“PROFITS” IN HOSPITAL LABORATORIES: THE EFFECTS OF REIMBURSEMENT POLICIES ON HOSPITAL COSTS AND CHARGES

PREPARED FOR THE HEALTH CARE FINANCING ADMINISTRATION, U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PATRICIA MUNCH DANZON

R-2582-HCFA
SEPTEMBER 1980
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This is the second in a series of four reports being prepared under Contract No. 500-78-0048 with the Health Care Financing Administration, U.S. Department of Health, Education, and Welfare, "Analysis of the Clinical Laboratory Industry." Other work performed under this contract includes an analysis of the effect of economic factors on the utilization of laboratory tests by office based physicians. Data from the 1975 and 1976 Surveys of Physician Practice Costs and Income were used. Forthcoming work will extend the analysis with data from the Health Insurance Experiment currently being conducted at Rand.

The present study provides a theoretical and empirical analysis of the effects of Medicare reimbursement policies on hospital costs and charges. The basic Medicare formula is intended to provide payment for the share of hospital costs incurred on behalf of Medicare beneficiaries. Two modifications of this formula designed to control costs are examined in this report: a ceiling on per diem costs for routine services and a requirement that Medicare pay the lesser of (1) its share of costs and (2) what it would pay if it reimbursed on the basis of charges (prices to private patients) instead. The analysis applies to MediCal, the California Medicaid program, but not necessarily to Medicaid programs in other states that use different formulas.

If reimbursement is based on costs, accounting costs become a price to cost-paying patients. Like any price, accounting costs will be optimized to maximize revenue. A theoretical model analyzes the effect of cost-based reimbursement on the level of hospital costs and charges and on accounting profits. The model is tested with 1976 data on short term general hospitals in California, obtained from Medicare cost reports and reports to the California Health Facilities Commission. Differences among non-profit, for-profit, and government hospitals are examined. The shortcomings of cost-based reimbursement per se and of these two cost reporting systems are discussed.

The report should be of interest to those concerned with the often conflicting goals of hospital cost containment and equitable reimbursement.
SUMMARY

This study provides a theoretical and empirical analysis of the effects of Medicare reimbursement policies for hospital services. The basic Medicare reimbursement formula is intended to pay for the share of hospital costs incurred on behalf of Medicare beneficiaries. There are several modifications of this basic formula designed to control costs. Two that are included in this analysis are: (1) a ceiling on per diem costs for routine daily services (basic room and nursing services) and (2) the constraint that Medicare pays the lesser of its share of costs and what it would pay if it reimbursed on the basis of charges rather than costs. ("Charges" are prices charged to private patients.) This study examines the effects of these policies on costs and charges in hospital based clinical laboratories. However, because the theory indicates that laboratory costs and charges are not independent of costs and charges in other hospital departments, the analysis is extended to the day services department and total hospital operations (day services plus all ancillary departments). MediCal, the Medicaid program in California, uses a similar reimbursement formula, so the analysis applies to MediCal but not necessarily to Medicaid programs in other states, which may use different formulas.

Earlier studies examined the effect of cost reimbursement on production efficiency. This study adopts the premise that cost reimbursement must be analyzed as modifying the demand structure faced by the hospital. Accounting "costs" reported for reimbursement purposes are viewed as prices to cost-paying patients, rather than as economic or opportunity costs.¹ Like any price, accounting cost is a choice variable to be optimized. If the hospital serves both cost-paying and charge-paying patients, it can set two price schedules: charges are prices to charge-paying patients, costs are prices to

¹To the extent inputs other than the hospital administrator capture any potential profit, these accounting costs may become opportunity costs over time.
cost-paying patients. If the hospital's objective is to maximize economic profit, the standard conclusions on single priced versus price discriminating monopoly apply: (1) economic profit is greater with price discrimination, if the demand elasticity of cost- and charge-paying patients differ; (2) accounting costs (prices to cost-paying patients) will exceed charges (prices to charge-paying patients) if the demand of cost payers is less elastic than the demand of charge payers. An accounting profit ratio (ratio of total charges to total costs) is not a measure of economic profit but of relative prices to charge- and cost-paying patients.\(^1\) It is therefore an indicator of cross subsidy among patients but not among services.

A theoretical model is developed to analyze the effect of Medicare reimbursement policies on the level of charges and the allocation of a given level of overhead cost between two revenue producing departments, the laboratory and daily services. The hospital selects charges in each department and allocates overhead costs between them to maximize net revenue (profit). The formula for computing Medicare's share of costs creates incentives to raise charges to charge-paying patients above the level that would be set by a profit maximizing monopolist.\(^2\) If the Medicare share of charges is equal in both departments, revenue is maximized. If not, it is maximized when as much as possible of the overhead cost is allocated to the revenue producing department where the Medicare share of services is greatest.

These conclusions are modified somewhat by the imposition of the two forms of cost control used by Medicare. A binding ceiling on per diem costs tends to raise the optimum allocation of overhead to the laboratory and raise optimum charges for laboratory services. The constraint that Medicare pay the lesser of costs and charges also raises the optimum charge level for all services, provided the

\(^1\) These strong conclusions presuppose that third party payers are unable to monitor economic as opposed to accounting costs.

\(^2\) The Medicare share of costs in the laboratory is obtained by multiplying total laboratory costs by the hypothetical fraction of charges Medicare would pay if it paid charges. See formula, p. 7.
elasticity of the collection ratio with respect to charge levels is low.\textsuperscript{1}

These predictions were tested with 1976 data on a sample of short-term general California hospitals. The data are from Medicare cost reports and the California Health Facilities Commission (CHFC). Although the data are voluminous, they have many deficiencies for purposes of estimating parameters of hospital production functions (economies of scale, input substitution elasticities) and the effects of reimbursement policies.

