NBER WORKING PAPER SERIES

THE ROLE OF PHYSICIANS IN THE PRODUCTION OF HOSPITAL OUTPUT

Mark Pauly*

Working Paper No. 73

CENTER FOR ECONOMIC ANALYSIS OF HUMAN BEHAVIOR AND SOCIAL INSTITUTIONS
National Bureau of Economic Research, Inc.
204 Junipero Serra Blvd., Stanford, CA 94305

February 1975

*Northwestern University and NBER

Partial research support was provided by a grant from The Johnson Foundation to the NBER for a research program in the economics of health. I am grateful for helpful comments from Victor Fuchs, Michael Grossman, Charles Phelps, Joseph Newhouse, Willard Manning, and Gerald Goldstein.

The Role of Physicians in the
Production of Hospital Output

Mark Pauly

1. Introduction

Physicians' time is an input in the production of useful hospital output. This elementary proposition is so obvious that it might be surprising that estimates of hospital production and cost functions for U.S. hospitals have not generally included physician inputs or any measure of their opportunity costs. The reason for this omission is not difficult to find; hospitals in the United States typically bill for and compensate only those services provided by hospital employees or for certain physicians in specialty departments such as radiology or pathology. But the bulk of physician services in the United States are rendered by physicians to their private patients, for which billing and reimbursement are handled wholly outside the hospital. Nor do hospitals typically record the amount of time a physician spends in the hospital providing services to his patients there.

The purpose of this paper is to present estimates of production functions for hospitals in which a measure of the level of physician input is utilized. Since no data on the total number of hours worked by non-salaried physicians is available for a large sample of U.S. hospitals, alternative measures of physician input had to be constructed. As these measures are somewhat imperfect, the results I obtain should be considered tentative and preliminary.

It is worthwhile to get some measures of hospital production functions including physicians' inputs for two reasons. The first is that if the level of this omitted input is related to the level of other included inputs, estimates of their coefficients will be biased.

For example, observed economies of scale might only reflect a systematic increase in the relative proportions of physician inputs as output increases, with the "true" production function being one of constant or decreasing returns to scale.[1] The second reason is that estimation of a production function may permit us to say something about the optimal combination of productive inputs. There has recently been a considerable amount of research on the process by which ambulatory care is produced in the United States and the possibilities of input substitution to increase output and reduce cost [Reinhardt (1972); Smith, Miller, and Golladay (1972)]. In particular, this research has concentrated on the extent to which aides could be substituted for office physician time in the production of output. It is ironic that the United States non-federal hospital sector, which uses a considerably larger share of total medical resources, has not been subject to the same scrutiny. While there has been some work on the substitution of non-physician personnel in the hospital, there has been to my knowledge no empirical estimation using United States data of the possibility of substituting non-physician for physician inputs in the hospital or vice versa. Feldstein's (1967) estimates for the (ostensibly) very different hospital system in the United Kingdom do include a measure of physician input.

This scarcity of effort is not the result of a consensus on appropriate resource allocation. On the one hand, it may be asserted that physicians delegate too few tasks within the hospital, just as they appear to do in

---

[1] See Pauly and Redisch (1973), esp. p. 88.

private practice. The fear of malpractice charges, the possibility that "the hospital" will be able to capture monopoly rents that accrue to physicians as long as they are nominally in charge of the medical care given, and the psychic costs of supervision might account for such behavior. On the other hand, it has been contended that physicians have an incentive to subtitute hospital inputs for their own to too great an extent. It would appear appropriate to investigate the matter empirically to determine what is actually happening.

2. Measures of Physician Input.

The way in which inputs are to be measured when estimating a production function depends upon the use to which the results are to be put. In an engineering context, where it is the purely technical relationships that are of interest, the most appropriate measure would be some index of homogeneous productive effort. If, on the other hand, one is interested in the behavioral response of the system, the appropriate measure is the level of input that can feasibly be manipulated by the decision-maker. In more concrete terms, whether one wishes to measure labor input by minutes actually worked at various tasks or by hours of work for which full wages are received depends upon whether or not a feasible control mechanism exists for monitoring, controlling, and paying for only minutes of actual work. (This observation probably explains why task-analysis studies, such as Smith et.al., tend to show higher productivity for physician aides than do cross-sectional studies such as those of Reinhardt. In the former case, there is no allowance for non-working free time or waiting, while in the latter an hour of "work" really represents only the average fraction of that hour devoted to productive activity.) Even this states the matter too simply, since what is feasible may often times be too costly, and the actual methods of control and reimbursement (and hence the actual allocation of effort) may vary widely among occupations, firms, or skill levels.

All of this discussion is by way of elaborate rationalization for the use in the production function estimates that follow of the number of physicians available to provide care, rather than actual hours worked. The concrete reason for this is the unavailability of hours-worked data, but the reason for continuing with the analysis is that, at the present time, the most that might be manipulable from a public policy viewpoint is the number of physicians in an area or on a hospital staff, not the number of hours the physician spends at the hospital. In general, the kind of question to be posed is if one pours additional physicians into a hospital's cachement area, or places additional physicians on its staff, what effect will this have, ceteris paribus, on the hospital's output? Put another way, the question is that of how physicians affect hospital productivity.

While allegations of physician overuse of hospital inputs are common, concrete description of the form this overuse might take are less common. The possiblity of overuse is probably most transparent for hospital-employed physicians; they can be substituted for the time of private practice physicians, and one suspects that there is not an offsetting diminution in fees charged by the private practice physician. A similar argument might be made with respect to nurses; they can perform actions which can save the attending physician the time and trouble of making a visit to the patient. The argument that when nurses are scarce, physicians will end up making more visits is a little weaker, but perhaps plausible, especially if one adds the notion of "highly skilled" nurses.

Another way in which physicians substitute for hospital inputs can be found in Feldstein, "By increasing the number of doctors, for instance, a hospital may be able to shorten the length of patient stay and thus decrease the input of beds for a given output." [Feldstein (1967), p. 93]. While Feldstein's study referred to hospitals in the U.K., the same sort of reasoning might be applied to hospitals in the U.S., and to other hospital inputs (nurses, for instance) as well. The story here would seem to be that either rate of recovery or delay in performing procedures can be affected by the number of physicians. Where the number of staff members are few, rounds may be less frequent, and patients may have to wait in bed for the physician to come by to order procedures, perform operations, or sign discharge forms. One of the things I shall be interested in is whether any effect of physicians on output does come through length of stay.

