1967 and 1977.

Demographic and economic information on Zipcode areas is limited, as discussed earlier, but the available information does permit the exploratory empirical analysis included here. However, the data do not permit estimation of the supply and demand functions using a simultaneous equations model. Therefore, the empirical analysis presented here is based upon a simple linear model relating the observed intersection of supply and demand to a variety of community characteristics.

The explanatory variables included in the analysis are the following:

Population and urbanization. The number of persons residing in an area (PERSONS) and the proportion of the population that lived in an urban area (PCURBAN) were highly intercorrelated; therefore, they are not used together in the same equation. The square of the population term (PERSONSQ) is also included in one of the regression equations presented below.

Population income. As discussed, the income of the population has often been used as a proxy for the demand in an area, but it also reflects economic status of the community, which represents a non-pecuniary attribute of a particular location. In other words, even if demand did not vary by income, physicians might choose to locate in affluent communities. These two aspects of income obviously cannot be easily distinguished empirically, and in the present study, its principal impact is assumed to be on demand. In the analysis, two alternative measures of population were used: per capita income (PCINC) and the proportion of families having an annual income of $25,000 or more (FAMINC). The latter measure of income is based on the descriptive data in table 2-4, which suggests that the number of dermatologist-visits per person remains fairly constant over a wide range of family income but increases dramatically at the $25,000 level.

Population education. The measure of educational attainment of the population has been defined as the percent of the population 25 years of age and older who have had at least one year of post high-school education (PCCOL), based on the information in table 2-5. The educational level of the population is almost invariably highly correlated with income level, and the data used for the present study were no exception. Therefore this variable was used only as an alternative to income in some of the equations.

Age of the population. Based upon the utilization data presented in table 2-6, the age variable used was the percent of the population who are between 15 and 24 years of age (PC1524). As discussed, this departs from the measure based on 65 years of age, often used in studies of general health services. The percent of the population that is female was also included as an explanatory variable in the early stages of the analysis; this variable performed as expected based on the descriptive information in chapter 2, i.e., that women account for about three-fifths of visits to all physicians, as well as those to dermatologists. Unfortunately, this variable was highly correlated with the age variable and was, therefore, deleted from the equations presented here.

Professional ambience and training activity. In this study, the per capita number of dermatology residency positions located in an area (PCRESD) was used as the measure of professional ambience. In earlier phases of the study, the number of medical school places in an area was used an an alternative measure (the two variables were highly intercorrelated), but the volume of residency training in the specialty consistently performed better.

The location of training programs in an area not only enhances the professional ambience, in general, but it produces a pool of practitioners that have a close familiarity with the area and have established early professional relationships there. As a number of observers have noted, a major proportion of individuals who receive residency training in a particular state remain in that state to practice.[1] Moreover,

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[1]H.G. Weiskotten and Marion E. Altenderfer, "Trends in Medical Practice: An Analysis of the Distribution and Characteristics of Medical College Graduates, 1915-1945," Journal of Medical Education 31 (part 2, July 1956): 1-14; Herman G. Weiskotten et al., "Trends in Medical Practice: An Analysis of the Distribution and Characteristics of Medical College Graduates, 1915-1950," Journal of Medical Education 35 (December 1960): 1071-1095; Henry R. Mason, "Medical School, Residency, and Eventual Practice Location: Toward a Rationale for State Support of Medical Education," Journal of the American Medical Association 233 (July 1975): 49-53; and Richard M. Scheffler, "The Relationship Between Medical Education and the Statewide Per Capita Distribution of Physicians," Journal of Medical Education 46 (November 1971): 995-998.

the location of residency training is more closely associated with practice location than are place of birth, medical school attendance, or internship. These findings for physicians in general were recently found to be true for dermatologists in particular.[1] Thus, the number of dermatology residency positions in an area may reflect the effects of both the general professional environment and the local production of practitioners.