As predicted by the model of profit maximization, the larger the share of laboratory charges due to Medicaid and Medicare and the larger the fraction of total Medicare charges derived from the laboratory, the higher are laboratory costs and charges. In these data, laboratory costs and charges are unaffected by the per diem ceiling on routine day service costs; but for the majority of hospitals the ceilings were not binding at that time, making this a very weak test of the prediction that binding ceilings on day service costs will tend to raise costs and charges in the laboratory and other ancillary departments.

In the case of the routine day services department, the evidence does not support the model. With Medicare cost report data, day service costs are unrelated to the Medicare and Medicaid share. With CHFC data, the relation is negative. Ceilings on per diem rates apparently do not account for the negative relation: The regression coefficient of the ratio of actual to allowed cost per day is positive, suggesting that the ceilings are closer to being binding on high cost hospitals.

Only CHFC data were available to test the effects of Medicare and Medicaid on total operating costs and charges.\textsuperscript{2} There is no evidence that total hospital costs and charges are affected by the

\textsuperscript{1}The collection ratio is the fraction of billed charges actually collected from charge-paying patients.

\textsuperscript{2}The accounting conventions and incentives facing a hospital differ in reporting to Medicare and CHFC, but this is expected to affect the allocation of costs between departments, not the level of costs for the hospital as a whole.
Medicare share. The higher costs and charges in the laboratory are offset by lower costs and charges for day services (I did not analyze other ancillary departments). In the case of Medicaid, the lower costs and charges for day services more than offset the higher costs and charges in the laboratory, with the result that total operating costs and charges are negatively related to the Medicaid share. These results are net of effects due to ownership type, so they cannot be explained by the nonrandom distribution of Medicare and Medicaid patients across types of hospitals.

Assuming the long-run marginal cost of serving cost- and charge-paying patients is equal, a profit ratio different from 1 implies a cross subsidy between them. There is little evidence that less than cost reimbursement leads to a shifting of costs to charge-paying patients overall: For this sample of hospitals, total operating costs exceed charges by 1-2 percent. This obscures the differences by type: Charges exceed costs in for-profit and nonprofit hospitals (by at most 4 percent), whereas costs exceed charges in government and district hospitals. However, there are larger percentage cross subsidies within departments. (See Table 1.) Because economic as opposed to accounting costs cannot be observed, no conclusions can be drawn about the extent of cross subsidy among services. In particular, in the absence of data on economic costs, there is no evidence for or against the common assertion that hospital laboratories are operated at a profit in order to subsidize day services.

The effect of ownership type on hospital costs and charges, by department and overall, was also examined. The hypothesis was that all types of hospitals compete in the charge-paying market and all maximize net revenue. Because of the nonprofit status of voluntary and government hospitals, potential rents are likely to be reflected in higher accounting costs rather than residual profit to the firm. However, this simple conclusion is undermined by cost-based reimbursement, which creates an incentive for all hospitals to report

---

1 A cross subsidy among services exists if there is a difference in the markup of price over economic marginal cost for different services.
potential residual economic profit as accounting cost, in order to maximize reimbursement from cost payers. Assuming that the demand of cost payers is less elastic than that of charge payers, accounting costs are optimally higher than charges. Because the Medicare rule restricts reimbursement to the lesser of costs and charges, profit maximization subject to this constraint implies reporting costs at least equal to charges. Thus for-profit hospitals are not necessarily expected to report an accounting profit. In fact, for-profit hospitals report higher charges and a slightly higher profit margin than nonprofits overall, but significantly lower costs in the laboratory. The estimated cost differential of for-profits on day services and total operations is not significantly different from zero, so costs appear higher in the other ancillary departments. Government hospitals appear to have lower costs and charges than nonprofits in the laboratory and no difference on day services or total hospital activities. District hospitals have lower charges in all departments.

The effect of the reimbursement policy used by the Medicare fiscal agent, which is Blue Cross for most California hospitals, was also examined. The hypothesis was that in Southern California, where Blue Cross pays costs and therefore has more incentive to monitor them, costs would be lower relative to charges than in the North, where Blue Cross pays charges and may face a potential conflict of interest between monitoring costs as the Medicare carrier and monitoring charges as a private insurer. This prediction was borne out for the laboratory, with the markup of laboratory charges over costs being significantly lower in the North. However, it is offset by the significantly higher markup of charges over costs for day services in the North, such that although both costs and charges are higher in the North, the overall difference between them is not statistically significant. Again, this may result from the Medicare constraint that costs not exceed charges, which creates incentives for all hospitals to report accounting costs at least equal to charges.

Finally I tested for evidence of competition in the markets for laboratory and hospital services. If competitive pressure is related
to the number of close competitors, then charges for laboratory services should be inversely related to the number of hospital and independent laboratories in an area, and charges for day services should be inversely related to the number of hospitals in an area. Laboratory charges were marginally negatively related to number of independent laboratories, but unrelated to the number of hospital laboratories. Charges for day services were unaffected. By this crude test, there is little evidence of competition on charges in the market for hospital services. The finding of significant differences in charge levels, by the type of hospital, points to the same conclusion.

The finding that laboratory charges are positively related to the Medicare and Medicaid shares and negatively related to the percent of tests performed for outpatients is evidence that hospital laboratories do not face a totally inelastic demand for their services. The finding that day service charges are unrelated to Medicare and Medicaid shares is consistent with a totally inelastic demand, in which case the model of price determination breaks down. These results could be due to nearly complete insurance coverage of day services but not laboratory services, but the data necessary to test this are lacking.