3. The Model.

What the hospital might be thought to maximize is a subject of controversy. The most commonly suggested maximand is some measure of output which enters the administrator's utility function (Feldstein, 1971; Newhouse, 1970). I have suggested elsewhere (Pauly and Redisch, 1973) that it might be appropriate to view hospitals as being run in the interests of their physician staffs. Accordingly, the hospital will maximize whatever its staff physicians maximize. A reasonable maximand for physicians would be a utility function in money income and leisure, as suggested by Reinhardt. Assuming that all staff physicians have the same utulity function, the hospital would maximize physician utility subject to market and time and constraints and the production function:

(1) $Q_h = f\ (M, L, K)$

where M is the amount of physician inputs, L is a vector of non-physician labor inputs, and K is a vector of non-labor inputs. Since it may be reasonable to assume that input prices vary widely, that the level of physician inputs is almost exogenous, and that hospital decisions on input combinations may differ because of differential coverage, problems of simultaneous equation bias should not be severe. A more serious problem is whether one should assume that, once the level of inputs is chosen, output is indeed maximized. If hospitals differ in their productive efficiency, and if some maximization process analagous to profit or utility-maximization is going on, the resulting coefficients will be subject to simultaneous equations bias. Both the output-maximization models and a physician-income maximization model would suggest that maximization occurs. But if physicians maximize utility rather than profit, and if the variations in taste for leisure and input prices are large relative to the variation in productive efficiency, bias should not be severe.

In short, it would appear that the same assumptions that were made by Reinhardt to justify his ambulatory care production function estimates can be made here, and that the results will have the same degree of veracity. The fact that the sample hospitals vary considerably in size because of differences in sizes of the population to be served is another reason why outputs should vary primarily for reasons other than variations in productive efficiency. Finally, Since I am primarily interested in the ratios of input coefficients, simultaneous equations bias in returns to scale estimates less of a problem.

There is, however, one additional problem in the hospital estimates. It is likely that the degree of technical efficiency will be related to the number of physicians, because of the difficulty of coordinating a larger number of physicians. Since the data to be used do not permit physicians to be varied without also changing the number of physicians, there is the possibility that the effect of physician input on output is understated.

There are two versions of the physician utility maximization model. In one, physicians are assumed to cooperate perfectly in choosing input combination and output. In the other, imperfect cooperation by physicians implies that physicians may engage in behavior which, while individually rational, leads to undesired results for the group of all physicians.

In the first model, it is easy to show that the existence of cost-reimbursement hospitalization insurance, which covers about 90 percent of inpatient hospital care in the United States, will lead "the hospital," as personified in its (non-salaried) physician staff, to use too much hospital input relative to physician inputs. Consider first the case in which there is no insurance coverage of physician fees. Using more hospital imputs and less physician time input than the optimal combination will lead to higher total costs (hospital plus physician) for a given level of output. The reduced opportunity costs of physician time are more than offset by higher hospital input costs. However, the rise in hospital input costs raises insurance reimbursement to the hospital-physician cooperative, and this will, at least in initial departures from the optimum, more than offset any increases in total costs. In effect, if insurance covers 90 percent of hospital costs, the perceived cost to the cooperative of hospital inputs is 10 percent of their true cost. Hospital inputs will be substituted for

for physician inputs to a greater extent than is efficient.

If physician fee insurance is present, it may provide an offsetting incentive to substitute physician for hospital inputs, but only if insurance reimbursement rises when physician input rises. This will not occur at all under indemnity insurance, which is a common method of fee insurance. It will not occur under insurance which pays the "reasonable and customary" fee unless that fee can be made to vary with physician time input. While some extra time might be reimbursable as additional procedures, not all will. Consequently, physician fee insurance, which is not as extensive as hospitalization insurance anyway, will not fully offset the effect of hospitalization insurance on input combinations.

The imperfect cooperation version of this model suggests that overuse will also arise if the hospital does not or cannot price at marginal cost. Then each physician will ignore some of the consequences of his own actions in ordering hospital inputs which can be substituted for his own, since the cost of such behavior is spread over all patients of all physicians. One testable implication of this argument is that overuse should get worse as hospital and physician staff size grow larger.

The alternative "hospital administration utility-maximization" models developed by Feldstein and Newhouse make no direct prediction about physician-hospital input ratios, since they do not treat non-salaried physician time as a productive input. The result of overuse of hospital relative to physician input would, however, be consistent with this kind of theory if higher "quality" is equated with more hospital and less physician input. Whether hospital administrators, who run the hospital according to this theory, actually judge quality in this way or not is unknown.

It should be emphasized that, inasmuch as this is a production function estimate, these results do not bear directly on the question of whether physicians can create demand for hospital services. As in other production function studies, we do not ask whether the output should have been produced, or why it was produced; we only ask about the relationship between outputs and inputs. These results do, however, bear indirectly on the question of demand creation, in that they indicate the maximum extent of demand creation, at least as far as physicians directly are concerned. That is, they indicate the maximum amount of increase in output that could be attributed to demand creation by additional physicians when all hospital inputs are held constant. However, since inputs and outputs are not measured in per capita terms, the results are not directly comparable to those from demand studies.

4. The Sample.

A sample of 165 predominantly rural counties in the 9 midwestern states was selected. Each of these counties had throughout the period 1966-72 just one short-term general hospital with more than 50 beds, so that it is reasonable to suppose that the great bulk of hospital care provided by physicians in that county was provided at the sample hospital. The intent was to choose approximately 50 hospitals in each of four categories: not-for-profit, 50-100 beds in 1966; governmental, 50-100 beds in 1966; not-for-profit, over 100 beds; and governmental, over 100 beds. There was not a sufficiently large number of hospitals with reasonably complete data in the third and fourth categories to permit 50 observations , the second category was slightly oversampled, and later editing reduced the sample size in all categories. However, since the sample was non-random to begin with, these characteristics did not seem to justify a complex procedure of stratifying or replacing observations excluded by editing, which would have required adding observations from non-Midwestern states. Editing consisted of removing hospitals for which data was missing, and removing one hospital which, though classified in 1966 as short term, changed to long-term in some subsequent years. Data on these hospitals for 1966-72 from the American Hospital Association Annual Survey was obtained. The American Medical Association's Distribution of Physicians data was used to list the number of patient care physicians of various types in each of these counties.

This means that my measure of physician input is a measure of the number of physicians available for patient care in the county. This is obviously not the measure of physician input most desirable for production function estimates. However, it is the level of input that is likely to be manipulable by policy. That is, public policy has been and is generally directed at getting more physicians to locate in rural areas. It is not directed at controlling the allocation of their time. Thus my results show what may be expected in terms of hospital output from adding or removing physicians.

While it has not yet occurred, it is conceivable that hospital staff appointments might be a matter of public policy. For a single year (1972) I obtained data from the Social Security Administration's Master Provider File on the number of staff physicians at each of the sample hospitals, and on a finer breakdown of non-physician personnel into categories. This data is provided periodically by all participating hospitals as part of the Medicare certification program.

