Physicians and surgeons. C.2

INDUSTRIAL RELATIONS CENTER

UNIVERSITY OF MINNESOTA

Working Paper
72-05

MANPOWER SHORTAGES: THE CASE FOR PHYSICIANS

[by] M. F. Bognanno [and]
J. R. Jeffers

[Minneapolis] November 1972.

Working Paper
72-05

MANPOWER SHORTAGES: THE CASE FOR PHYSICIANS

M. F. Bognanno
J. R. Jeffers

The authors gratefully acknowledge the financial support for this research provided by Public Health Service Grant 5 T01 HS00027 awarded to the Health Economics Research Center, The University of Iowa. However, the views expressed here are the authors' own and in no way reflect those of any agency of the United States Public Health Service.

In addition, the authors would like to thank Hyman Joseph and Roy J. Ruffin for helpful comments during various stages of the preparation of this manuscript. Naturally, any errors or omissions are the sole responsibility of the authors.

November 1972

MANPOWER SHORTAGES: THE CASE FOR PHYSICIANS

M. F. Bognanno and J. R. Jeffers*

1. Introduction

The problems encountered when attempting to assess the presence or absence of a "shortage" of some component of the work force are among the most difficult of those confronting economists. This is particularly so in the case of health manpower.

During the last two decades the performance of the health services industry has become a matter of major concern to health professionals, politicians, and the general public. Numerous policy proposals designed to increase the efficiency of the industry's production units, its effectiveness in combatting illness and consumer accessibility to health services have been hotly debated in the recent past. In the 1960's this debate culminated in the passage of many pieces of legislation that directly and indirectly have infused billions of dollars into the nation's health care delivery system.[1] Yet, in spite of these efforts, many speak loudly of the existence of a "crisis" in health care in the United States [28].

Central to most of the debate revolving around the issue of a crisis in health care delivery is the question of whether or not there currently exists a shortage of physicians in this nation. It is generally conceded that physicians are the most important component of the stock of health

---

*The authors are Associate Professor, Industrial Relations Center, University of Minnesota, and Associate Professor, Department of Economics, The University of Iowa, respectively.

manpower and that a shortage of physicians would be the most serious "bottleneck" to increasing the flow of medical services now and in the future.

The purpose of this paper is to review and critique the various methodologies employed to investigate the existence of physician shortages, with primary emphasis on the techniques employed to estimate physician "requirements." No attempt will be made to review techniques of estimating "supply." We present actual estimates of physician requirements made by other authors. However, our purpose in presenting these data is to facilitate an understanding of how past applications of various methodological approaches and different assumptions have lead to different conclusions, and not to judge the accuracy of the results of any particular author's study of the problem. In doing this we hope to leave the reader with a better understanding of both the techniques used for analyzing the existence of a shortage of a particular component of the general workforce and of the "physician shortage problem."

In the following three sections, we review the need, relative income and internal rate of return approaches to investigating physician shortages. The next section provides a theoretical comparison of these three approaches. In making this comparison, we provide a theoretical framework within which numerical estimates of physician requirements may be derived from the relative income and internal rate of return approaches to investigating physician shortages. A final section summarizes the major conclusions of the paper and presents some suggestions for future research. Our major conclusion is that if the various approaches are applied correctly, then theoretically, all will yield consistent estimates of physician requirements; and hence, will yield consistent policy recommendations concerning the future supply of physicians.

2. Review of Need Requirements Studies

In the interests of facilitating subsequent discussion, we introduce some simple identities that will provide a useful framework for reviewing studies of physician shortages.

Assume that the quantity of the output of physicians in year t is measured as O(t) patient visits in that year. Let N(t) represent the total population in year t and U(t) represent the average number of patient visits per member of the population in year t. We then can write the following identity:

$$O(t) \equiv U(t) \cdot N(t). \tag{2.1}$$

Let output per physician in year t, measured in terms of the average number of patient visits per physician in year t, be P(t), and the total number of full-time equivalent physicians in that year be represented by D(t). We can write the following identity:

$$O(t) \equiv P(t) \cdot D(t). \tag{2.2}$$

Equating identities (2.1) and (2.2) and solving for D(t) yields,

$$D(t) \equiv \frac{U(t)}{P(t)} N(t), \text{ i.e.,} \tag{2.3}$$

the number of physicians existing in year t is the product of the ratio of the rate (average) of consumer utilization and the rate (average) of physician productivity, multiplied by the total population of consumers in year t.[2] These relationships will simplify our review of studies of physician requirements.

Lee-Jones Study

The Lee-Jones study of 1933 is one of the earliest attempts to quantitatively estimate the "need" for physicians in the United States [26]. This study quantified "need" for physicians by proceeding as follows:

(a) developing a table of annual "expectancy rates for diseases and injuries";

(b) canvassing leading physicians regarding their opinions of the number of services required to diagnose and treat a given illness;

(c) estimating the number of physician hours required to furnish care for each major disease and injury category; and

(d) assuming that the average physician spends 2,000 hours per year in caring for patients, they were able to translate requirements for physicians' hour into a "need" of 165,000 physicians.

The Lee-Jones methodology may be formalized in the following fashion. Let S_j^i represent the total annual number of physician hours of service required to provide the jth medical service ($j = 1, \ldots, m$) necessary for the treatment of the ith "illness" ($i = 1, \ldots, n$). S_j^i equals the product of the number of services of type j provided per year, times the average number of physician hours required each time the jth service is rendered. Let I_i represent the frequency of the illness in the population in a given year. The expected total annual number of physician hours S required to treat the population in a given year may be expressed as,

$$S(t) = \sum_{i=1}^{n} \sum_{j=1}^{m} S_j^i I_i. \tag{2.4}$$

If we assume $S^H(t)$ equal the number of hours worked in year t by the typical physician, then we compute,

$$\frac{S(t)}{S^H(t)} = D(t), \tag{2.5}$$

where D(t) is the total number of physicians required in year t, given S(t). Multiplying both the numerator and the denominator of the l.h.s. of (2.5) by the average number of patient visits rendered per hour yields,

$$\frac{O(t)}{P(t)} = D(t). \tag{2.6}$$

Note that (2.6) is similar to (2.2), rearranged. The reader will recall that O(t), P(t), and D(t) represent annual rates of output, productivity and required physicians in year t, respectively. Therefore, we interpret the Lee-Jones study as a careful attempt to estimate physician requirements in terms of the service needs of the population, translating these needs into physician requirements based on a rather simplified assumption about the nature of the production function for physician output, the latter assumption being that the physician's average (marginal) physical product is fixed.