This study has two main policy implications. First, despite heavy reporting requirements by Medicare and the California Health Facilities Commission, the available data are inadequate to answer many simple questions relevant to reimbursement and analysis of hospital performance, even assuming accounting data reflected the underlying economic reality. Further, the inevitable discrepancies between accounting and economic constructs are exacerbated by cost-based reimbursement. The intent of cost reimbursement is to limit payment to economic costs. But because economic costs are unobservable, accounting costs become a price to be optimized, the price to cost-paying patients. In the absence of prohibitively costly surveillance, basing reimbursement on costs rather than charges is unlikely to limit the amount billed to the opportunity cost of providing the services.
ACKNOWLEDGMENTS

I would like to thank the hospitals and fiscal intermediaries, the California Health Facilities Commission, and William Milliken of Laboratory Management for making available the data used in this study. Jeffrey E. Harris, Paul L. Joskow, Joseph P. Newhouse, Donald Penner, and George Westlake made helpful comments on an earlier draft. Special thanks are due to Christine Peterson for invaluable assistance in data preparation and in computer programming.

This report was written in part while the author was a National Fellow at the Hoover Institution.
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I. INTRODUCTION

Under the Medicare and Medicaid programs introduced in 1965, hospitals are reimbursed on the basis of the costs incurred on behalf of program beneficiaries. Many Blue Cross plans also use some form of cost-based reimbursement. Most commercial insurers and the remaining Blue Cross plans reimburse hospitals on the basis of charges, as is the common practice for ambulatory care.

It is widely believed that retroactive cost-based reimbursement, by encouraging inefficient production and inflation of input prices, has been a major contributor to the rise in hospital costs. For example, Bauer (1978), in discussing the recent movement toward hospital rate setting, states:

The current trend toward prospective rate setting rests on the premise that a major reason for the recent rise in hospital costs was the adoption by Medicare and Medicaid of retroactive cost-based reimbursement.

Similarly, Pauly (1976) argues:

When much of output is sold on a cost-plus basis, [this] level of efficiency may not be very high.... For-profit firms may push up costs to some extent to maximize the size of the "plus," or may engage in too much capital investment. Not-for-profit firms may take their "profits" not as entries in the net income column for the institution, but rather as higher real incomes for the dominant group or groups—in the case of hospitals, physicians and administrators.

The theoretical analysis and empirical evidence in Davis (1973) does not strongly support the contention that cost-based reimbursement is more inflationary than charge-based reimbursement. Davis analyzes cost reimbursement in the context of two alternative models of hospital behavior: profit maximization and quantity maximization. She concludes that with either behavioral assumption, the "plus" or
markup over cost allowed under cost reimbursement would have to be unrealistically large to motivate the hospital to increase costs, even if a large fraction of patients are covered by it. She concludes from her empirical analysis that cost reimbursement has no effect on either average cost per admission or hospital wage rates. Thus there is no consensus on cost-based reimbursement's effect on the level of costs.

Cost-based reimbursement is also criticized for its effects on the structure and level of charges to charge-paying patients. Davis (1970) and Hellinger (1975) show that the formula used for determining Medicare's share of costs creates an incentive to distort the structure of charges for different services within a hospital department. Specifically, there is an incentive to raise charges on services used relatively frequently by Medicare patients.\(^1\)

In addition to distorting relative charge levels, cost-based reimbursement is alleged to result in an increase in the average level of charges. Davis (1970) argues that cost-based reimbursement creates an incentive for the hospital to increase charges to charge-paying patients if it is functioning on a decreasing portion of its average cost curve. More recently, the attempts by Medicare, Medicaid, and state rate-setting commissions to control hospital costs are said to have forced hospitals to increase their charges to charge-paying patients, in order to cover their costs.\(^2\) As one hospital administrator describes it:

The regulations have the effect of enabling us to pass through to commercial insurance carriers . . . the less-than-cost reimbursement of Medicare and Medicaid. The

\(^1\)This hypothesis has not been tested empirically, because of lack of data on charges for individual services. Hellinger (1975) has applied and tested the same analysis in the context of average charge levels for individual departments, for hospitals using the "combination method" to compute Medicare reimbursement.

\(^2\)Between 1970 and 1975 the number of state rate-setting programs grew from two to 27. Bauer (1978).
commercials are subsidizing Medicare, Medicaid and the 
free care we provide.\(^1\)

If true, this outcome conflicts with one of the alleged purposes of 
the rate-setting commissions:

Most important, hospital leadership saw rate setting 
as a possible answer to the problem of cost shifting 
by major third party payors. As over the years each payor tried to define ever more narrowly the costs it 
would consider "allowable," expenses for items such 
as free care, and losses from emergency room and out-
patient care were falling between the cracks, becoming 
no one's responsibility. Hospitals were increasingly 
having to load such expenses on the bills of self-pay 
patients.\(^2\)

The argument that less than cost-based reimbursement leads to a 
shifting of nonreimbursed costs to charge-paying patients requires 
that charges exceed costs. Yet evidence from several sources shows 
that this is not uniformly the case. Table 1 reports accounting 
profit ratios for various hospital departments at different time 
periods and in different locations.\(^3\) Costs typically exceed charges

---

\(^1\) John Betjemann, Administrator, University Hospital, Boston, 

\(^2\) Bauer (1978).