5. Functional Forms.

A Cobb-Douglas function is probably the most convenient functional form to use in estimating production functions. Whether it is appropriate is another matter. One problem that arose in Reinhardt's study is not present here. In the physician's office, output can be produced even if zero aides are employed. The four inputs that I use in most of the estimates are hospital beds, non-physician hospital personnel (full-time equivalents), other non-labor hospital inputs (meals, drugs, etc.) and physicians. Each of these inputs would appear to be essential. Hence, the requirement of the Cobb-Douglas form that every input be positive is not onerous. A more serious restriction of the Cobb-Douglas form is that it constrains the elasticity of substitution to unity. Other forms are available which do not require this constraint, but their use raises more complex estimation problems. Since a priori we do not know whether the Cobb-Douglas form is reasonable or not, I have followed Feldstein [1967, chapter 4], in first estimating that form and then considering alternative specifications only if the Cobb-Douglas form appears "unreasonable." Judgment is obviously involved here.

When physicians or personnel are disaggregated into specialty types, zero observations do occur. Results are obtained both using the Cobb-Douglas functional form, but with a positive constant (one) added to all values of these variables, and using the "transcendental" form suggested by Reinhardt (1972).

6. Variables.

For the cross-sections 1966-71, and for the pooled cross-sections, values of both beds and personnel were taken from the American Hospital Association's Guide Issue. A variable to represent non-labor inputs other than beds was constructed by subtracting from non-labor expense the product (BEDS X 1000), where $1000 is an estimate of the depreciation expense on beds alone. Sensitivity of the results to this assumption will be discussed below. Output was measured by the number of cases treated, as measured by the number of admissions. While it would have been desirable to have an explicit measure of casemix, such data were not available. Because the sample hospitals are the sole hospitals serving relatively homogeneous populations and are not major teaching hospitals, variation in casemix is not likely to be great. The output of the hospital is assumed to a "treated case." Each case is treated to the same degree; quality is assumed to be unrelated to input mix, and days of stay are assumed not to be of value in themselves. Fuchs (1969) has noted that it is not even clear whether additional days of stay should be treated as beneficial, because they mean more bed and board, or as detrimental, because they delay the patient's resumption of normal activities.

7. Results.

Table 1 indicates the results using total patient care physicians (MD) as a measure of physician input, and hospital full-time-equivalent non-physician personnel as a measure of the non-physician labor input. The coefficient on the physician input, the elasticity of admissions with respect to the number of physicians in the county, is always significant, and in the range of 0.11 to 0.17.[2] Personnel and non-labor expense are likewise always

[2] One implication of these results is that increased medical staff will lower cost per admission. Cost functions that were actually estimated with this data do indeed show that hospitals in counties with more physicians or with more active medical staff members tend to have lower costs per admission or per patient day. These results contradict the findings of Davis (1974) and Manning (1973) which indicate that, in the hospitals in in their data, more medical staff members meant higher costs. They attributed these higher costs to the difficulties of coordinating larger medical staffs. One way to resolve this apparent conflict is to note that the hospitals

(continued on following page...)

significant. Measured hospital productivity decreased during this period at a rate of about three percent per year. Beds is significant only for non-profit hospitals; except for this difference, the production function does not appear to differ across hospital types. Not-for-profit hospitals above 100 beds display approximately constant returns to scale, while for all other hospital subsamples the sum of coefficients is significantly less than unity. Large hospitals overall have returns to scale not significantly different from unity, while the full sample shows decreasing returns to scale.

The most likely reason for the insignificance of beds is the high correlation of this variable with personnel (r = .91). High multicollinearity is to be expected in production function estimates; perhaps its existence might explain why Feldstein's results for British hospitals were "unreasonable," with low or insignificant coefficients for such obviously important inputs as nurses. Heteroskedasticity was anticipated, but did not occur; error variances were almost identical for each quartile.

The possibility of excess capacity in any of the inputs is disturbing in any production function study. It is even more disturbing here because the measured amount of one input may well be correlated with the extent of excess capacity in the other outputs. If it is supposed that hospitals may have excess capacity in the hospital inputs (beds, personnel, and other

---

[2](cont'd)

Davis and Manning looked at were primarily in SMSA's or at least in areas in which physicians might be likely to hold appointments at more than one hospital. In such a situation, larger numbers of staff members might well not mean much more physician time input, but would mean that each physician would bear a smaller share of the costs of his cost-increasing actions.

non-labor inputs), and if physicians can in part create or activate demand for hospital care, then it is possible that any observed increase in output related to presence of larger numbers of physicians, observed hospital inputs held constant, may not in fact reflect physician input productivity. Instead, we may only be observing more intensive use of previously under-utilized hospital inputs. Even if physician hospital inputs actually rise, the total change in hospital output would be the sum of the direct effect of physician inputs, holding the utilization of hospital inputs constant, plus the increase in output arising from the greater flows of productive services from the hospital inputs.

In order to determine whether the estimates presented above can properly be thought of as production functions, it is useful to determine whether the measured effect of physicans on output varies with the level of hospital excess capacity. For the lower the level of excess capacity, the closer the coefficient on physicians will approximate the true output elasticity. The average accupancy rates of all hospitals in the sample is 70 percent. A subsample of these hospitals with occupancy rates (in any year) greater than 75 percent was selected. The estimated production function is shown in the second-last line of Table 1. The values of coefficients on all variables, including physicians, are practically unchanged from the full sample results. It does not appear that excess capacity in hosiptal inputs, if any, varies with the level of physician inputs.[3]

---

[3] Occupancy rates of less than 100 percent do not necessarily indicate excess capacity, because a hospital faced with demand which is stochastic over short periods of time would want to have some empty beds on average. An ideal occupancy rate for all hospitals of about 80 percent is sometimes suggested in the literature, and for the isolated rural hospitals in this sample a target of 75 percent might not be inappropriate.

Of course, if additional physicians mean no physician input, or if none of the hospitals ever reach a capacity constraint, then this argument does not hold. But neither of these suppositions seems plausible.

Finally, comparison of the first and last lines in Table 1 indicates that omission of the physician input did not bias estimates of returns to scale. Omission of physicians does, however, lead to an overestimate of both the effect of personnel and of the rate of decrease in productivity over time. Adding the physician input makes only a modest contribution to the explanatory power of the regression, as might be expected given the high multicollinearity of the input variables.

Table 2 shows the result of a similar estimate using disaggregated measures of physician input. (For each of these physician measures, a constant (1) was added to prevent zero observations.) The explanatory power of the regression is not appreciably improved by this change, but the results do shed some light on the way hospital output responds to subspecialities. (The coefficient on the time variable is almost the same as in Table 1, and so is omitted.) Not surprisingly, hospital based specialists, uncommon in hospitals under 100 beds anyway, tend to depress output there, probably because their presence is a proxy for case complexity. Similarly, medical specialists (internists, pediatricians, etc.) tend to affect output only in the large hospitals. Both surgical specialists and GP's have positive output elasticities everywhere. Interpretation of the coefficients on GP's and surgeons can be simplified by converting the elasticities into marginal products per physician. Table 3 shows that the marginal product of a physician is about 35 admissions per year. As might be expected, the marginal product is higher for surgeons than GP's, and the difference tends to widen in the larger hospitals and counties where specialization by surgeons may be carried to a greater extent. The purely hospital based physicians have a high marginal product in the larger hospitals.