The Lee-Jones study has much to commend. It has been reviewed by several others thus our comments will be brief [24]. First, the study represents an outstanding effort to measure the health needs of the population in terms of both objective and well-organized subjective data, the latter consisting of informed medical opinion. Lee-Jones made no attempt to conceal the fact that they neglect economic factors in their analysis [26, p. 111]. As such, their projection of physician requirements is to be interpreted strictly as a normative assertion concerning the quantity of physicians required to provide the quantity of services consumers ought to consume. Second, Lee and Jones' conception of the physician production function is overly simple allowing no changes in physician productivity due to changes in technology or substitution of capital services for those of labor. The contribution of the services of capital and of ancillary personnel to the output of physician services are not investigated thus consideration of possible increases in physician productivity through more intensive and varied use of capital and allied-health manpower are precluded. Third, the study appears to ignore changes that might occur over time in the frequency of illness resulting from public health measures and increases in the consumption of medical care. With respect to the latter, we draw attention to externalities or "spill-overs" resulting from an expansion of health care delivery such as the reduced frequency of disease due to increased immunizations and the early detection and treatment of secondary illnesses often accompanying examination and treatment of "specific complaint" illness. Fourth, common to most studies of physician requirements, Lee-Jones assume infinite substitutability among physicians in terms of their interest and ability to treat different types of illness. All in all however, the Lee-Jones study is the only and best of its kind.

Ratio Criterion Need Approach

For many years after the Lee-Jones study various prestigious committees, commissions, agencies and individual scholars projected future physician requirements by the ratio criterion method. The first step in this procedure consisted of selecting the ratio of physicians to population existing for a particular region or at a point in time as reflecting an ideal balance between the supply and demand of physician services. Next, the "standard" ratio was multiplied by the size of the population that was forecast to exist in some future time period.

In terms of the simple identities stated at the beginning of this section, this procedure may be expressed as,

$$\frac{D(0)}{N(0)} \equiv \frac{U(0)}{P(0)} = \alpha^*, \tag{2.7}$$

where the 0 index represents the value of each variable in the base region or time period. Once having adopted the standard physician to population ratio α^*, the latter is multiplied by the population expected to exist in the future period, $\hat{N}(t)$, yielding estimated physician "requirements" for that period, $D^*(t)$, viz,

$$D^*(t) = \alpha^* \hat{N}(t). \tag{2.8}$$

The positive difference between $D^*(t)$ and the projected supply of physicians in year t yields an estimate of a "shortage" of physicians. Thus, those studies adopting a simple physician to population ratio have one feature in common namely they all implicitly assume that the ratio of rates of utilization and productivity remain constant. Indeed, from reading these studies it seems clear that many authors assume that U(t) and P(t) are constant overtime, and invariably no mention is made of the actual time path followed by these variables.

Some examples of projected future physician requirements for the year 1975 are presented in Table 2.1 below. Projected "supplies" of physicians, broken-down by Medical Doctors and Doctors of Osteopathy (M.D.'s and D.O.'s) and Medical Doctors only, and 1975 population estimates are also provided.[3]

The ratio criterion method of projecting physician requirements has been critiqued by various authors; therefore, we only need briefly discuss the most salient features of the procedure here [24].

The first question to be raised is, in what sense is the selected criterion ratio in any way "optimal," or in what manner does it relate "supply" to "need"? In this regard Klarman states:

> Sometimes a personnel to population ratio is chosen at the upper end of an array of such ratios as the criterion or standard. No attempt is made to validate the choice by examining the level of care rendered in the geographical area from which the criterion is derived [22, p. 367].

He goes on and makes another point that can be easily overlooked, namely:

> This method is logically bound to lead to a finding of shortage, since geographic areas above the standard ratio are allowed to keep their existing personnel [22, p. 368].

The standard ratio implicitly assumes an equilibrium between the demand for and supply of physicians in the base region or period, and that the relation between the criterion ratio and future supply and demand

TABLE 2.1

Constant Utilization and Productivity Projection of Physician Supply and Requirements for 1975*

Date of Projection		Projected Population	Projected M.D.'s & D.O.'s	Projected M.D.'s only	Projected Requirements M.D.'s & D.O.'s
1958	[45]	228,463,000		{290,409 293,382	{301,370 325,139
1959	[3]	235,246,000	{312,800 318,400		330,000
1959	[15]	235,246,000		296,100	311,500
1960	[42]	235,246,000		296,100	339,220
1966	[39]			304,000	
1967	[46]				375,000
1967	[43]	223,000,000	360,000		400,000
1967	[37]				390,000

*Table constructed from sources developed by Irene Butter [6] and by W. Lee Hansen [12].

conditions will remain unchanged. Of course, whether or not this is the case is never analyzed. In a broad sense, the criterion ratio selected by the various agencies and commissions represents a value judgement of the physicians needed per capita in the nation. However, to supply physicians according to an expert second party's "judgement" may result in a serious misallocation of national resources. These studies, along with the Lee-Jones study, fail to suggest: (a) how to persuade the population that "expert" judgement of need is correct and how to persuade them to translate this "need" for physicians' services into a willingness to consumer physicians' services; (b) how consumer willingness to consumer services can be translated into market demand which is consistent with perceived "need," given that the population faces a financial constraint; and (c) how the experts determined that society is willing to adopt the implied health standard regardless of cost.

A final criticism is rather lengthy. The standard ratio approach implicitly assumes that the production function for physicians' services is linear homogeneous, with fixed technical coefficients (i.e., factors are most efficiently combined in a specific proportion irrespective of their relative costs) and stable over time. True, if this production function existed and were known, the future population were the only determinant of physicians' services demanded and this relationship were known, then given the projected population and the corresponding quantity of physicians' services demanded, it would be possible to determine the future number of physicians required to match the future demand for physicians' services.

However, as a point of fact, the demand for physicians' services and for most other goods and services depends on numerous factors in addition to population size. Among these variables, for example, is insurance. The more people covered by insurance and the broader the type and amount of health service coverage, the greater the amount of care demanded. The logic supporting this proposition is that insurance, by lowering the "point-of-service" price to the individual below the true cost, causes him to increase the quantity of care he demands. Clearly, therefore, the projected requirements for physicians' services which rely solely on estimates of future population will be below the true requirements mark if a national health insurance program such as that proposed by either President Nixon or Senator Kennedy is enacted, ceteris paribus. The Kennedy Bill, S4297, would supersede Medicare and Medicaid and substitute in their place a national health insurance program covering the medical expenses of all U.S. residents for the entire range of health services. Likewise, President Nixon's recent proposal would substitute a Family Health Insurance Plan for Medicaid and would require all employers to provide basic health insurance coverage for their employees. Sharing costs, much as employers and employees do today under most collective bargaining agreements, the administration program would require minimum coverage for a wide range of health care services. Failure to consider such a major and likely change in the financing of physicians' services is but another illustration of the weakness of the criterion ratio approach as viewed from the standpoint of the demand for physicians' services.

As for the nature of the production function, most empirical evidence to date suggests that the production function implicit in the criterion ratio approach does not exist in reality.