\(^3\) An accounting profit ratio is the ratio of hypothetical total 
charges (i.e., the amount of revenue that would have been received if 
all patients paid charges and paid them in full), to total cost. Thus 
the accounting profit ratio is simply the ratio of the average price 
to average cost, aggregated over all services within the hospital 
department.

\[
\text{Accounting profit ratio} = \frac{\sum_{i} p_i q_i}{\sum_{i} c_i q_i} = \frac{p}{c}
\]

where \(p_i\) = charge for ith service
\(c_i\) = cost of ith service
\(q_i\) = total units of ith service (for charge and cost paying 
patients)
### Table 1

**HOSPITAL ACCOUNTING PROFITS BY DEPARTMENT**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Laboratory</th>
<th>Delivery Room</th>
<th>Other Ancillary</th>
<th>Daily Services</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1962-66 National</td>
<td>1.66</td>
<td>.89</td>
<td>1.34 (radiology)</td>
<td>1.40 (operating room)</td>
<td></td>
</tr>
<tr>
<td>n = 462</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1970 Ohio</td>
<td>1.41</td>
<td>.69</td>
<td>1.39 (radiology)</td>
<td>1.29 (operating room)</td>
<td></td>
</tr>
<tr>
<td>n = 17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1975-76 California</td>
<td>1.53</td>
<td>.60</td>
<td>1.38</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>- Unadjusted</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 296</td>
<td>1.37</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>- Adjusted</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1976 N. California</td>
<td>1.06</td>
<td>.60</td>
<td>1.06</td>
<td>.91</td>
<td>.98</td>
</tr>
<tr>
<td>- Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 30</td>
<td>1.08</td>
<td>.54</td>
<td>1.15</td>
<td>.94</td>
<td>1.04</td>
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<tr>
<td>- Profit</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>n = 38</td>
<td>1.07</td>
<td>.58</td>
<td>1.10</td>
<td>.97</td>
<td>1.03</td>
</tr>
<tr>
<td>- Non-Profit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 34</td>
<td>1.03</td>
<td>.64</td>
<td>.95</td>
<td>.81</td>
<td>.88</td>
</tr>
<tr>
<td>- Government</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1976 S. California</td>
<td>1.20</td>
<td>.55</td>
<td>1.09</td>
<td>.88</td>
<td>.99</td>
</tr>
<tr>
<td>- Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 137</td>
<td>1.31</td>
<td>.53</td>
<td>1.13</td>
<td>.87</td>
<td>1.02</td>
</tr>
<tr>
<td>- Profit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 106</td>
<td>1.15</td>
<td>.58</td>
<td>1.09</td>
<td>.93</td>
<td>1.01</td>
</tr>
<tr>
<td>- Non-Profit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 42</td>
<td>.98</td>
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<td>.96</td>
<td>.74</td>
<td>.87</td>
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<td>- Government</td>
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</tbody>
</table>

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**a** Source: Medicare Cost Reports (Davis and Foster, 1972).
Definition: (total charges - direct cost).

**b** Source: Medicare Cost Reports (Hellinger, 1975).
Definition: (total charges - fully allocated cost).

**c** Source: Medicare Cost Reports.
Definition: (total charges - fully allocated cost).
Unadjusted: costs net of professional component, some charges gross of professional component.
Adjusted: costs and charges gross of professional component.

**d** California Health Facilities Commission.
Definition: Total (net) charges / total (net) cost. Hospital component only, net of costs and charges for professional component.
for daily services and the labor and delivery rooms, but charges exceed costs for the laboratory and other ancillary departments. For California hospitals in 1976 (the only sample where I have total operating results), total operating costs exceed total operating charges on average, but by less than 2 percent.\footnote{At this time California did not have an active rate-setting commission, but ceilings on reimbursable per diem costs for routine services were in effect for Medicare and MediCal. Jeffrey Harris has suggested that these results for California hospitals may be atypical. He found an overall accounting profit ratio of 1.15 in a study of a Pennsylvania hospital in 1971-73. See Harris (1979).} This evidence indicates that shifting from cost- to charge-paying patients in some departments is more than offset by a reverse shift in other departments.

This study provides a theoretical and empirical analysis of the effect of cost-based reimbursement as defined by Medicare, on the level of hospital costs and charges. Because costs and charges determine accounting profits, the analysis is relevant to the issue of profits and cross subsidy between hospital departments; because costs and charges are paid by different patient groups, the analysis is also relevant to the issue of cross subsidy between cost- and charge-paying patients. The emphasis is on hospital laboratories. However, the theory indicates that costs and charges in different hospital departments are jointly determined, so other departments are included to the extent necessary. The theory is tested with data from a sample of short-term general hospitals in California in 1976.

The thesis is that accounting "costs" reported for reimbursement purposes should not be interpreted as economic costs but rather as the price to cost-paying patients that is subject to optimization. A hospital that serves both cost- and charge-paying patients can use two price schedules: "charges" are prices to charge-paying patients and "costs" are prices to cost-paying patients. Accounting profit ratios are not measures of economic profit but of the relative prices to these two groups of patients.

\[
\begin{align*}
\bar{p} & = \text{average charge} \\
\bar{c} & = \text{average cost.}
\end{align*}
\]
The model of hospital response to reimbursement policies posits maximization of net revenue (profits). In the empirical analysis I test for differences among nonprofit, for-profit, government, and district hospitals. I also discuss and test for effects due to cost- or charge-based reimbursement by the Medicare fiscal agent, Blue Cross.¹

The data are from Medicare cost reports and hospital reports to the California Health Facilities Commission. Even pooling these two sources, the data have serious inadequacies for measuring input and output quantities, input prices and factor shares, total costs, and charges. The problems are particularly serious in the laboratory because of the lack of a reliable measure of test output and because of the special reimbursement and contractual arrangements for hospital based physicians. Because of the current interest in hospital reporting requirements for reimbursement and regulation, the data problems are discussed in some detail.