What is perhaps most striking about these figures is that they suggest that the hospital workload of the marginal physician is less than one admission per week, even for surgeons. Hughes et al (1972) have found the average complexity of operations performed by surgeons in their sample was 0.94 hernia equivalent, and the mean workload was 4.3 HE per week. The admissions to our sample hospitals are unlikely to be more complex than one HE. Our results therefore suggest that the marginal surgical workload is less than one HE per week. This shortfall of incremental workload relative to mean workload implies either that additional surgeons have low workloads or that the presence of an additional surgeon in a county, even if he shares the work-equally with others, reduces the average workload of all. If an average work-load of 4.3 HE is regarded as evidence of underutilization of surgical manpower, the results obtained here suggest that, at the margin, underutilization is even more severe.[4]

---

[4] The specification used by Reinhardt was also applied to this set of data. That specification takes logarithms of all inputs which are theoretically needed in positive amounts, but is log-linear and log-quadratic in other inputs. The particular specification used was:

$$q = A + \delta_1 \text{ persnl} + \delta_2 \text{ beds} + \delta_3 \text{ nlxp} + \beta_1 \text{ GP's} + \beta_2 \text{ SURSPEC}$$
$$+ \beta_3 \text{ MEDSPEC} + \beta_4 \text{ OTHSPEC} + \beta_5 \text{ HOSPBDS} + \delta \quad (\text{MD's})^2$$

where lower case variables represent logarithms.

The results are roughly similar to those in Tables 2 and 3. For example, for the full sample, $\bar{R}^2$ was .869 (vs. .869 in Table 2) and the marginal admissions product for a GP was 38.4 (vs. 31.3) and for a surgical specialist 54.7 (vs. 46.0).

Since many of the measures of input used here are obviously very crude, it seems appropriate to test the sensitivity of the results to alternative measures. Table 4 presents the results of such tests.

Output has been measured by the admission or case treated. I have argued that "quality" or casemix is not likely to differ in a systematic way across the sample hospitals, since the hospitals are stratified by size and since the populations served are all from relatively rural midwestern counties. One attempt to control for "quality" would be by introducing the number of approvals (of education programs) and accreditations, as well as the number of facilities at the hospital as independent variables (line 1, Table 4). While approvals were significant and positively related to admissions (somewhat unexpectedly), its inclusion did not affect the production function coefficients nor contribute appreciably to the explanatory power of the regression. The number of facilities was not significant.

Measuring hospital labor input with the number of full-time-equivalent personnel and the physician input by the number of practicing physicians in the county is obviously imperfect. One possible way to improve the measure of labor input is to follow Feldstein's procedure with British hospitals and use payroll expense. If personnel are heterogeneous, if relative wages reflect relative marginal products, and if absolute wage levels do not differ, the implicit weighting by marginal product should provide a better input measure than does just counting all employees equally. Even though there is no reason to suppose that quality-constant wage levels do differ, this error may not be too severe. Lines 3 in Table 4 show the result of replacing personnel with payroll.

In general, payroll did not improve, and sometimes worsened the explanatory power of the regression. The only exception is in the case of smaller not-for-profit hospitals. The only other charge was an increase in the coefficient on beds. A final test was to replace the measure of bed cost used in calculating non-labor input from one in which the annual cost of a bed was figured at $1000 to one in which the cost was set at $3500. Except for the expected change in the relative magnitudes of the BED and NLXP coefficients, the results were unaffected.

Since it is unclear whether hospital outputs respond immediately to the presence of all inputs, espicially beds, medical staff, and specialized facilities, since the precise dating of when an input was actually available is questionable in the data, and since standard errors may be understated owing to the presence of serial correlation, results were also obtained using seven-year average values for each hospital for inputs and outputs. The results are shown on line 5, Table 4. The results are very similar to the pooled results of Table 1, except that beds is now insignificant.

8. <u>Length of Stay</u>

Holding beds constant, the only ways physician input (or any other input) can increase the number of cases treated are either by increasing the occupancy rate or by reducing length of stay. Feldstein's results for Great Britain strongly suggest that when output is increased, by increased medical input or other input, average duration of stay declines but the occupancy rate is only slightly affected (Feldstein, 1967, pp. 78-79). Does additional physician input in this sample of U.S. hospitals also increase output primarily by shortening stay? One way to tell is by including average stay directly in the production function. One can either interpret this as a "characteristic" of output which one may wish to hold constant, or as another output of a multiproduct firm.[5]

Line 2 of Table 4 suggests that reductions in stay are an important part of the way in which physicians contribute to output. The coefficient of mean stay is negative and significant; its inclusion substantially improves the $\bar{R}^2$. The coefficient on MD's falls to about one-third of its former value, the coefficients on personnel and LNIP fall by 25-35 percent, while the coefficient on beds increases substantially. Since the percentage increase in cases treated is much smaller when stay is held constant than when it is left free to vary, one possible conclusion is indeed that an important way in which physicians "produce" admissions is by shortening the length of stay. It also appears that one of the reasons why the effect of beds on admissions was relatively slight is that beds produce bed-days, and that many of these additional days show up as extended stays rather than new admissions.

There are, of course, some other explanations which are consistent with these results. One is that there are substantial differences in case complexity, and complexity tends to be positively related to the number of beds and negatively related to the number of physicians.

Another, perhaps more plausible explanation is indicated by Fuchs (1969) in his review of Feldstein's book. He suggests that length of stay may vary for reasons other than medical input -- regional differences in medical practice, socioeconomic characteristics of patients and area, etc. If physician input primarily "produces" admissions, not days of stay, while beds and (to a lesser

---

[5] The latter interpretation is not, of course, consistent with the simple Cobb-Douglas specification.

extent) personnel do produce days of stay, a consequence of reduced length of stay will be a reduction in the ratio of medical staff to hospital inputs, but the increased ratio does nothing to cause the reduction in stay. This explanation would imply that there was, in some sense, an "excess" of days of stay (at least in the sense of not being needed for the production of a treated case) when medical input was less; it suggests that some hospital inputs cannot be substituted for medical inputs in the production of treated cases. With the available data it is not possible to tell which interpretation is correct. In order to do so, one would need to have much more case-specific data on physician and hospital inputs and length of stay. In future work, I intend to explore more fully a model of the hospital in which some inputs produce treated cases, others produce days of stay, and still others contribute to the production of both.