In addition to the approach discussed above several recent studies, some undertaken by economists, have attempted to incorporate notions of possible changes in rates of utilization, U(t) productivity, P(t), or both into estimates of physician requirements in the present and in the future. The results of five such studies are presented in Table 2.2 below.

In addition to accounting for population changes between 1967 and 1975, Fein makes a careful effort to estimate the utilization rate U(t) for the year 1975, taking account of changes in the age-sex distribution

TABLE 2.2

Projections of Physician Requirements Incorporating Assumptions Concerning Possible Changes in Rate of Utilization and Productivity for 1967 and 1975*

Date of Projection	Projected Population		Projected Requirements M.D.'s & D.O.'s
1. Fein [8]	224,730,000	(a)	340,000 to 350,000
		(b)	372,000 to 385,000
2. Bureau of Labor Statistics [47]			390,000
3. National Advisory Commission on Health Manpower [28]		min	346,000
4. Public Health Service [48]		(c)	400,000
		(d)	425,000
5. Stevens* [41]	192,359,000	(e)	141,938
		(f)	173,360
		(g)	197,000

*The 1975 estimates were obtained from sources developed by Irene Butter [6] and W. Lee Hansen [12]. The 1967 estimates are from Stevens [41]. For all 1975 requirements projections the actual supply of physicians was estimated to be approximately 360,000 in that year. In 1967 Stevens estimates the supply of physicians at 225,396.

of the population; increased urbanization; the changing population distribution by color; the rising levels of education and incomes; and the likely impact of Medicare on demand. On the assumption that the relative price structure will not change between 1965 and 1975, Fein's study represents the most complete analysis of the estimated increase in the rate of utilization ("demand" for) physician services to date.

Considering population growth alone during the 1965-1975 period, Fein projected a 12 to 15 percent increase in the demand for physicians' services. However, considering changes in all of the above-mentioned factors, Fein projected an increase of from 22 to 26 percent. On the assumption that an increase in the demand for physicians' services will lead to a proportionate increase in the demand for physicians, Fein's projections may be interpreted as projected increases in the demand for physicians.

Fein concluded that the projected increase in supply of active and inactive M.D.'s and D.O.'s of 19 percent over the 1960 to 1975 period was more than adequate to cover the increased demand for physicians resulting from population growth alone (i.e., 12 to 15 percent). Note that this conclusion conflicts with those studies which projected 1975 "shortages" based on some physician-to-population standard. However, "in the absence of a rise in productivity," he concluded that a 19 percent increase in supply would not be sufficient to meet the increase in demand resulting from changes in all remaining factors affecting utilization. The weakness in this conclusion is, of course, found in Fein's own observation that physician productivity has and probably will continue to increase. On this point he states:

> With normal productivity increases, all of the consumer demand resulting from higher incomes could be met. But greater productivity increases are required if "unsatisfied demand" exists today, if consumer tastes for medical services increases, or if new financing programs are enacted whose purpose is to increase the amount of medical care available to part, or all, of the population [8, p. 138].

The Bureau of Labor Statistics' [47] estimate of physician requirements also takes into account the impact of expected changes in population composition on U(t) the utilization rate. In addition, the BLS' estimates attempts to forecast increased utilization across all age groups and includes estimates of increased need for physicians engaged in teaching and research.

The projections of physician requirements provided by the National Advisory Commission on Health Manpower [28] also include estimates of future changes in the utilization rate U(t) in a manner very similar to Fein; and as a result, their estimates are similar to Fein's projections.

The Public Health Service [48] projected physician requirements on the basis of two different assumptions. The first estimate of 400,000 was based on the "professional standards" assumption that U(t) for the entire population in 1975 would be equal to the utilization rate of members of prepayment group practice plans in the base period. Their second estimate of 425,000 was based on the assumption that the utilization rate for the 1975 population would equal the highest utilization rate among the four major regions of the United States.

In summary, studies 1 - 4 in Table 2.2 took into account changes in the size of population over the period for which physician requirements were projected. In addition, all attempted to incorporate estimates of the probable (possible) utilization rate of the 1975 populations in their forecasts of physician requirements. Clearly, the nature of the assumption that is made concerning the expected utilization rate makes a significant difference in the results obtained. The above picture is rather confusing. Estimates of the potential imbalance between the "demand" and "supply" of physicians provided by lines 1 - 4 of Table 2.2 range from a <u>surplus</u> of 21,700 physicians (Fein: 361,700 - 340,000) to a <u>shortage</u> of 35,000 physicians (PHS: 425,000 - 390,000) for the year 1975. However, none of these studies incorpoated numerical estimates of changes in physician productivity along with estimates of changes in population and utilization in their forecasts of physician requirements.

Stevens takes both differences in utilization and physician productivity rates into account in his study of the physician shortage problem [41]. The first estimate of national physician requirements provided by Stevens in line 5 of Table 2.2 applies the utilization rate of Kaiser members U(K) and the Kaiser physician productivity rate P(K) to America's 1967 population N(A). Stevens second estimate applies Kaiser's utilization rate U(K) and America's average physician productivity rate P(A) to the nation's 1967 population total. The third estimate applies America'a average utilization rate U(A) and Kaiser's productivity rate U(K) to the U.S. population in 1967. The first and second estimates (e and f) incorporate Stevens arbitrarily determined 10 percent upward adjustment in the utilization rate of Kaiser members to take into account the probable occasional use of non-Kaiser physicians on the part of Kaiser members. All of Stevens' estimates of national physician requirements for the year 1967 fall below the existing stock of physicians available for that year, 225,396, and thus Stevens concludes that under the hypothetical conditions assumed, a <u>theoretical</u> surplus of physicians existed in all three instances.[4]

Stevens' procedure can be conceptualized easily in terms of identity (2.3) above. Stevens' calculations may be written formally as:

$$(e) \quad D^1(A) = \frac{U(K)}{P(K)} N(A),$$

$$(f) \quad D^2(A) = \frac{U(K)}{P(A)} N(A), \text{ and} \qquad (2.9)$$

$$(g) \quad D^3(A) = \frac{U(A)}{P(K)} N(A),$$

where A and K designate the United States and Kaiser (Portland), respectively. Identity (2.3) shows that the number of physicians required to serve a given population is directly related to the utilization rate and is inversely related to the rate of physician productivity. The reason Stevens' calculations consistently show a surplus of physicians in 1967 is that Kaiser's membership utilization rate is lower than the average utilization rate of the total United States population, and Kaiser's physician productivity rate is higher than the average rate of productivity to the nation's total stock of physicians. Thus, if the United States were to "experience" <u>either</u> Kaiser's utilization rate <u>or</u> Kaiser's physician productivity rate, <u>or</u> <u>both</u>, the U.S. could "get-by" with fewer physicians.