¹In Northern California, Blue Cross pays charges, whereas in Southern California Blue Cross pays the lesser of costs and charges.
II. REIMBURSEMENT POLICIES

MEDICARE

Inpatient Hospital Services

Inpatient hospital services are covered under Part A of Medicare. Providers are reimbursed for Medicare's share of "reasonable" costs. For reimbursement purposes, the hospital is divided into revenue producing departments (day service and ancillary departments) and non-revenue producing departments (administration, cafeteria, housekeeping, etc.). Costs of the non-revenue producing departments are allocated to the revenue-producing departments. Thus total costs of each revenue producing department include its direct costs (labor, supplies) plus some fraction of the overhead costs of the nonrevenue producing departments. There are certain guidelines for the allocation of overhead across department, but some flexibility remains.¹ Medicare's share of costs in each revenue producing department is calculated by computing the ratio of departmental charges to Medicare patients to total charges, and applying this ratio to total departmental cost.² This formula is referred to as the ratio of charges to charges applied to costs (RCCAC).

Thus Medicare's share of costs for the jth department is:

\[
\text{Medicare reimbursement} = \frac{\sum_{i \in I} p_i q_i}{\sum_{i \in I} p_i} \times \left( \frac{\sum_{i \in I} c_i o_i + \alpha_j z_j}{\sum_{i \in I} c_i o_i + \alpha_j z_j} \right)
\]

¹For example, administration costs are allocated in proportion to the direct costs of the revenue producing departments, cafeteria costs are allocated in proportion to meals served, etc.

²Before 1975, hospitals with fewer than 100 beds had the option of using the combination rather than the departmental method described here. Under the combination method, all ancillary departments are combined and a single ratio of Medicare charges to total charges is applied to total costs, summed over all ancillary departments, whereas under the departmental method there is aggregation over services
where \( p_i \) = cost of the \( i \)th service in department \( j \)

\[ q_i^m \] = amount of \( i \)th service due to Medicare patients

\( Q_i \) = total amount of \( i \)th service

\( c_i \) = average direct cost of \( i \)th service

\( Z \) = total hospital overhead cost (nonrevenue producing departments)

\( a_j \) = function of overhead allocated to department \( j \).

If the department produces only a single service, Medicare's share is simply the fraction of that service provided to Medicare patients. If the department produces many services, Medicare's share is a weighted average of all services, where services are weighted by their charges. In the case of day services, Medicare's share is the number of Medicare days multiplied by the average cost per day. This is equivalent to the RCCAC formula used for the ancillary departments for the case of a department producing a single service.\(^1\)

There are three potential limits on costs reimbursable by Medicare. First, certain costs are disallowed, including bad debts to non-Medicare patients, luxury accommodations, gift shop, etc.; depreciation is calculated as straight line depreciation at historic cost. Second, there is a ceiling on the per diem cost for day services, gross of the 8-1/2 percent nursing cost differential but excluding the cost of intensive care units. Third, since 1974 Medicare pays the lesser of costs and charges—i.e., total reimbursable costs, aggregated over all departments, cannot exceed the charges that would be attributable to Medicare, if Medicare paid charges. To compute this charge limit, multiply all services provided to Medicare patients by their charges to obtain a hypothetical charge bill to Medicare. Then multiply this total by the fraction of charges to charge-paying

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\(^1\) The average cost per day for Medicare patients includes an 8-1/2 percent markup on the nursing component, on the grounds that aged patients require more nursing attention than the average patient.
patients that is actually collected. The hospital is reimbursed the lesser of (a) this fraction of hypothetical charges and (b) Medicare's share of costs, obtained by the RCCAC method summed over all departments and subject to the per diem limit on day services. However, any excess of costs over charges in one year may be carried forward as an allowable cost in the following year.

The copayment provisions for inpatient hospital services have varied over time. In 1979 there was a $160 deductible, zero copayment for the first 60 days per spell of illness, and a flat $40 per day thereafter. Thus, the patient's out-of-pocket expense is independent of the actual cost.¹

Hospital Based Physicians

Hospital based physicians (HBP's) include pathologists, radiologists, and anesthesiologists. To maintain comparability with office based physicians, the services of HBPs to Medicare patients are reimbursed under Part B, on the basis of "reasonable" charges. The hospital is required to allocate the time of these physicians into the fraction spent in general hospital functions, such as administration and research, and fraction spent in direct patient care, the "professional component." The former is reimbursed along with other hospital costs under Part A. The latter part is subtracted out of hospital costs, billed separately to Medicare Part B, and reimbursed on the basis of charges.²

This division of the services of HBPs under Medicare creates a practical problem for reimbursement and complicates the monitoring of costs and charges in the laboratory. Hospital based physicians typically do not bill private patients directly for their services; these are included in the bill submitted by the hospital. There is no schedule of customary charges to which Medicare reimbursement can be

¹ Out-of-pocket costs under Part A may be covered by Medicaid or by privately purchased supplemental insurance.
² An exception to this general rule is that teaching hospitals may elect to be reimbursed for all services of HBPs under Part A, on the basis of costs.
linked, as in the case of office based physicians. Many hospitals continue to bill on behalf of the physicians, using a RCCAC formula.\textsuperscript{1} The monitoring problem arises because it is impossible to tell from Medicare cost reports whether charges for laboratory services are net charges for the hospital component only or gross charges for both the hospital and professional components. In computing the ratio of Medicare charges to total charges to apply to laboratory costs, the hospital may elect to use charges either gross or net of the professional component.\textsuperscript{2} There is no copayment by patients on charges for services of HBP s.

**Outpatient Services**

Outpatient services are reimbursed under Part B on the basis of charges. They are subject to a deductible ($60 in 1979) and 20 percent copayment on all subsequent charges.