9. Optimal Input Ratios.

If the hospital minimized cost for a given output, it would choose that mix of inputs at which the ratio of regression coefficients (output elasticities) just equalled the ratio of expenditures on the inputs. (This assumes that inputs are purchased at constant prices, or at least at prices which are proportional to marginal input costs.) For those inputs for which dollar cost estimates are available -- personnel, non-labor inputs, and beds -- the optimal ratios and the actual sample mean input expenditure ratios are shown in Table 5. For physicians, the table shows the shadow price of a physician -- the price per physician which would yield a ratio of inputs which equals the optimal one. A shadow price for physicians relative to all hospital inputs is also obtained by calculating the price per physician which would produce equality between the ratio of physician costs to hospital costs and the ratio of the coefficient on physicians to the sum of all hospital input coefficients.

There are two main messages from these computations. First, hospitals tend to underuse personnel relative to non-personnel inputs -- either beds or other non-personnel inputs -- in all but large non-profit hospitals. Second, the shadow price of the physician's annual input into the production of hospital output is in the neighborhood of $17,000 per year. It is higher for not-for-profit hospitals than for governmental hospitals.

There are other costs that should be considered, if only the data were available. To the extent that increased physician input shortens stays, to the opportunity cost of physician input one should add the explicit and implicit costs of home and other non-hospital inputs used to care for the patient during out-of-hospital convalescence, but subtract the opportunity cost of increased "sick time" that may accompany longer stays.

Physicians do not, on average, spend all of their working hours at the hospital. Instead, the most physician working hours are spent in their offices, treating and diagnosing ambulatory persons. How does this fact affect the interpretation of the output coefficient?

Suppose for the moment that the ratio of physician office to hospital hours is constant across the sample hospitals. If what the physician does in his office has no effect on the demand or supply of admissions, if physicians allocate their time to equate net income per hour worked at every location, and if prices reflect consumer evaluations, an appropriate measure of the opportunity cost of the time spent per physician in the hospital would be average physician net income times the average fraction that hospital hours are of total working hours.

But it may be objected that physician office time is in part spent diagnosing or in other ways creating demand for hospital admissions, so that the opportunity cost of an additional physician hour spent at the hospital should include some reduction in demand as well as the explicit money cost. Put another way, the effect of adding one whole new physician on hospital admissions is the sum of his demand creation <u>and</u> production efforts, and so overstates the effect on output of shifting physician time from office to hospital holding total physician work time constant.

The answer to this objection is the point made above: that a production function estimate, in effect, takes as given the requirement to produce output. The value of what the physician does in office practice is, under the assumptions above, measured by his net income. These estimates do not tell us what will happen if we increase physician hospital input without creating a demand for output; they tell us what will happen if the demand is there. That demand for hospital care might shrink if physicians all cut back on office time to spend more time in the hospital might argue for fewer physicians in total, but it is <u>relative</u> input use that is important.

In what sense do these results answer the planner's question of what will happen to hospital admissions in an area if he pours more physicians in, holding hospital inputs constant? They tell him that if demand for hospital admissions is related to numbers of physicians in his area <u>in the same way</u> as it was related in the sample counties, then the increase in output is given by the estimated elasticities. On course, if he adds physicians where there is little demand for their services in the hospital, then there may be less increase in admissions.

These considerations suggest that it is useful to measure the opportunity cost of physician hospital time in the way described above. Even such measures are not easy to obtain, but the following calculations are probably reasonably accurate. Average physician net income in non-metropolitan locations was about $39,000 in 1969. For non-metropolitan physicians in 1969 hospital visits were about 25 percent of total patient visits. If one assumes equal time for hospital or office visits, this suggests that physicians spend, on average, about one-fourth of the work time at the hospital.[4] If the average physician "wage" per visit is a legitimate measure of his opportunity cost, that cost is about $9750 per year, compared to a shadow price of $17,000 per year. The conclusion then is that there is overuse of hospital inputs relative to physician inputs in all hospitals taken together, and in all types of hospitals except small governmental ones. The actual savings from moving to an optimal physician-hospital input ratio in the average not-for-profit hospital in the sample would be $144,000, or about 8 percent of total expenses. To this should be added the net costs (positive or negative) of convalescence out of the hospital owing to shorter stays. The relatively greater overuse in not-for-profit hospitals, as compared to governmental ones, is consistent with the notion that physicians may be able to control not-for-profit hospitals more effectively than they can control governmental hospitals, which at least have an identified political constituency.

10. Tests for Bias.

As described above, the initial measure of physician input was in

---

[4] Even less is, as suggested by Reinhardt, average time per hospital visit is less than average time per office visit.

terms of the number of patient care physicians in the county. The ideal measure of physician input that we seek could be defined as

$$m_H = h \cdot s \cdot M$$

where M is the number of physicians in the county, s is the hospital's staff of active physicians as a proportion of the total number of physicians in the county, and h is the average number of hours per week worked at the hospital by each staff physician. Since m_H is measured by M, there are several possible sources of inconsistency. I will argue that the result is that the estimates above, if they are in error, will tend to undestimate physician productivity, and so tend to underestimate overuse of hospital inputs.

First, even if h, s, and M are uncorrelated, M will measure m_H only with an error. This produces a standard errors-in-variables bias toward zero. Second, if either h or s is correlated with M, the coefficient on M will be a biased measure of m_H.

To account for such correlation, two things are done: First, data was obtained on the number of physicians with staff appointments at each of the hospitals in late 1972. The Social Security Administration's survey also provides some more disaggregated measures of the type of personnel. If the ratio of physicians with staff appointments to total physicians in the county varies across counties, and if it is correlated with one of the inputs, the earlier measures would be biased.

Physician staff members were divided into two groups: active staff members, and all other staff members (courtesy, honorary, etc.). A comparison of the results for 1972 using alternatively all county M.D.'s and staff members is shown in Table 6. The coefficient on physicians is only slightly lower when Md's are used. When the sample is disaggregated, it becomes apparent that, at least in 1972, there was some bias in the coefficient estimate for larger hospitals, but not for smaller hospitals. There does seem to be a little evidence therefore that overuse of hospital inputs may be somewhat more severe than indicated above.

Second, it may be hypothesized that physician hospital hours and numbers of physicians relative to hospital inputs might be inversely correlated. At least, with demand held constant, the number of hours worked in total by a physician may decline as the number of physicians increases (either because price declines or because of some pro-rata rationing effects). Moreover, as the number of physicians relative to beds increases, each physician may spend less time at the hospital. This is another reason to suspect that these estimates may underestimate the overuse of hospital inputs.