Stevens' results are extremely provocative and they raise a number of questions. First, why is Kaiser's utilization rate lower than the U.S. average? Second, why is Kaiser's physician productivity rate higher than the U.S. average? Third, is the quality of care rendered by the Kaiser plan higher or lower than the average quality of care rendered in a more traditional fashion?

Limitations of space preclude discussion of these questions. For the purposes at hand, it is important to appreciate that Stevens' analysis directly considers "differences" in physician productivity in estimating physician requirements. Further, Stevens' study dramatically illustrates that the organization of health care delivery can effect both rates of consumer utilization and physician productivity.

3. <u>Review of Relative Income Approach</u>

An operational definition of shortage was developed by Blank and Stigler in their study of the market for scientific personnel [4]. Their definition of shortage was adopted by Rayack in his study of the market for physicians and was stated as follows:

> ...a shortage exists when the quantity of physicians' services supplied increases less rapidly than the quantity demanded at incomes received by physicians in the recent past. Under such conditions, the incomes of physicians relative to the income of others will tend to rise. As the relative income of physicians rises, there will be attempts to substitute less costly services for the services of physicians [35 , p. 222].

Let us assume that two markets are of interest. Let the first market designated by a 1 superscript be the market for physicians, and let the second market be designated by a 2 superscript be a "comparable" occupation or profession. Excluding the comparison criterion concerning substitution between factors of production, Rayack's condition of shortage may be expressed as follows:

$$\begin{aligned} \text{If} \quad & D^1(t) - S^1(t) > 0 \text{ at } Y^1(t-1), \\ & D^2(t) - S^2(t) \geq 0 \text{ at } Y^2(t-1), \text{ and} \qquad (3.1) \\ & D^1(t) - S^1(t) > D^2(t) - S^2(t), \end{aligned}$$

where D represents quantity demanded, S represents quantity supplied, and $t = 1, \ldots, T$, then physician income, $Y^1(t)$ will rise relative to income in other markets; thus, indicating the existence of a shortage. Assume that when equilibrium exists between the two markets the following relation holds:

$$Y^1(0) = aY^2(0), \qquad a \geq 1. \qquad (3.2)$$

If the conditions posited in (3.1) hold for all subsequent periods, then with respect to the base period physician income will increase relative to that of others. Or stated generally:

$$\frac{Y^1(t)}{Y^1(0)} \geq \frac{Y^2(t)}{Y^2(0)} \tag{3.3}$$

Substituting for $Y^1(0)$ from (3.2) above and simplifying yields,

$$Y^1(t) \geq aY^2(t), \qquad t = 1, \ldots, T. \tag{3.4}$$

The inequality in (3.4) shows that physician income in any time period after any changes in demand and/or supply in the two markets will be equal or greater than the multiplicative factor, a, times income in the comparable occupation or profession. Only if long-run demand and supply forces cause the two markets to reestablish relative equilibrium would (3.4) hold as a strict equality; beginning in the time period in which this occurred, it would hold thereafter so long as demand and supply conditions remained unchanged.

Rayack compared the relative change in the incomes of physicians over the period 1939-1959 with that of dentists; lawyers; professional, technical, and kindred workers; and managers, officials, and proprietors (nonfarm) over the same period [35]. He found that the income of physicians increased 534 percent while those of the other components of the workforce increased only 361 percent. He also found substantial evidence of the substitution of the services of cheaper (less well and highly trained) medical personnel for those of physicians. He cites the growth in the relative number of internships and residencies held by foreign trained personnel (9.6 percent in 1950 to 26.4 percent in 1960), and the more rapid growth in the numbers of physical therapists, occupational therapists, professional nurses, practical nurses and midwives relative to physicians (626, 840, 77, and 109 percent, respectively as compared to 35 percent in the case of physicians) over the period 1939 - 1960.

Based on these findings, Rayack concluded that the evidence is consistent with his definition of a shortage of physicians' services. Rayack's final statement reads:

> This article gives a qualitative answer in economic terms about the "direction of effort" which implies the need for a greater growth in the supply of physicians services than has been recommended by the government [35, p. 237].

The relative income approach used by Rayack in his investigation of the physician shortage problem has the merit of being highly objective in its approach. Further it recognizes the importance of the role of the market in allocating labor services throughout the economy. The methodology has some serious shortcomings, most of which were recognized and dealt with in varying degree in his analysis.

First, the method poses the problem of the appropriate choice of the base period from which relative changes in income are to be calculated and the selection of an appropriate occupation to which incomes of physicians may be compared overtime. Suppose, for example, that the base period selected actually was one in which physicians were in surplus in the sense of excess supply at a given wage <u>ceteris paribus</u>, rather than one of equilibrium as is implicitly assumed by this method. Policy makers mistakenly would view the subsequent decline in physicians' income relative to those of comparable professions as evidence of a <u>developing</u> surplus of physicians, when in fact the relative decline in physician income would merely reflect market forces operating to remove the initial surplus. Second, one should be extremely careful in merely comparing relative incomes of members of different occupations without adjustments for average age of members of the profession or hours worked. Also it should be pointed out that comparisons of relative income should be made over long periods of time if major concern is expressed for the possibilities of the existence of market imperfections. Short-run comparisons may merely reflect differences in the price adjustment (fee) mechanisms existing in the two occupational categories compared due to information and learning lags, long-term price or wage contracts and employer myopia in recognizing changing demand and supply conditions.[5] The length of supply adjustments in the training and education of physicians are of quite long duration, approximately ten years in the case of specialists. The time lag for supply adjustments is appreciably longer if additional educational facilities must be constructed to train more doctors. Third, the relative income approach fails to explicitly incorporate costs or changes in the costs of training and education required of the occupations that are compared. The internal rate of return approach discussed in the next section explicitly takes costs of training and education into account.

4. Review of the Internal Rate of Return Approach

Friedman and Kuznets used a discounted present value of net income approach to investigating the existence of a shortage of physicians [10]. In general, the discounted present value of net income for the ith profession, P^i, may be expressed as,

$$P^i = \int_0^{T_i} [Y^i(t) - O^i(t) - C^i(t)]\, e^{-rt}\, dt, \qquad (4.1)$$

where $Y^i(t)$ equals the income stream overtime of the ith profession, $O^i(t)$ represents foregone income opportunity costs, $C^i(t)$ represents net direct-cost outlays (education and training costs less stipends, scholarships, part-time earnings, etc.) required to enter the ith occupation, r represents an appropriate rate of discount, and $t = 0, \ldots, T_i$. Ideally, the returns stream $Y^i(t)$ should include the value of consumption aspects of training and education, options for career advancement, prestige, and other non-pecuniary factors associated with a particular profession. Only a few of these factors are accounted for in most studies. In principle, when making comparisons among or between occupations adjustments could be made for differences in special skills, intelligence, prior experience, and "quality" of training required of individuals of different professions.