As discussed above, number of hospital beds in an area may be used as a measure of professional environment, and it also can act as a measure of services that are complementary to (and, to a more limited extent, substitutes for) physician care in the production of health. Unfortunately, this information was not readily available and was not expected to be very important in studying dermatological care (see chapter 2). However, as the use of Zipcode areas for economic analysis increases, especially for analysis of other physician specialty groups, the information on hospital beds and other pertinent information can be assembled on the basis of Zipcode areas without excessive difficulty.

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[1]David L. Ramsay et al., "The Distribution of Dermatologists and Residency Programs," Journal of Medical Education 53 (February 1978): 144-146.

Migration. In analyzing the change in the supply of dermatologists between 1967 and 1977, it is useful to know the change in the general population during this period. Unfortunately, this information could not be obtained on the basis of Zipcode areas. As a rough approximation of the migration into an area, the percent of the population that did not live in the same state in 1965 (PCDIFST) was used.

Physician fees. The general level of physician fees in an area was estimated on the basis of information from the Medicare Program, as discussed earlier. Strangely, the fees for initial visits were not highly correlated with fees for follow-up visits. The two sets of fee levels were used alternatively in the initial phases of the analysis; neither of the two performed especially well, and no consistent pattern of superiority emerged. Therefore, the two measures of general fee levels, (a) the prevailing fee for an initial visit (FEE-1) and, (b) the prevailing fee for a follow-up visit (FEE-2), are included alternatively in different equations on the basis of the empirical result in each case.

General attractiveness of an area. Because many non-pecuniary variables play a major role in the location decisions of individuals and families, particularly in the decisions of the relatively affluent,

such as physicians, many of the studies of locational choice and geographic distribution try to include among the independent variables some measure of the amenities of an area. The variables used in the various studies include degree days as a measure of the attractiveness of the climate, public appropriations for recreation or education, or square miles of parks or beaches; unfortunately, these variables represent only a small portion of the factors that contribute to the non-pecuniary attractiveness of a particular area. The value of land (excluding the value of natural resources contained therein) has also been used as a measure of the attractiveness of a geographic area, because the advantages of a place should be captured in the price of this immobile factor of production. Unfortunately, the only information available for Zipcode areas was value and rental of homes, which (a) on a conceptual level, are measures quite different from land value and (b) on a practical level, were highly correlated with the income variables. Thus, no distinct measure for amenities was included in the present analysis.

Empirical analysis

Before presenting the regression results, it would be useful to describe the nature of the distribution under study. Table 7-1 shows the number of

TABLE 7-1

DISTRIBUTION OF DERMATOLOGISTS RELATIVE TO POPULATION, BY STATE, ZIPCODE SECTIONAL AREA, AND CONSOLIDATED AREA

Number of Dermatologists per 100,000 Population in Each Area	Number of Consolidated Zipcode Areas	Number of Zipcode Sectional Areas	Number of States
None	59	252	1
0.1 to 1.0	88	140	4
1.1 to 2.0	150	152	27
2.1 to 3.0	64	119	9
3.1 to 4.0	23	61	2
4.1 to 5.0	5	30	1
5.1 & Over	3	29	0
Total	392	783	44

areas that fall into each dermatologist-to-population-ratio category. A large number or the Zipcode areas have no dermatologist, but that is largely a result of the method used to delineate these areas. Many of these areas are small and in fact economically integrated with neighboring areas to a great extent, but they are assigned separate Zipcode numbers for a variety of administrative reasons. When all the areas are completely consolidated on the basis of economic integration, the distribution of areas by dermatologist-to-population ratio appears to be more regular.

The regression results are presented for all three geographic areas: states, Zipcode Sectional Areas, and consolidated Zipcode areas. The purpose for presenting empirical findings for each of these areas is to provide an empirical basis for evaluating the appropriateness of the areas, particularly consolidated Zipcode areas as a geographic unit of analysis. Unfortunately, there is no simple objective method to assess the relative superiority of the alternative geographic units based on the present empirical findings. The reader is, therefore, generally left to form his own conclusion on the basis of the coefficient of multiple determination (R^2) and the t values for the individual regression coefficients. It should be recognized, however, that averaging small area observa-

tions, which may often include extreme values, over an entire state generally produces substantially greater coefficients of multiple determination. Another point worth noting is that the equations included here represent only a portion of the equations run; obviously, the equations were selected on the basis of the strength of the association of the explanatory variables with the dependent variable, but no conscious attempt was made to select equations that displayed better performance for one geographic unit than for another.