One adjustment that can be made is to estimate the effect of physicians with the physician-population ratio held constant. If one supposes that physicians work shorter hours (at the hospital or in total) when they are plentiful, or if, as suggested by Reinhardt, the pace of work is likely to be less hectic, then omission of the physician-population ratio will bias the output-elasticity of physicians downward.

However, when the physician-population ratio (or its log) was entered, it had a significant coefficient only for the small non-profit hospitals sub-sample, and the change there in the coefficient on MD's, while positive, was not statistically significant.

11. Conclusion.

The empirical results presented in this paper suggest that, at least for the sample hospitals, once a patient is hospitalized, there will be some overuse of hospital inputs relative to physician inputs. It would be possible to maintain the production of hospital admissions even while reducing the level of hospital inputs, if additional physicians' time were added. The reduction in costs from the hospital inputs thus saved would exceed the increase in costs attributable to the additional physicians, at least if the social costs are measured by the portion of physician net income coming from time spent at the hospital. Whether these costs equal the social costs of providing physician services is, of course, very uncertain, given the way in which physicians are supplied. Nevertheless, if these output elasticities are accepted as measures of the effect of physician hospital hours, and if the cost measure is taken as appropriate, the conclusion is that the given stock of physicians could be used more efficiently if physicians spent more time at the hospital and hospitals eliminated some personnel and non-labor inputs.

This is inefficiency in the opposite direction from that found by Reinhardt for office practices. However, it is by no means obvious that a shift toward more physician-intensive production of hospital care, even though it would lower hospital and total costs, would raise physician utility. For reductions in hospital costs reduce hospital insurance benefits. Depending on the amount and type of physician fee insurance, the result may be a decrease in physician utility. Here, at least, we have a reason why resource misallocation occurs.

One message for policy is that what is likely to be important is the relatively low marginal product of specialists, especially of surgeons. Given the high cost of training physicians and surgeons, one may wonder whether the hospital output, even if that output is thought to be appropriate in some sense, justifies those costs. Of course, in practice increases in physicians are likely to be accompanied by increases in hospital inputs; the hospital inputs mean more output, but also more cost.

Another message is that even primary care physicians -- GP's and medical specialists -- have a significant positive effect on hospital admissions. If the goal is to increase the number of primary care physicians without increasing the hospitalization rate, the analysis above suggests than an appropriate strategy is to couple physician increases with hospital input decreases.

References

1. Karen Davis, "The Role of Technology, Demand, and Labor Markets in the Determination of Hospital Cost," in The Economics of Health and Medical Care, edited by M. Perlman (London: Macmillan, 1974), pp. 283-301.

2. M. Feldstein, Economic Analysis for Health Service Efficiency, (Amsterdam: North Holland, 1967).

3. ____________, "Hospital Cost Inflation, A Study of Nonprofit Price Dynamics," American Economic Review, 61 (December, 1971), 853-72.

4. V. Fuchs, "Health Services Research Moves Ahead," Health Services Research 5 (Fall, 1970), 242-50.

5. E. Hughes, V. Fuchs, J. Jacoby, and E. Lewit, "Surgical Work Loads in a Community Practice," Surgery, 71 (March, 1972), 315-27.

6. W. G. Manning, "Comparative Efficiency in Short-Term General Hospitals," Unpublished Ph.D. dissertation, Stanford University, 1973.

7. J. Newhouse, "Toward a Theory of Nonprofit Institutions: An Economic Model of a Hospital," American Economic Review, (March, 1970), 64-73.

8. M. Pauly and M.Redisch, "The Not-for-Profit Hospital as a Physicians' Cooperative," American Economic Review, 63 (March, 1973), 87-99.

9. U. Reinhardt, "A Production Function for Physician Services," Review of Economics and Statistics, 54 (February, 1972), 55-66.

10. K. Smith, M. Miller, and F. Golladay, "An Analysis of the Optional Use of Inputs in the Production of Medical Services," Journal of Human Resources 7 (Spring, 1972), 208-25.

TABLE 1

PRODUCTION FUNCTION ESTIMATES: ALL MD's

DEPENDENT VARIABLE: ADMISSIONS

(t ratios in parentheses)

SAMPLE	CONSTANT	BEDS	PERSONNEL	MD's	NON-LABOR INPUT	TIME	Σ CO-EFFS.	n	$\bar{R}^2$
FULL SAMPLE	3.9	.086 (2.7)	.52 (16.4)	.15 (10.7)	.15 (8.7)	-.029 (7.7)	.904 (41.1)	1145	.864
BEDS>100	3.7	.16 (3.3)	.49 (10.2)	.16 (3.3)	.14 (4.9)	-.030 (5.1)	.941 (29.2)	421	.857
BEDS: 50-100	4.2	.002 (0.1)	.53 (12.1)	.13 (6.0)	.15 (7.3)	-.027 (5.3)	.810 (32.7)	724	.658
GOVERNMENTAL	3.9	.00 (0.01)	.57 (11.0)	.14 (6.2)	.17 (5.2)	-.031 (6.2)	.873 (19.7)	615	.807
NOT-FOR-PROFIT	3.8	.18 (4.0)	.45 (11.2)	.17 (10.0)	.13 (6.7)	-.030 (6.1)	.934 (40.0)	530	.907
NFP, BEDS>100	3.6	.28 (4.5)	.37 (6.0)	.16 (6.8)	.16 (4.2)	-.032 (4.3)	.979 (33.8)	240	.877
NFP, BEDS 50-100	4.1	.091 (1.6)	.50 (9.5)	.17 (5.8)	.12 (5.3)	-.027 (4.0)	.878 (32.0)	291	.700
GOVT. BEDS>100	3.9	.004 (0.0)	.62 (8.5)	.15 (3.7)	.11 (2.2)	-.026 (2.9)	.888 (16.3)	181	.800
GOVT. BEDS 50-100	4.3	-.057 (0.9)	.53 (8.0)	.11 (3.9)	.19 (5.2)	-.032 (4.3)	.778 (13.1)	434	.637
OCCUPANCY >75%	3.9	.065 (1.4)	.47 (9.2)	.17 (7.4)	.19 (6.1)	-.032 (4.8)	.898 (49.9)	463	.887
FULL SAMPLE	3.5	.088 (2.6)	.64 (19.3)	-- --	.18 (7.2)	-.041 (10.0)	.904 (60.0)	1145	.849

TABLE 1A

SAMPLE MEANS AND STANDARD DEVIATIONS

(STANDARD DEVIATIONS IN PARENTHESES)