P^i may be either positive or negative depending on the value chosen for r. Using this approach, Friedman and Kuznets calculated the net present values of incomes of physicians and dentists, using a 4 percent discount rate. Their computations showed that the discounted present value of the net incomes of physicians exceeded that of dentists, and they concluded that physicians were in short supply as compared to dentists [10].

A variant of the present value approach is the internal rate of return approach used by Hansen in his study of investment in health manpower [13].

The internal rate of return, r^i, for the ith occupation is that rate which yields the following equality:

$$\int_0^{T_i} [Y^i(t) - O^i(t) - C^i(t)]\, e^{-r^i t}\, dt = 0, \qquad (4.2)$$

where all variables in (4.2) are defined as in the discussion of (4.1) above with the exception of r^i. In (4.2) r^i is calculated rather than introducted a priori as in the case of r in (4.1). Obviously, if the internal rate of return on the ith profession, r^i, equals the norm or standard "appropriate" rate of discount, r, the discounted present value of net income equals zero, i.e., $P^i = 0$ in (4.1) above.

Calculating the r^i for various occupations assists individuals in making occupational choice decisions. Ceteris paribus, a rational individual would chose, from all occupations open to him, that occupation in which the internal rate of return is highest.[6] However, the approach has also been used to assist in investigating the existence of a shortage or surplus of labor services in a particular occupation or profession by comparing the internal rate of return of the occupation of interest with some standard or norm associated with another or other occupations. The rationale is that if the internal rate of return of the occupation of interest is above or below the "norm", a shortage or surplus of labor services, respectively, exists in that occupation.

For example, Hansen calculated rates of return to physicians, dentists and male college graduates for the years 1939, 1949, and 1956 [13].* According to Hansen's calculations, rates of return to male college graduates were 13.7, 11.5 and 11.6 in years 1939, 1949 and 1956, respectively. Rates of return to physicians for comparable years were 13.5, 13.4 and 12.6. Ratios of rates of return to physicians from training relative to rates of return to male college graduates from training were .98, 1.16, and 1.10 in 1939, 1949, and 1956, respectively. Hansen choose the rates of return to male college graduates as the "norm", and concluded that neither a surplus nor a

---

*Hansen defines $0^i(t)$ as the average income of a male high school graduate of the same age (t).

shortage of physicians existed in 1939, but that a shortage of physicians existed in years 1949 and 1956. Since the ratio of rates to physicians relative to rates to male college graduates was less in the year 1956 than in 1949, Hansen concluded that the shortage of physicians diminished during the interval of years, 1949-1956.

The internal rate of return approach to investigating the question of possible manpower shortages has a great deal of merit. In principle, it takes into account a myriad of factors, pecuniary and non-pecuniary, that impinge on both demand and supply factors comprising a market for labor services. However, by not explicitly taking non-pecuniary factors into account, those using this approach fail to capture non-pecuniary cost and benefit differences among occupations. Therefore, for example, the "real" internal rate of return would be underestimated for an occupation enjoying relatively more non-pecuniary benefits relative to a comparable occupation, ceteris paribus.

For purposes of social policy, the internal rate of return approach poses the problem of choosing the appropriate norm or standard rate of return with which the internal rate of return earned by members of a particular occupation may be compared. Because of this, changes over time in the difference between calculated rates of return of a particular profession and that chosen as the "equilibrium" rate of return should be interpreted very cautiously as indicating that a shortage or surplus of some component of the work force is being accentuated or alleviated. For example, Hansen recognized that the choice of the internal rate of return to male college graduates as the standard against which to compare that of physicians was essentially arbitrary [13, p. 85]. Hansen allowed for possible error by an, equally arbitrary, assumption that only plus or minus deviations from the standard exceeding 4 percent (not 4 percentage points) were to be regarded as indicative of a shortage or surplus, respectively [13, p. 86]. Clearly, if the rate used as a basis of comparison is not the equilibrium rate, then this approach is of little value. Whether or not one accepts Hansen's conclusions regarding a "diminishing shortage" of physicians between 1949 and 1956 depends, therefore, on the degree of confidence one has in the assumption that the "prevailing" rate earned by male college graduates is the equilibrium internal rate of return.[7]

5. Theoretical Comparison of the Three Approaches

Those authors who have used the relative income and internal rate of return approaches to investigate the "physician shortage problem" did not provide numerical estimates of physician requirements, because such estimates do not flow from these procedures, hence, they did not attempt to estimate the magnitude of a physician shortage or surplus. In order to compare the various methodologies used to investigate the existence of manpower shortage discussed above, it is necessary to derive theoretical estimates of requirements implicit in the relative income and internal rate of return approaches. In this section, we provide a theoretical framework within which numerical estimates of physician requirements may be calculated using the economics constructs underlying the relative income and internal rate of return methodologies, and compare them with those obtained by using the need method.

The relative income and internal rate of return approaches are both concerned with the analysis of physicians as a factor of production in the delivery of health services. Assume that the markets for physicians and for physician services are perfectly competitive, and that physician wages (annual income)[8] and the prices (fees) of physician services are determined therein. Thus, the employer/producer perceives the latter pair of rates as being given and fixed. The employer/producer will use physician inputs up to that quantity where

$$Y(t) = MRP(t). \tag{5.1}$$

Y(t) simultaneously represents physician wages and the marginal cost of employing physician inputs in year t and MRP(t) represents the physicians marginal revenue product in year t. The latter quantity is the product of the prices (fees) of physician services, F(t), and the physicians' marginal physical product MPP(t). Assuming equal marginal and average values of the relevant variables when (5.1) holds, we may rewrite (5.1) as follows:

$$Y(t) = \frac{O(t)}{D(t)} F(t). \tag{5.2}$$

From (2.2) above $\frac{O(t)}{D(t)} \equiv P(t)$ and from (2.3) above, $P(t) \equiv \frac{U(t) \cdot N(t)}{D(t)}$. Substituting into (5.2) above and solving for D(t) yields,

$$D(t) = \frac{F(t) \cdot U(t) \cdot N(t)}{Y(t)} \tag{5.3}$$

Thus, if F(t), U(t) and Y(t) are determined for period t, D(t), the required stock of physicians, can be calculated using equation (5.3). The relative income approach provides a market based rationale for calculating an equilibrium level of income, i.e., a level of physician income that if attained would imply an absence of a shortage or surplus of physicians. This level of income is given in (3.4) above. It remains to derive a theoretical estimate of physicians requirements from the internal rate of return approach.