**MEDICAL (MEDICAID)**

Reimbursement under Medicaid varies across states. The California Medicaid program, MediCal, pays for hospital inpatient services on the basis of costs computed by the RCCAC formula used by Medicare. No distinction is made between services of HBP s and other hospital costs. Outpatient services are reimbursed on the basis of a charge schedule. Copayment by patients is zero for both inpatient and outpatient services.

**BLUE CROSS**

Blue Cross plans differ in their reimbursement formulas. In California, Blue Cross North pays charges billed for services to

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\textsuperscript{1}The bill submitted to the Part B trust fund is simply the Medicare share of the fraction of physician costs due to direct patient care.

\textsuperscript{2}Because laboratory costs are always net of the professional component, failure to control for the possibility of gross charges has led some researchers to exaggerate the "profit rate" (ratio of charges to costs) in the laboratory and other ancillary departments that employ hospital based physicians.
Blue Cross patients. Typically the hospital bills Blue Cross directly. There is a wide variety of insurance plans, containing differing coinsurance provisions. On outpatient, physician, laboratory and x-ray services, 20 percent coinsurance is typical.

Blue Cross South pays the lesser of costs and charges. The formula used to determine the Blue Cross share of costs differs from that used by Medicare. Reimbursable costs are simply an average cost per day, inclusive of all routine (day) and ancillary services, multiplied by the number of Blue Cross patient days:

\[
\text{Blue Cross reimbursement} = \frac{\text{total Blue Cross allowable cost}}{\text{total patient days}} \times 1.06 \times \text{Blue Cross days}.
\]

There are some differences between costs allowed by Blue Cross and by Medicare. For example, Blue Cross allows depreciation at replacement value. A 6 percent markup over actual costs is permitted to cover items excluded from allowable costs, such as return on equity, teaching costs other than those associated with patient care, etc.

Charges are the hypothetical charges that would be billed to Blue Cross if it paid charges. In any one year the hospital is reimbursed for the lesser of costs and charges. However, the difference (excess of costs over charges or vice versa) is carried forward as a cost in the next year and is reimbursed, provided costs, inclusive of this carry-forward, do not exceed charges.

Costs are subject to the limit that they must be "reasonable," which is determined by comparison with other hospitals, but there are no hard and fast rules.\(^1\) Charges are also supposed to be "reasonable." In the case of day services, the hospital is required to file per diem rates with Blue Cross. These rates are subject to disapproval within 30 days after filing. Charges for other services are monitored on an ad hoc basis—i.e., if a particular bill seems out of line, the

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\(^1\)Personal communication with personnel at Blue Cross South.
quantity of services rendered and charges are investigated and may be disallowed.

Although the hospital is reimbursed for costs, copayment provisions are calculated as a percentage of charges.
III. REVIEW OF THE LITERATURE

A complete survey of the extensive literature on hospital costs and cost inflation is beyond the scope of this report. The following review is confined to studies that have specifically analyzed the effect of cost reimbursement on costs or charges, in order to point out and explain differences between their conclusions and those reached in this study.

Davis (1973) develops and tests a theoretical model of the effect of cost reimbursement on the average level of hospital costs. Specifically, the question posed is: Does cost reimbursement that allows a "plus" over and above actual cost create an incentive for a hospital to increase "X-inefficiency"? X-inefficiency is characterized as a proportional vertical shift of the average cost curve.

Two alternative models of hospital behavior are considered: profit maximization and quantity maximization subject to a breakeven constraint. Both models yield the conclusion that the "plus" allowed, over and above the actual cost, would have to be unrealistically large to motivate a cost increase, even if a large fraction of the hospital's patients are covered by cost reimbursement. For example, if the allowed markup over cost were 5 percent, more than 95 percent of

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1 In fact, the second model is maximization of quantity of services to charge paying patients only. A model that postulates maximization of total quantity in the context of cost reimbursement with zero copayment has no equilibrium. The demand curve of cost-paying patients coincides with and includes the entire space above the average cost curve. The breakeven constraint is always satisfied if quantity is expanded to cost-paying patients. The optimal level of output is therefore infinite.

2 In both models the necessary condition for cost reimbursement to generate an increase in X-inefficiency is:

\[
\frac{q_m}{q_n + q_m} > \frac{1}{k}
\]

where \(\frac{q_m}{q_n + q_m}\) = proportion of patients covered by cost reimbursement;

\(k = \frac{\text{proportion of average cost reimbursed}}{\text{e.g., } k = 1.05 \text{ if 5 percent plus is allowed.}}\)
patients would have to be covered by cost reimbursement before the hospital would benefit from X-inefficiency. The conclusions are identical under both profit and quantity maximization.

Davis's conclusion depends on the characterization of the cost increase as an increase in X-inefficiency—i.e., an increase in production cost that has zero benefit to the hospital other than through the increase in the plus obtained from cost-paying patients. The characterization proposed here is to view cost reimbursement as modifying the demand curve of cost-paying patients but having no effect (initially) on the hospital's opportunity cost of production. With cost reimbursement, the demand "space" of cost-paying patients is the entire area above the average (opportunity) cost curve. The hospital could increase revenue by reporting higher accounting costs, without any increase in economic cost, in the absence of audits and if the hospital decisionmaker had exclusive rights over potential profits. In practice, because rights to them are not well defined in nonprofit hospitals, potential profits may be captured by factors other than capital in one period; and the opportunity or economic cost of these inputs to the hospital decisionmaker may rise in subsequent periods.