Regression results

Table 7-2 shows the regression results for the geographic distribution of dermatologists, with the absolute number of dermatology practitioners as the dependent variable. Almost 90 percent of the variation among states and consolidated areas is explained by the three variables: size of the population, its educational attainment, and the per capita number of residency positions in the area. The t values of the coefficients in the consolidated area equation are consistently higher than those in the state equation. Educational attainment of the population appeared to be more strongly related to the distribution of dermatologists than was income level.

TABLE 7-2

REGRESSION EQUATIONS ON THE GEOGRAPHIC DISTRIBUTION OF DERMATOLOGISTS, BY STATE, ZIPCODE SECTIONAL AREA, AND CONSOLIDATED AREA

	Consolidated Zipcode Areas	Zipcode Sectional Areas	States
PERSONS	.000023 (58.61)	.000022 (44.09)	.000024 (17.95)
PCCOL	.00093 (7.43)	20.6189 (11.68)	572.7845 (4.05)
PCRESD	1.6977 (3.21)	.8795 (7.05)	-4.0154 (-0.31)
R^2	.91	.76	.89
N	392	783	44

NOTE: Figures in parentheses are t values.

The per capita supply of dermatologists is the dependent variable in table 7-3. The R-squares are markedly lower across the board here than they were in the previous table, as one would expect since population size is deleted as an explanatory variable. The R-square for the state equation is substantially higher than for the consolidated area equation, but the latter has consistently higher t-values for the individual coefficients. The Zipcode equation performed surprisingly well overall, though the fee variable was not statistically significant.

In table 7-4, the dependent variable is the change in the supply of dermatologists between 1967 and 1977. As shown, the supply of dermatologists appears to have increased in areas having a large population, but population size made a diminishing marginal contribution, as indicated by the negative and significant coefficient of the population squared term in the consolidated area and Zipcode area equations. The proportion of the area's population that were relatively new migrants to the state (PCDIFST) seems to be closely associated with the increase in dermatologist supply in the small-area equations. Overall, the consolidated-area equation performed very well, having a higher R-square and higher t values for the coefficients than the state equation.

TABLE 7-3

REGRESSION EQUATIONS ON THE PER CAPITA DISTRIBUTION OF DERMATOLOGISTS, BY STATE, ZIPCODE SECTIONAL AREA, AND CONSOLIDATED AREA

	Consolidated Zipcode Areas	Zipcode Sectional Areas	States
PCURBAN	1.6904 (5.55)	1.8503 (4.99)	3.2979 (3.77)
PCINC	.0035 (3.01)	-.0100 (-6.33)	-.0017 (-0.65)
PCRESD	.4420 (7.19)	.3133 (4.50)	.5613 (2.97)
FEE-2	.0648 (2.97)	-.0004 (-0.03)	.0500 (1.11)
PC1524	4.6324 (2.66)	40.3983 (17.44)	12.2168 (1.47)
R^2	.41	.45	.63
N	392	783	44

NOTE: Figures in parentheses are t values.

TABLE 7-4

REGRESSION EQUATIONS ON THE CHANGE IN THE STOCK OF DERMATOLOGISTS, BY STATE, ZIPCODE SECTIONAL AREA, AND CONSOLIDATED AREA

	Consolidated Zipcode Areas	Zipcode Sectional Areas	States
PERSONS	.0000077 (16.51)	.0000087 (15.43)	.0000047 (1.35)
PCCOL	.00024 (3.16)	5.6030 (4.26)	106.1387 (0.66)
FEE-2	.03397 (1.47)	.0112 (1.28)	.2701 (0.41)
PCRESD	.3876 (1.36)	.0585 (0.78)	-5.2174 (-0.54)
PCDIFST	15.1221 (3.73)	7.0682 (4.67)	58.7152 (0.45)
PERSONSQ	* (-9.53)	* (-14.42)	* (0.41)
R^2	.61	.33	.53
N	392	783	44

* = Magnitude of the coefficient equal to 10^{-9} or less.