Let $I^1 = \int_0^{T_i} [O^1(t) + C^1(t)] e^{-r^1 t} dt$. Substituting I^1 into (4.2) above and rearranging terms yields,

$$I^1 = \int_0^{T_i} Y^1(t) e^{-r^1 t} dt. \qquad (5.4)$$

Assuming that $Y^1(t) = Y^1(t-1) = Y^1(0)$, $t = 0, \ldots, \infty$, and solving for $Y^1(t)$ yields,

$$Y^1(t) = I^1 r^1 .^9 \qquad (5.5)$$

If the physician market is in "equilibrium" in the sense that $Y^1(t)$ reflects neither a shortage nor a surplus, then $r^1 = r^*$, where r^* represents the "appropriate" or "equilibrium" rate of discount, i.e.,

$$Y^1(t) = I^1 r^*. \qquad (5.6)$$

Thus (3.4) and (5.6) may be used in connection with (5.3) above to yield a generalized framework for estimating the physician requirements associated with the relative income and internal rate of return approaches, respectively. These estimates may be compared with those obtained from using the need approach, and the relevant theoretical estimating relations are included for the readers convenience in Table 6.1 below.

6. Conclusions and Suggestions for Future Research

The estimating relations presented in Table 6.1 appear to be quite different. All three equations require estimation of U(t) and N(t). The relative income estimating relation (6.2) requires the estimation of F(t) and $Y^2(t)$ instead of the estimation of P(t) as in the need relation, (6.1). In the case

TABLE 6.1

Equations for Estimating Physician Requirements

Criterion	Equilibrium Criterion	Physician Requirement Estimating Relations	
1. Need:	$U(t)N(t) = P(t)D(t)$	$D^*(t) = \frac{U(t) \cdot N(t)}{P(t)}$	(6.1)
2. Relative Income:	$Y^1(t) = aY^2(t)$	$D^*(t) = \frac{F(t) \cdot U(t) \cdot N(t)}{aY^2(t)}$	(6.2)
3. Internal Rate of Return:	$Y^1(t) = I^1\ r^*$	$D^*(t) = \frac{F(t) \cdot U(t) \cdot N(t)}{I^1\ r^*}$	(6.3)

*Designates theoretical equilibrium values of variables.

of the internal rate of return method, (6.3), estimates are required of F(t), I^i and r^* instead of P(t) as in (6.1). Thus, the relative income and internal rate of return estimating relations appear to represent methods for estimating physician requirements that are theoretical alternatives to the need approach.

In the context of economic theory, all three approaches, could yield consistent estimates of physician requirements. Equation (6.1) assumes equality between the quantity of services needed and the quantity of service available. Equations (6.2) and (6.3) were derived on the assumption that physician factor and product market equilibrium exists. If all of these equality assumptions hold and given the relationship between P(t) and the ratio of F(t) and $Y^2(t)$ in (5.2) above, we show that consistent solutions follow from these approaches. The denominators of (6.2) and (6.3), respectively, represent alternative interpretations of the level of physician income $Y^1(t)$ that would satisfy conditions of intermarket equilibrium between the market for physicians and those of other occupations. If (6.2) and (6.3) are going to yield consistent estimates, the denominators of (6.2) and (6.3) must be equal,

$$aY^2(t) = I^1 r^*. \qquad (6.4)$$

Consistent application of the internal rate of return equilibrium criterion requires that income in the reference occupation $Y^2(t)$ be in equilibrium,

$$Y^2(t) = I^2 r^*. \qquad (6.5)$$

Substituting this result for $Y^2(t)$ in (6.4) and solving for a yields,

$$a = \frac{I^1}{I^2}, \qquad (6.6)$$

as the condition under which (6.2) and (6.3) yield consistent estimates of D(t). Therefore, given that equilibrium exists in each occupation and between occupations (markets), (6.2) - (6.3) will yield equivalent results. If (6.1) can be interpreted as expressing equilibrium in the output market (quantity of patient visits "supplied" equals the quantity "demanded"), in theory, (6.1), (6.2) and (6.3) would yield consistent estimates of the number of physicians, D(t), required for equilibrium in both markets. Such consistency, however, requires that actual estimates of F(t), U(t), P(t), $Y^2(t)$, I^1, I^2, and r^* represent equilibrium values in a relevant economic sense.

Economists may safely leave the task of estimating N(t) to demographers. However, the burden of estimating the remaining variables falls on the economist. Fein has set an excellent example in forecasting the effects of changes in income and demographic characteristics on U(t) [8]. Additional refinements include providing forecasts of future income, relative prices, and insurance coverage. Summaries of estimates of the income elasticity of demand and a discussion of its importance to projecting future physician requirements are presented in Klarman [22]. Klarman also discusses the importance of the possibility that physicians may exert a significant influence on U(t) (demand) [22].

Ignoring replacement needs, if the percentage change in physician productivity, P(t) is equal or greater than the sum of the percentage changes in utilization and production, the number of physicians required in a future time period would be equal to or less than the number currently available.[10] Note that the population function for physician services incorporated in the analysis is over simplified. More work must be done to explore the consequences of the increasing use of ancillary personnel and the form of business organization [36, 49, 50]. An excellent discussion of the importance of estimates of changes in productivity appears in Klarman [22]. Altman has contributed some interesting ideas concerning measuring the importance of differences in productivity [1].

Very little work has been done concerning physician pricing mechanisms, i.e., how physicians set fees F(t). Kessel argues that physicians are price discriminators [20]. Ruffin and Leigh argue that is not so [38]. Klarman argues that physician fees are becoming increasingly "fractionated" and thus are rising more rapidly than the fee component of the CPI [23]. The impcrtant question for purposes of projecting physician requirements is as follows: what is the market-clearing level of F(t) that will prevail in some future period of interest?

Study of the full-costs of physician education and training is in its infancy; however, several studies have appeared recently [9, 25, 40]. There is a compelling need to estimate correctly the costs of medical education in the future for reasons other than to improve the accuracy of projections of physician requirements, not the least of which is that medical colleges currently receive in excess of one billion dollars of federal funds annually.

It may be that there are significant advantages to using the relative income or the internal rate of return method to estimate physician requirements, not the least of these is the incorporation of factor market considerations into the calculation of physician requirements.[11] However, the procedure we have outlined here of substituting calculated "equilibrium" values of physician income into some rather simple identities is far from being entirely satisfactory. As briefly discussed above, the task of estimating physician requirements involves a great deal of effort in estimating relevant parameters. Even sophisticated estimates can not overcome the simplicity of the basic models presented above; however, their basic simplicity is also one of their virtues.[12]

Before terminating our remarks, one last consideration warrants mention. Given the "current state of the art" none of the models discussed above are capable of producing irrefutable evidence that the physician market is subject to significant long-run market imperfections. The case for imperfections in the physicians market place must be tried on grounds other than the probable presence or absence of a relative shortage that may be adduced as a result of the application of the methodologies reviewed above.[13]

Footnotes

[1]Currently expenditures on Medicare and Medicaid alone are forecasted to exceed 10 billion dollars during the next calendar year.