Assuming that all potential profits are captured by the hospital decisionmaker, cost reimbursement should be modeled as an increase in potential revenue, with no increase in opportunity cost. At the limit, if the hospital can increase accounting "costs" with no increase in economic costs, there is no limit on the optimum increase in "costs," unless the cost payor imposes some ceiling on reasonable costs.¹

In the absence of a "reasonable cost" ceiling, the optimum increase in costs is limited only if the hospital cannot practice perfect price discrimination between cost- and charge-paying patients. If (and only if) the hospital is subject to a constraint that "costs" not exceed charges, then the analysis of the optimum increase in "costs" requires consideration of the effect on revenue from both charge- and cost-paying patients, not the partial analysis confined to cost payers only used by Davis. An increase in "costs," subject

¹See Newhouse (1978).
to the constraint that "costs" not exceed charges, has two effects on revenue: (1) an increase in revenue from cost-paying patients and (2) a decrease from charge-paying patients. Thus the optimum increase in "costs" depends on the demand elasticity of charge paying patients and is infinite only if that elasticity is zero.

Davis (1973) does note that other models of hospital behavior might lead to different conclusions:

If the hospital desires to maximize some component of costs, such as nurses' salaries, a cost reimbursement scheme could be expected to have a more immediate effect on hospital costs even if only a fairly small proportion of patients were covered by the scheme.

This possibility is not developed theoretically, but one variant is tested in the empirical analysis.

In the empirical section Davis estimates the effect of cost reimbursement on average cost per admission and average hospital wage rates, using average statewide data for three years spanning the introduction of Medicare (1965, 1967, and 1968).\footnote{Cost reimbursement is measured as Blue Cross reimbursement on the basis of costs plus Medicare reimbursement plus public assistance hospital vendor payments (primarily Medicaid) divided by total hospital expenses.} After controlling for year effects, she rejects the hypothesis that cost reimbursement increases either average cost per admission or hospital wage rates. However, the extent to which the significant increases in costs in 1967 and 1968 are attributable to the growth of cost reimbursement under Medicare in 1966 cannot be distinguished from other factors. In particular, it is impossible to distinguish the effect of the form of reimbursement used by Medicare from the fact that Medicare augmented aggregate demand for medical services by a population facing zero marginal coinsurance on hospital payments. If the supply of hospital services was less than perfectly elastic, some increase in hospital costs would have occurred regardless of whether Medicare paid costs or charges.
The effect of cost reimbursement on charges is analyzed in Davis (1970) and Hellinger (1975). Davis distinguishes the effect on the average level and structure of charges for different services. Using a model of short-run profit maximization, she shows that cost reimbursement with the Medicare formula implies an increase in the profit maximizing level of charges to charge-paying patients, if average costs are decreasing over the relevant range. The reason is that an increase in services to charge-paying patients reduces reimbursement from Medicare because of the reduction in average cost, if costs are falling. The optimum level of services to charge-paying patients is therefore lower; hence, optimum price is higher than in the absence of cost-paying patients.\footnote{A similar result is obtained below, but the interpretation is slightly different.}

In addition to raising the average charge level, the structure of charges is affected. With the RCCAC method of reimbursement, the Medicare share of total costs is a weighted average of charges for different services within the department, where the weights are use by Medicare relative to total patients. Medicare reimbursement is thus maximized by raising charges for services used intensively by Medicare relative to other patients, and lowering charges for services used relatively little by Medicare patients (compared with profit maximizing charges in the absence of cost reimbursement).

Hellinger (1975) extends this analysis of the effect of the Medicare formula on the structure of charges within a department to average charge levels across departments for hospitals using the combination method to compute Medicare reimbursement. With that method, the Medicare share of total charges is calculated for all ancillary departments combined. Total reimbursement can therefore be increased by raising average charge levels in departments little used by Medicare patients. Hellinger tests this hypothesis with data on departmental profit ratios from 17 Ohio short-term general hospitals that used the combination method in 1970. He finds that the ratio of charges to costs across departments is indeed positively related to
Medicare use. However, he does not examine hospitals using the departmental method, which in principle should not be subject to this effect. In fact, evidence from other sources (see Table 1) shows that the pattern of profit ratios he finds is not confined to hospitals using the combination method. A similar pattern is found in the sample of hospitals studied by Davis and Foster (1972) before Medicare, and in our 1976 sample of California hospitals, all of which were using the departmental method. Although Hellinger's analysis of the effect of the combination method is logically correct, it is neither a necessary nor a sufficient explanation of the pattern of departmental profit ratios. The marginal effect of the combination method has not been determined. \(^1\)

\(^1\) Although Hellinger improves on the Davis and Foster measure of costs by using fully allocated rather than direct costs, he does not address the problem of hospital based physicians—i.e., that the numerator may include some charges for their services to patients, but the denominator definitely excludes these costs. This biases comparisons across departments, only some of which use hospital based physicians.
IV. MODEL OF HOSPITAL BEHAVIOR

ASSUMPTIONS OF THE MODEL

This section develops a simplified model of hospital response to the incentives created by Medicare reimbursement policies. The hospital is assumed to operate two revenue-producing departments—day services and a laboratory—and one nonrevenue-producing or overhead department. Each revenue-producing department produces a single service at a constant cost per unit.\(^1\) The cost of the overhead department is assumed fixed, but its allocation between the two revenue-producing departments is a choice variable.\(^2\)

The hospital's objective is to maximize net revenue. Revenue is derived from two "types" of patients, who are distinguished by the reimbursement formula used by their third party copayers.\(^3\) Charge-paying patients pay some fraction of charges. Because charge-based insurance plans often contain a deductible or coinsurance provision, demand by charge-paying patients is assumed sensitive to the level of charges.\(^4\) Cost-paying patients pay their fraction of costs.