In table 7-5, however, where the dependent variable is also the change in dermatologist supply from 1967 to 1977, the state equation has a higher R-square, but the consolidated-area equation has higher t values. The state equation has an implausible sign, albeit not very significant, for family income. The per capita number of residency positions was significantly positive, as one would expect, in the consolidated area equations.

In early phases of the study, the supply of dermatologists relative to population in 1967 was included as an independent variable in the analysis of the change in supply between 1967 and 1977, to see if the migration of dermatologists over the past decade tended to mitigate the uneven distribution of these specialists. Although the sign of the coefficient of this variable was consistently negative, it was not statistically significant in most equations. The weak empirical relationship is probably a result of two opposing forces involved. The inverse relationship between the stock in 1967 and changes in the stock over the following decade implies that dermatologists respond to relative shortages of practitioners in an area and tend to locate in places where they can expect relatively strong demand for their services. In conflict with this relationship, however, is a ten-

TABLE 7-5

REGRESSION EQUATIONS ON THE CHANGE IN THE STOCK OF DERMATOLOGISTS, BY STATE, ZIPCODE SECTIONAL AREA, AND CONSOLIDATED AREA

	Consolidated Zipcode Areas	Zipcode Sectional Areas	States
PERSONS	.0000037 (14.44)	.0000017 (4.64)	.0000073 (6.34)
FAMINC	27.4298 (1.87)	15.3630 (3.99)	-609.9003 (-1.92)
FEE-1	.0801 (3.15)	.0218 (1.32)	.4474 (0.71)
PCRESD	.8457 (2.68)	.1077 (1.28)	7.1240 (0.71)
PCDIFST	17.4607 (4.05)	9.2478 (6.14)	257.7258 (2.18)
R^2	.50	.14	.56
N	392	783	44

NOTE: Figures in parentheses are t values.

dency for physicians to be attracted to places that have an abundant supply of physicians perhaps because the attributes of a place that attracted and kept physicians there in the past also continues to do so in more recent years. The ample local supply of specialists also offers potential migrants the advantages of professional comraderie and cooperation.

Overall, the regressions suggest that consolidated Zipcode areas are appropriate units of analysis. The R-squares of the consolidated area equations were not consistently lower than the R-squares for the state equation, even though the state data minimize variation by averaging extreme values for small areas. The t values of the individual coefficients were, virtually without exception, higher for the consolidated area equations, though the larger sample size may have played a role here.

The performance of some of the individual variables however, was somewhat disappointing. The proportion of the population aged 15 to 24 was expected to be an important explanatory variable, but it turned out not to be significant in a number of equations. Fee levels in an area, though having the expected sign, did not perform consistently. As shown in the tables, some equations include the prevailing fee for an initial visit and other equations use the fee for a follow-up

visit, the alternative measures being selected on the basis of their significance in the equation. As discussed at the end of chapter 5, the fee variables used in this analysis are based on broadly-determined physician fee levels; these variables, therefore, can be considered exogenous to each individual practitioner and are probably exogenous even to the group of dermatologists. Therefore, the direct relationship between the supply of dermatologists and general physician fee levels probably implies that dermatologists are attracted, ceteris paribus, to areas that have high fee levels. The possibility that an abundant supply of practitioners may cause fee levels to be higher, though in conflict with conventional economic principles, has also been mentioned by some analysts, as discussed in chapter 5. However, the traditional market response to abundant supply, i.e., downward pressure on price levels, may have been operative to some extent in the opposite direction, and thus may have weakened the empirical relationship.

The overall explanatory power of the equations was also somewhat disappointing, although the results reported here are not substantially different than the results of similar studies. It must also be noted that in addition to the relatively small size of the areas under study, the results are influenced by the degree

of heterogeneity of the sample. Zipcode areas encompass rural and urban areas, and they exhaust the land area of the United States. Therefore, one should expect greater variation and a smaller proportion of "explained" variation using Zipcode areas than one would expect, for example, in studying a few hundred metropolitan areas.