[2]Taking the total differential of D(t) in (2.3) allowing U(t), N(t) and P(t) to vary, dividing by D(t), setting dD(t)/D(t) = 0, simplifying and rearranging terms yields,

$$\frac{dP(t)}{P(t)} = \frac{dU(t)}{U(t)} + \frac{dN(t)}{N(t)} . \qquad (2.3.1)$$

Equation (2.3.1) shows that there would be no change in physician requirements to the extent that a percentage change in physician productivity is equal to the sum of percentage changes in the rate of utilization and total population, respectively.

[3]A more comprehensive study of projected physician requirements and shortages may be found in [5].

[4]Stevens qualifies his conclusion by noting that his calculations "are not themselves measures of demand and supply...consequently, comparison of projected physician requirements based on these data with the exact number of physicians does not say much directly about supply-demand equilibrium" [41, p. 141]. It also should be noted that Stevens' analysis excludes phone but includes inpatient hospital visits.

[5]Short-run "excess demand" disequilibria due to lagged price adjustments are discussed in detail in [2]. We have argued elsewhere [18] that because of charity, philanthropic and tradition motives, in the past medical prices have been "administered" below market clearing levels thus maintaining a condition of "excess demand" over time. Also, Yett has argued that monopsony and oligopsony pricing behavior among nurse employers (hospitals) serves to maintain nursing salaries below market clearing levels at which the aggregate demand and the aggregate supply of nurses are equal, resulting in the chronic reporting of vacancies which is interpreted by many as indicating that a chronic shortage of nurses exists, see [51, 52].

[6]In principle, discounted present value of net income comparisons would also lead to the correct choice of occupations.

[7]The condition that, <u>ceteris paribus</u>, internal rates of return be equal over all occupations, is a <u>necessary</u> condition for an optimal allocation of resources. However, equality of internal rates of return, even under the

usual simplifying assumptions discussed above, is not sufficient for an optimal allocation of resources, since optimality also requires that the rate of return on "human capital" be equal to that earned on physical capital. Thus theoretically, the equilibrium rate of discount that could serve as the norm against which occupational internal rates of returns could be compared in the interests of determining the existence of a shortage or surplus for purposes of social policy, should reflect considerations of the marginal efficiency of physical capital and the marginal rate of time preference. However, for the purpose of individual career decisions, it is rational for an individual, ceteris paribus, to choose that occupation in which the internal rate of return earned is highest from all those available to him.

[8]Using income as a surrogate for the wage rate presents certain difficulties. Not all physicians work the same hours per week or the same number of weeks per year. The use of the phrase "typical physician" is adopted partly in recognition of differences between wage rates and income of the sort mentioned.

[9]Extracting the result of (5.4) as $t \to \infty$ is merely a convenience and is presented in the text in the interests of simplicity. The upper bound of the integral in (5.4), T_i, represents expected working years and in practice incomes are adjusted by age-specific mortality (survivor) rates, etc. to take into account differences in years of active professional life. If (5.4) were evaluated at the upper bound, T_i, prior to taking the limit as $t \to \infty$, the result would be,

$$Y^1(t) = (I^1 r^1)(1 - e^{-r^1 T_1})^{-1}. \qquad (5.4.1)$$

[10]See footnote 2 above.

[11]The case in favor of introducing market factors into the determination of the optimum stock of physicians is not entirely clear-cut. Holtman [17] and Klarman [22] both mention, as does the text, the possibility that substantial externalities may accompany the delivery of physician services. Klarman does not regard these as serious [22, p. 369], but Holtman does [17]. Holtman also argues that it is in the social interest to maintain the stock of physicians "high" to assure the existence of capability sufficient to meet irregular ("option") demands for service [17, p. 424]. It might be added that if charity, philanthropy and health insurance distort the usual calculus that rational consumers are assumed to exercise in consuming bundles of commodities, existing medical (physician) prices may not possess the same normative welfare connotation that is true in the case of the prices of other privately produced commodities. To the extent that such distortion is significant in addition to the presence of externalities, the social need to provide for option demand and the fact that certain medical services qualify as public goods, market criteria may not result in an allocation of resources that is Pareto optimal.

[12] The authors are currently engaged in a research project designed to yield accurate estimates of calculated "equilibrium" values for purposes of providing alternative estimates of physician requirements and, consequent shortages. Our results will be available in about a year.

[13] This is not saying that these studies do not provide useful evidence. If the physician market were perfect, we would expect that internal rates of return would fluctuate widely, particularly since physician supply adjustment can only occur with an appreciable lag. Hansen's results [13, p. 86] show that internal rates of return for physicians changed only .7 percentage points as compared to 2.1 percentage points in the case of male college graduates over the period 1939-1956. Many would argue that stability of income (price) in the face of wide swings in demand is evidence of market imperfections. A comprehensive study of the American Medical Association's (AMA) role in restricting the supply of physicians is provided by Rayack [33]. A provocative discussion of the AMA's use of the Flexner report to serve the selfish interest of physicians by maintaining physician incomes at high levels is provided by Kessel in his review of the Carnegie Commissions's recent recommendations concerning medical education [19].

References

1. Altman, Stuart H. Present and Future Supply of Registered Nurses. Washington: United States Government Printing Office, DHEW Publication Number 72-134, 1971.

2. Arrow, Kenneth J., and Capron, William M. "Dynamic Shortages and Price Rises: The Engineer-Scientist Case." Quarterly Journal of Economics, 73 (May 1959), pp. 292-308.

3. Bane, Frank. Chairman, Surgeon General's Consultant Group on Medical Education. Physicians for a Growing America. Washington, D.C.: United States Government Printing Office, 1959.

4. Blank, David S., and Stigler, George J. The Demand and Supply of Scientific Personnel. New York: National Bureau of Economic Research, 1957.

5. Bognanno, Mario F., and Jeffers, James R. "Evidence on the Physician Shortage." Bureau of Business and Economic Research Working Paper Series (#71-13), The University of Iowa, May 1971.

6. Butter, Irene. "Health Manpower Research: A Survey." Inquiry, 4:4 (December 1967), pp. 5-41.

7. Ewing, Oscar R. The Nation's Health, A Ten Year Program. Report to the President. Washington, D.C.: United States Government Printing Office, September 1948.

8. Fein, Rashi, The Doctor Shortage. Washington: The Brookings Institution, 1967.

9. Fein, Rashi, and Weber, Gerald I. Financing Medical Education, 191. New York: Carnegie Commission on Higher Education, 1971.

10. Friedman, Milton, and Kuznets, Simon. Income from Independent Professional Practice. New York: National Bureau of Economic Research, 1945.

11. Ginzberg, Eli. "Manpower in a Service Economy." in U.S. Department of Labor. Training Health Service Workers: The Critical Challenge. Washington, D.C.: United States Government Printing Office, 1966, pp. 16-20.