SAMPLE	HOSPI-TALS	BEDS	PER-SONNEL	MD's	NLIP ($ thou)	GP's	SURG SPEC	MED SPEC	OTHER SPEC	HOSP. BASED PHYS.
FULL SAMPLE	165	108 (60)	190 (127)	17.4 (15.4)	491 (435)	9.3 (5.1)	3.7 (4.9)	1.8 (3.3)	1.8 (3.1)	0.7 (2.1)
BEDS >100	60	158 (70)	292 (154)	28.3 (20.4)	777 (561)	11.8 (6.5)	7.3 (6.4)	4.0 (4.5)	3.7 (4.3)	1.5 (3.2)
BEDS 50-100	105	78 (24)	131 (46)	11.1 (4.9)	325 (202)	7.9 (3.3)	1.6 (1.5)	0.5 (0.9)	0.7 (1.1)	0.3 (0.7)
GOVT.	88	97 (45)	171 (45)	15.3 (10.7)	432 (335)	9.3 (4.6)	2.9 (3.2)	1.2 (2.2)	1.4 (2.3)	0.6 (1.2)
NON-PROF	77	119 (72)	212 (153)	19.8 (19.2)	560 (519)	9.4 (5.6)	4.7 (6.2)	2.5 (4.1)	2.3 (3.8)	0.9 (2.8)
NFP BEDS: >100	35	168 (80)	315 (174)	30.8 (23.9)	860 (621)	11.4 (7.0)	8.4 (7.5)	4.9 (5.1)	4.3 (4.8)	1.7 (4.0)
NFP BEDS: 50-100	42	79 (22)	127 (42)	10.8 (4.6)	312 (194)	7.8 (3.3)	1.6 (1.5)	0.5 (0.7)	0.7 (1.0)	0.3 (0.5)
GOVT BEDS >100	26	143 (48)	262 (117)	25.1 (13.7)	666 (449)	12.4 (5.8)	5.9 (4.2)	2.8 (3.2)	3.0 (3.2)	1.1 (1.4)
GOVT BEDS: 50-100	62	78 (26)	133 (48)	11.2 (5.1)	334 (206)	8.0 (3.2)	1.7 (1.5)	0.6 (1.0)	0.7 (1.2)	0.3 (0.9)
OCC> 75%	66	120 (76)	229 (161)	22.1 (20.3)	596 (524)	10.3 (5.9)	5.3 (6.4)	2.9 (4.3)	2.6 (4.1)	1.0 (2.9)

TABLE 1B

POPULATION RATES

SAMPLE MEANS AND STANDARD DEVIATIONS

RATES ARE RATES PER 100 PERSONS

SAMPLE	POPU-LATION (00)	ADM / POP	MD / POP	PERSON-NEL / POP	BEDS / POP	GP's / POP	SURG / POP
FULL	283 (185)	14.4 (6.5)	0.060 (0.025)	0.75 (0.35)	0.45 (0.23)	0.036 (0.013)	0.012 (0.012)
BEDS >100	402 (238)	16.0 (7.3)	0.072 (0.029)	0.85 (0.40)	0.48 (0.27)	0.031 (0.011)	0.019 (0.015)
BEDS: 50-100	214 (94)	13.5 (5.8)	0.054 (0.019)	0.69 (0.31)	0.43 (0.21)	0.039 (0.013)	0.008 (0.009)
GOVT.	271 (164)	13.7 (6.5)	0.057 (0.022)	0.70 (0.33)	0.41 (0.19)	0.036 (0.011)	0.010 (0.011)
NON-PROF	297 (208)	15.2 (6.4)	0.065 (0.027)	0.80 (0.37)	0.49 (0.27)	0.035 (0.014)	0.014 (0.013)
NFP BEDS: >100	403 (251)	17.2 (7.6)	0.076 (0.032)	0.93 (0.42)	0.53 (0.31)	0.030 (0.012)	0.021 (0.015)
NFP BEDS: 50-100	208 (99)	13.5 (4.6)	0.055 (0.016)	0.69 (0.27)	0.45 (0.21)	0.040 (0.014)	0.008 (0.008)
GOVT BEDS: >100	399 (220)	14.3 (6.6)	0.066 (0.024)	0.74 (0.33)	0.42 (0.18)	0.033 (0.010)	0.016 (0.013)
GOVT BEDS: 50-100	218 (90)	13.4 (6.4)	0.053 (0.020)	0.68 (0.33)	0.41 (0.20)	0.038 (0.012)	0.008 (0.010)
OCC> 75%	336 (233)	14.8 (7.3)	0.064 (0.029)	0.76 (0.37)	0.42 (0.20)	0.034 (0.011)	0.014 (0.015)

TABLE 2

PRODUCTION FUNCTION ESTIMATES

DISAGGREGATED PHYSICIANS

(Logarithmic Specification)

SUB-SAMPLE	CON-STANT	BEDS	PERSNL	NON LABOR INPUT	GP's	SUR-GEONS	MED SPEC	OTH SPEC	HOSP BASED	n	$\bar{R}^2$
FULL SAMPLE	4.1	.068 (2.1)	.53 (16.1)	.13 (8.1)	.088 (6.1)	.059 (4.9)	.028 (2.1)	.037 (3.4)	-.001 (0.1)	1145	.869
BEDS>100	4.3	.14 (3.0)	.45 (9.1)	.11 (3.7)	.049 (2.6)	.080 (3.8)	.034 (2.0)	.038 (2.4)	.033 (3.7)	421	.856
BEDS: 50-100	4.1	-.001 (0.2)	.56 (13.0)	.14 (6.9)	.11 (5.6)	.055 (3.7)	.001 (0.2)	.029 (1.9)	-.043 (2.1)	724	.662
GOVERN-MENTAL	4.0	-0.0 (0.0)	.56 (11.2)	.16 (5.3)	.10 (4.3)	.071 (3.8)	.032 (0.1)	.003 (0.1)	-.016 (0.8)	615	.810
NOT-FOR-PROFIT	4.1	.13 (3.1)	.47 (10.2)	.12 (8.2)	.082 (4.6)	.046 (2.9)	.025 (1.6)	.078 (5.2)	.012 (0.9)	530	.910
NOT-FOR-PROFIT, BEDS>100	4.4	.25 (4.0)	.34 (5.8)	.11 (3.2)	.043 (2.1)	.055 (2.0)	.068 (3.4)	.068 (3.4)	.028 (1.6)	240	.888
NOT-FOR-PROFIT, BEDS 50-100	4.1	.036 (0.0)	.55 (10.0)	.12 (5.0)	.14 (4.7)	.065 (3.3)	-.057 (1.9)	.067 (2.9)	-.019 (0.5)	291	.709
GOVT., BEDS>100	4.2	.00 (0.0)	.60 (7.5)	.12 (2.0)	.063 (1.6)	.087 (2.6)	.008 (0.1)	.00 (0.0)	.026 (0.9)	181	.800
GOVT.,BEDS 50-100	4.3	-.053 (0.8)	.53 (7.7)	.19 (4.9)	.093 (3.3)	.058 (2.6)	.021 (0.8)	-0.0 (0.0)	-.044 (1.6)	434	.643
OCCUPANCY >75%	4.2	.017 (0.3)	.49 (9.1)	.18 (6.1)	.097 (4.7)	.12 (6.0)	-.004 (0.2)	.036 (1.9)	-.005 (0.1)	463	.893