Supply, productivity, and geographic area

For another rough evaluation of the appropriateness of consolidated areas as units of analysis, data on dermatologists' output, fully described earlier in this report, was used. As shown in table 5-1, the output of dermatologists is inversely correlated with the local supply of dermatologists. To examine the effect of using alternative geographic units, the supply of dermatologists relative to population was calculated on the basis of consolidated areas, Zipcode Sectional Areas, and states. The correlations between output and local supply were calculated using a slightly different sample size and a somewhat different measure of output, than used in chapter 5, and the results are shown below:

	Consolidated Areas	Zipcode Sectional Areas	States
Correlation with Output	-.15	-.14	-.10

Only the correlation based on consolidated areas was significant at the five percent level, though the coefficient based on Zipcode areas was significant at the ten percent level.

As discussed earlier in this report, the simple relationship between output and the local supply of dermatologists probably reflects the use of auxiliary personnel and variations in the amount of time the physician devotes to patient care. However, this relationship can also reflect differences in output even when holding the inputs constant, which may be perceived as intensity of effort. This aspect of the production of dermatologists' services can be captured by including in the production function a variable reflecting local supply conditions, as discussed in chapter 6.

One way to examine the appropriateness of alternative geographic units is to determine how each unit performs in revealing this phenomenon. Table 7-6 presents estimated production functions similar to those presented in chapter 6; the equation in the first column excludes the dermatologist supply variables, and the other three columns are equations that include this variable calculated on the basis of three alternative geographic units. As shown, the dermatologist-supply variable has the expected nega-

TABLE 7-6

ESTIMATED PRODUCTION FUNCTIONS FOR DERMATOLOGISTS' SERVICES INCLUDING ALTERNATIVE MEASURES OF THE LOCAL SUPPLY OF DERMATOLOGISTS RELATIVE TO POPULATION

		Geographic Area Used to Calculate DERMPOP		
		Consolidated Zipcode Areas	Zipcode Sectional Areas	States
Log of MDHRS	.9362 (10.05)	.9234 (9.97)	.9291 (9.84)	.9336 (9.98)
DERMASSTS	.0036 (3.49)	.0036 (3.58)	.0036 (3.48)	.0035 (3.52)
OTHSTAFF	.0015 (2.51)	.0014 (2.29)	.0015 (2.48)	.0015 (2.49)
(DERMASSTS & OTHSTAFF)^2	-.0000015 (-2.94)	-.0000014 (-2.77)	-.0000015 (-2.92)	-.0000015 (-2.92)
CERTIFIED	.2866 (3.13)	.3010 (3.30)	.2810 (3.04)	.2857 (3.11)
DERMPOP	--	-.0032 (-1.83)	-.0035 (-0.50)	-.0008 (-0.46)
R^2	.50	.51	.50	.50
N	151	151	151	151

NOTE: Figures in parentheses are t values.

tive sign in all three equations, but only the one based on consolidated areas is significant at the ten percent level.

As described in chapter 6, the quantity of auxiliary staff input in some dermatologists' practices was somewhat ambiguous, and therefore, production functions were also estimated on the basis of a selected sample of dermatologists for whom the survey data were relatively clear. This subsample was also used to examine the performance of the alternative geographic units, as shown in table 7-7. The results shown are very similar to those presented in table 7-6; all the dermatologist-supply variables had the expected signs, but only the dermatologist supply calculated on the basis of consolidated areas had a respectable t value (i.e., the coefficient for this variable was significantly different from zero at the ten percent level). Thus, the empirical results appear to affirm the appropriateness of the consolidated Zipcode area as a unit of analysis.