12. Hansen, W. Lee. "An Appraisal of Physician Manpower Projections." Inquiry, VII:1 (March 1970), pp. 102-113.

13. Hansen, W. Lee. "Shortages and Investment in Health Manpower." in The Economics of Health and Medical Care. Edited by Axelrod. Ann Arbor, Mich.: The University of Michigan, 1964, pp. 75-91.

14. Heistand, Dale L. "Research into Manpower for Health Service." Milbank Memorial Fund Quarterly, 44:4, Part 2 (October 1966), pp. 146-179.

15. Health Manpower Source Book. Section 9, "Physicians, Dentists, Nurses," U.S. Department of Health, Education and Welfare, Manpower Analysis Branch, Washington, D.C.: U.S. Government Printing Office, 1959.

16. Higher Education and the Nation's Health. The Carnegie Commission on Higher Education, October 1970.

17. Holtman, Albert G. "Another Look at the Shortage of Physicians." Industrial and Labor Relations Review, 18 (April 1965), pp. 423-24.

18. Jeffers, James R., Bognanno, Mario F., and Bartlett, John C. "On the Demand Versus Need for Medical Services and the Concept of 'Shortage'." American Journal of Public Health, 61:1 (January 1971), pp. 46-63.

19. Kessel, Reuben A. "Higher Education and the Nation's Health: A Review of the Carnegie Commission Report on Medical Education." Journal of Law and Economics, XV:1 (April 1972), 115-127.

20. Kessel, Reuben A. "Price Discrimination in Medicine." Journal of Law and Economics, I (October 1958), 20-53.

21. Klarman, Herbert E. "Changing Requirements for Health Manpower." Paper presented at the Special Session, 94th Annual Meeting of the American Public Health Association, San Francisco, November 2, 1966. Reprinted in Klarman, Herbert E. Medical Economics: Essays and Articles. Iowa City, Iowa: Graduate Program in Hospital and Health Administration, The University of Iowa, 1969, pp. 161-183.

22. Klarman, Herbert E. "Economic Aspects of Projecting Requirements for Health Manpower." Journal of Human Resources, 4:3 (1969), pp. 360-376.

23. Klarman, Herbert E. "Increase in the Cost of Physician and Hospital Services." Inquiry, VII:1 (March 1970), 22-36.

24. Klarman, Herbert E. "Requirements for Physicians." American Economic Review, Papers and Proceedings, 41 (May 1951), pp. 633-45.

25. Latham, Robert J. "The Cost of Medical Education: An Empirical Analysis of Production Costs, and Optimal Output Mixes in a Medical College." Unpublished Ph.D. dissertation, The University of Iowa, 1971.

26. Lee, Roger I., and Jones, Lewis Webster. The Fundamentals of Good Medical Care. Chicago: University of Chicago Press, 1933.

27. Mountain, Joseph W., Pennell, Elliott H., and Berger, Anne G. "Health Services Areas: Estimates of Future Physician Requirements." Washington, D.C.: United States Government Printing Office, Public Health Bulletin (#305), 1949.

28. National Advisory Commission on Health Manpower. Report, Vol. I. Washington, D.C.: United States Government Printing Office, 1967.

29. National Manpower Council. A Policy for Scientific and Professional Manpower. New York: Columbia University Press, 1953.

30. Perrott, George St. J., and Pennell, Maryland Y. "Physicians in the United States: Projections 1955-75." Journal of Medical Education, 33:9 (September 1958).

31. Perrott, George St. J., and Pennell, Maryland Y. "Physician Shortage Reconsidered." The New England Journal of Medicine, 275:2 (July 14, 1966), pp. 85-87.

32. President's Commission on the Health Needs of the Nation. Building America's Health, Vol. 2. Washington, D. C.: United States Government Printing Office, 1953.

33. Rayack, Elton. Professional Power and American Medicine. Cleveland and New York: World Publishing Co., 1967.

34. Rayack, Elton. "The Shortage of Physician Services," Industrial and Labor Relations Review, 18:4 (July 1965), pp. 584-587.

35. Rayack, Elton. "The Supply of Physicians Services." Industrial and Labor Relations Review, 7:2 (January 1964), pp. 221-37.

36. Robbins, Anthony. "Allied Health Manpower." Inquiry, VII:1 (March 1970), pp. 55-61.

37. Rosenthal, Neal H. "The Health Manpower Gap: A High Hurdle," Occupational Outlook Quarterly, Vol. II, No. 1 (February 1967).

38. Ruffin, Roy J. and Leigh, Duane E. "Charity, Competition, and the Pricing of Doctors' Services." Journal of Human Resources, Fall 1972.

39. Ruhe, C. H. William. "Present Projections of Physician Production." Journal of the American Medical Association, 198:10 (December 1966).

40. Sloan, Frank A. "Lifetime Earnings and the Physicians' Choice of Specialty." Industrial and Labor Relations Review, 24 (1970), 47-56.

41. Stevens, Carl M. "Physician Supply and National Health Goals." Journal of Industrial Relations (University of California, Berkeley journal) 10:2 (May 1971), pp. 119-144.

42. Stewart, William, and Pennell, Maryland Y. "Health Manpower, 1930-75." Public Health Reports, 75:3 (March 1960).

43. United States Bureau of Health Manpower, "An Introduction to Information Statement," United States Department of Health, Education and Welfare, 1967.

44. United States Department of Commerce, Bureau of the Census. Statistical Abstract of the United States: 1966. Washington, D.C.: United States Government Printing Office, 1966.

45. United States Department of Labor, Bureau of Statistics. America's Industrial and Occupational Manpower Requirements. 1964-1975. Washington, D.C.: United States Government Printing Office, 1966.

46. United States Department of Labor, Manpower Administration. "Professional and Supporting Personnel." 1967 Manpower Report of the President. Washington, D.C.: United States Government Printing Office, 1967.

47. United States Bureau of Labor Statistics. "A Study of Requirements and Supply." Health Manpower 1966-1975. Washington, D.C.: United States Government Printing Office, 1967.

48. United States Public Health Service. Health Manpower, Perspectives 1967. Washington, D.C.: United States Government Printing Office, 1967.

49. Weiss, Jeffrey H. "How Auxiliaries Increase Productivity of Dentists." Monthly Labor Review, 94:4 (April 1971), pp. 63-64.

50. Weiss, Jeffrey H. "The Changing Job Structure of Health Manpower." Unpublished Ph.D. dissertation, Harvard University, 1966.

51. Yett, Donald E. "Causes and Consequences of Salary Differences in Nursing." Inquiry, VII:1 (March 1970, pp. 78-99.

52. Yett, Donald E. "The Chronic 'Shortage' of Nurses: A Public Policy Dilemma." Empirical Studies in Health Economics. Edited by Herbert E. Klarman. Baltimore and London: The Johns Hopkins Press, 1970.