TABLE 3

ANNUAL MARGINAL ADMISSION PRODUCTS, BY PHYSICIAN SPECIALTY TYPE, EVALUATED AT MEAN

(— = coefficient not significant or negative)

SUBSAMPLE	ALL MD's	GP's	SURG SPEC	MED SPEC	OTHER SPEC	HOSP BASED
FULL SAMPLE	35.8	31.3	46.0	36.7	48.4	---
BEDS>100	33.3	21.2	53.5	37.7	44.8	73.2
BEDS 50–100	34.8	31.8	54.3	---	---	---
GOVERNMENTAL	32.6	32.3	60.5	48.3	---	---
NOT-FOR-PROF.	38.9	32.0	32.8	28.9	95.9	---
N-F-P,BEDS>100	34.7	20.6	34.7	68.3	76.1	---
N-F-P,BEDS 50–100	44.1	39.9	62.6	---	98.7	---
GOVT.BEDS>100	30.1	23.7	63.6	---	---	---
GOVT.BEDS 50–100	27.9	27.0	56.0	---	---	---
OCC>75%	38.1	38.0	84.5	---	44.3	---

TABLE 4

ALTERNATIVE SPECIFICATIONS OF PRODUCTION FUNCTION

FULL SAMPLE

LINE	BEDS	MD's	TIME	PAY-ROLL	PER-SONNEL	NLIP BEDS=1000	NLIP BEDS=3500	AP-PROV-ALS	FAC-ILITIES	AVG. STAY	$\bar{R}^2$	[illegible]
1.	.064	.15	-.028		.53	.14		.043	-.00		.867	1145
	(2.1)	(10.1)	(7.8)		(12.0)	(8.7)		(4.1)	(0.0)			
2.	.48	.055	-.027		.34	.11				-.66	.947	1145
	(20.3)	(6.1)	(11.3)		(14.3)	(10.8)				(40.2)		
3.	.18	.16	-.061	.44		.10					.861	1145
	(6.2)	(10.5)	(15.4)	(18.7)		(5.8)						
4.	.17	.16	-.026		.55		.030				.863	1145
	(5.1)	(10.2)	(7.1)		(16.3)		(7.8)					
5.	-.04	.13	--		.69	.11					.906	168
	(0.1)	(4.1)			(7.0)	(2.2)						

TABLE 5

OPTIMAL INPUT RATIOS AND SHADOW PRICES

OF PHYSICIAN INPUTS

(USING ESTIMATES OF TABLE 1)

(—) = Coefficient not significant at (0.8) or better

SAMPLE	BEDS/MDS		PERS/MDS		NLIP/MDS		BEDS + NLIP / MDS		ALL HOSP IP / MDS		PERS / NLIP + BEDS	
	OPT RATIO	PRICE OF MD	OPT RATIO	PRICE OF MD	OPT RATIO	PRICE OF MD	OPT RATIO	PRICE OF MD	OPT RATIO	PRICE OF MD	OPT RATIO	ACTUAL RATIO
FULL SAMPLE	0.57	107	3.47	148	1.00	283	1.57	219	5.04	170	2.20	1.49
BEDS>100	1.00	56	3.06	167	0.88	310	1.88	176	4.94	169	1.63	1.53
BEDS 50-100	——		4.08	129	1.15	250	1.15	310	5.23	169	3.53	1.43
GOVERNMENTAL	——		4.07	126	1.21	233	1.21	286	5.29	162	3.35	1.48
NOT-FOR-PROFIT	1.05	56	2.65	194	0.75	374	1.82	189	4.47	191	1.45	1.50
N-F-P,BEDS 50-100	0.54	136	2.94	182	0.71	407	1.24	291	4.18	215	2.38	1.48
N-F-P,BEDS>100	1.75	31	2.31	220	1.00	280	2.75	122	5.06	166	0.84	1.52
GOVT.BEDS 50-100	——		4.82	107	1.73	172	1.73	212	6.55	136	2.73	1.41
GOVT.BEDS>100	——		4.13	122	0.73	364	0.73	442	4.87	170	5.64	1.57
OCC>75%	0.38	143	2.76	177	1.12	241	1.47	221	4.24	192	1.88	1.50

TABLE 6

1972 PRODUCTION FUNCTION ESTIMATES
USING PHYSICIAN STAFF AND DISAGGREGATED LABOR

LINE	PERSON-NEL	NLXP	BEDS (AHA)	MD's	ACTIVE STAFF MD's	OTHER STAFF MD's	BEDS (SSA)	RN's	LPN's	OTHER PROFS.	OTHER PERSON-NEL	n	$\overline{R}^2$
					FULL SAMPLE								
1.	.57 (6.6)	.20 (3.8)	-.01 (0.1)	.10 (3.2)								160	.908
2.	.55 (6.3)	.20 (4.0)	-.02 (0.3)		.13 (3.8)	.019 (1.3)							.911
3.		.19 (3.6)	.00 (0.0)		.13 (3.6)	.018 (1.3)		.076 (2.3)	.056 (3.6)	.045 (1.6)	.40 (5.6)		.905
4.		.18 (3.6)			.12 (3.3)	.018 (1.4)	.19 (2.8)	.040 (1.2)	.046 (2.9)	.045 (1.7)	.32 (5.7)		.915
					BEDS: 50-100								
1.	.55 (5.1)	.21 (3.3)	-.09 (1.0)	.088 (2.1)								101	.792
2.	.55 (4.9)	.22 (3.4)	-.10 (1.1)		.084 (1.9)	-.00 (0.0)							.788
3.		.21 (3.3)	-.06 (0.8)		.080 (1.7)	.00 (0.0)		.092 (1.9)	.059 (2.7)	.035 (0.9)	.38 (4.2)		.786
4.		.21 (3.4)			.076 (1.7)	.00 (0.0)	.12 (1.4)	.058 (1.1)	.051 (2.8)	.032 (0.9)	.30 (4.1)		.789
					BEDS>100								
1.	.50 (3.3)	.27 (2.7)	.11 (1.0)	.066 (1.2)								59	.892
2.	.50 (3.3)	.16 (1.6)	.08 (0.6)		.22 (3.2)	.045 (2.1)							.913
3.		.16 (1.7)	.09 (0.7)		.23 (3.2)	.047 (2.1)		.038 (0.8)	.038 (1.6)	.031 (0.7)	.37 (3.1)		.908
4.		.13 (1.3)			.21 (3.2)	.043 (2.2)	.27 (2.7)	.019 (0.4)	.031 (1.4)	.042 (1.1)	.32 (3.7)		.919