TABLE 7-7

ESTIMATED PRODUCTION FUNCTIONS FOR DERMATOLOGISTS' SERVICES, INCLUDING ALTERNATIVE MEASURES OF THE LOCAL SUPPLY OF DERMATOLOGISTS RELATIVE TO POPULATION

		Geographic Area Used to Calculate DERMPOP		
		Consolidated Zipcode Areas	Zipcode Sectional Areas	States
Log of MDHRS	.9136 (6.90)	.9085 (6.94)	.9086 (6.79)	.9133 (6.71)
DERMASSTS	.0058 (2.85)	.0057 (2.87)	.0057 (2.79)	.0058 (2.84)
OTHSTAFF	.0034 (2.52)	.0032 (2.37)	.0035 (2.54)	.0034 (2.51)
(DERMASSTS & OTHSTAFF)^2	-.0000036 (-2.74)	-.0000034 (-2.61)	-.0000036 (-2.75)	-.0000036 (-2.72)
CERTIFIED	.2423 (2.32)	.2587 (2.49)	.2410 (2.29)	.2422 (2.29)
DERMPOP	--	-.0064 (-1.82)	-.0006 (-0.37)	-.0001 (-0.01)
R^2	.50	.52	.51	.50
N	100	100	100	100

NOTE: Figures in parentheses are t values.

CHAPTER VIII

CONCLUSION

The analysis of the production of dermatologists' services and the geographic distribution of these specialists presented in this report represents an early attempt to take into account specialty characteristics in analyzing physician manpower issues. The empirical analysis of production yielded a number of interesting results, in addition to providing estimates of a number of economic parameters. Most of the findings were generally as expected on the basis of economic theory, though some results were somewhat surprising. All of the production function coefficients had the expected signs, but some lacked statistical significance. The non-input variables also had the expected signs, with board certification found to be highly significant.

The estimated production functions indicate that dermatologists are employing at least an optimal level of auxiliary personnel, and that more highly trained personnel make a greater contribution to output than less-skilled staff. The low estimates of the marginal productivity of auxiliary personnel were disappointing, but this may reflect a reluctance by many practitioners

to delegate responsibility, as well as some weakness of the data.

An attempt to improve the measurement of output beyond a simple count of visits was, unfortunately, largely unsuccessful. The detailed information on patient visits that was collected in the USC survey of dermatologists was expected to provide a basis for weighting visits to reflect differences in the content of physician visits, particularly in dealing with a distinct specialty. Unfortunately, the refinements of output measurement described in chapters 4 and 6 did not appear superior to a simple count of visits. This suggests that more accurate measurement of output will require complex and extensive data collection and analysis.

The analysis of the geographic distribution of dermatologists strongly suggests the appropriateness of the consolidated Zipcode area as a unit of observation. The advantages of analyzing distribution on a specialty-specific basis were also described; unfortunately, not all of the points could be adequately illustrated with the available data.

Future research

Despite the limitations of information and resources, the analysis described here succeeded in three important ways: (1) applying conventional eco-

nometric analysis to a profession that had not previously been studied in this fashion; (2) extending and refining economic analysis of physician manpower by describing and illustrating the importance of a specialty-specific approach and by presenting the Zipcode Sectional Area as a conceptually meaningful geographic unit of observation; and (3) raising questions about medical manpower and specialization.

Further studies on individual specialties are clearly needed to provide an understanding of the full spectrum of physician manpower in this country. Because of the lack of much pertinent information, even the analysis of dermatologists' services is not complete, and insufficient data precluded a comparative analysis of the services of other specialties. Analysis of productivity and distribution of individual specialties requires the collection of extensive information on physician and patient characteristics, as well as a thorough understanding of the role and methods of each specialty.

Only limited information has been categorized by Zipcode area, but an increasing amount of information appears to be assembled on this basis as time goes on. Moreover, the inclusion of Zipcode numbers in every address facilitates tabulation on that basis. Therefore, further geographic analysis of physician distribution

based on Zipcode areas seems likely and highly useful.

Underlying any discussion of physician specialization are questions regarding the efficiency of current patterns of specialization and the identification of an optimal level of specialization. Although these questions are of critical importance to national health manpower policy, they are not addressed in this paper. With the measurement of physician output extremely difficult, as discussed, determination of optimal specialization is a formidable task. Nevertheless, the importance of this question demands a serious attempt to answer it. Specialization is characteristic of American medicine, and a great deal of additional research is needed to help us understand all of its implications.

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