\(^1\)I do not have data on charges and costs of individual services within a department, so a model that emphasizes the average price and cost of services for the department is relevant for the empirical analysis. It is also the relevant model for analyzing departmental profit ratios.

\(^2\)The model does not address the issue of the effect of cost reimbursement on input prices and the level of overhead costs. These effects are theoretically indeterminate in the context of cost reimbursement without exogenous controls.

\(^3\)For brevity I drop the distinction between patients and copayers and write as if the patients paid directly.

\(^4\)A nonzero elasticity of demand by charge-paying patients is necessary to obtain a determinate solution for optimum charges. In fact, the average coinsurance rate (fraction of hospital costs paid by patients) is 8 to 10 percent, and the marginal coinsurance rate for a nontrivial number of charge-paying patients could well be zero. As the marginal coinsurance tends to zero, so does the elasticity of demand. It is an empirical question whether, for the sample of hospitals used here, the elasticity of demand is sufficiently low to make the model irrelevant.
determined by the Medicare RCCAC formula. For brevity I refer to these cost-paying patients as Medicare patients, but the analysis applies equally to MediCal or any insurance plan using a similar formula. The quantity of services demanded by cost-paying patients is taken as given by the hospital administrator—it is totally insensitive to the level of costs and charges. This seems appropriate for both MediCal, which has zero copayment on all services, and Medicare, where the copayment for hospital days in excess of 60 is fixed per diem, independent of the actual level of hospital costs.

The hospital has three choice variables: the charge for laboratory services, the charge for day services, and the allocation of overhead costs between the laboratory and day services departments. Although Medicare sets guidelines, the hospital has some flexibility to allocate overhead in a manner to maximize net revenue. Making the extreme assumption of full flexibility, accounting costs inclusive of overhead can be treated as "prices" to be optimized. The ratio of charges to costs in a department is simply the ratio of optimum prices to charge-paying and cost-paying patients.

Medicare reimbursement policies impose two constraints on hospital behavior. First, there is a ceiling on the per diem cost for day services. Second, Medicare pays the lesser of costs and charges:

1. It does not apply to a cost reimbursement plan, like the one used by Blue Cross of Southern California, that pays an average daily rate, inclusive of day and ancillary services.
2. Medicare does have a 20 percent coinsurance on outpatient laboratory services. However, demand by Medicare patients is likely to be less elastic than demand by private patients with a similar coinsurance rate for two reasons. First, many Medicare beneficiaries carry supplemental insurance. Second, if Medicare patients fail to pay their share of the cost, the hospital can recoup this loss as part of allowable cost in the subsequent period. Thus the hospital's incentive to collect payments due from Medicare patients is less than in the case of charge-paying patients, where failure to collect the full amount charged may result not only in the obvious immediate loss of revenue but also in a reduction in Medicare reimbursement because of the reduction in the collection ratio, hence in the charge ceiling on Medicare reimbursement.

3. Other choice variables not considered here are the cost sharing and billing arrangements for pathologist services.
aggregate costs billed to Medicare, summed over all departments, cannot exceed the hypothetical charges Medicare would pay if it reimbursed on a charge basis and paid the same fraction of charges actually collected from charge-paying patients.

NET REVENUE MAXIMIZATION

The hospital serves two types of patients, cost-paying patients, denoted M, and charge-paying patients, denoted N. Both M and N use day services, D, and laboratory services, L. Day and laboratory services are provided at constant direct cost, \( c_d \) and \( c_L \) respectively. The hospital overhead cost, Z, is allocated between the two departments, with \( \alpha Z \) assigned to the laboratory and \( (1 - \alpha)Z \) assigned to day services. Charge-paying patients pay charges for laboratory services (\( P_L \)) and for day services (\( P_D \)). Reimbursement from cost-paying patients for laboratory services, using the RCCAC method, is their fraction of total charges applied to costs:

\[
\frac{P_L L_m}{P_L(L_m + L_n)} \left[ c_L(L_m + L_n) + \alpha Z \right].
\]

Reimbursement from cost-paying patients for day services (before limitations) is calculated as their number of units of service, multiplied by the average cost per day for all patients,\(^1\) which reduces to an RCCAC formula:

\[
\frac{D_m}{D_m + D_n} \left[ c_d + \frac{(1 - \alpha)Z}{D_m + D_n} \right] = \frac{D_m}{D_m + D_n} \left[ c_d(D_m + D_n) + (1 - \alpha)Z \right].
\]

The hospital faces a per diem limit on cost per day:

\[
\frac{c_d}{D_m + D_n} \leq \bar{c}_d.
\]

\(^1\)The 8-1/2 percent nursing cost differential for Medicare is ignored.
It is also subject to the constraint that total costs for M not exceed hypothetical collectible charges:

\[
\frac{L_m}{L_m + L_n} [c_L (L_m + L_n) + aZ] + \frac{D_m}{D_m + D_n} [c_d (D_m + D_n) + (1 - a)Z] \\
\leq \beta (P_{L_m} L_m + P_{D_m} D_m)
\]

where \( \beta \) is the collection ratio—the fraction of charges to charge paying patients actually collected.

Thus the hospital's objective is to maximize net revenue subject to two constraints. The choice variables are the charge for laboratory services, \( P_{L} \), the charge for daily services, \( P_{d} \), and the fraction of overhead to be allocated to the laboratory, \( \alpha \):

\[
\begin{align*}
\max_{P_L, P_d, \alpha} \quad & = \frac{L_m}{L} [c_L L + aZ] + \frac{D_m}{D} [c_d D + \frac{(1 - a)Z}{D}] + \beta [P_L L_m + P_d D_n] \\
& - c_L L - c_d D - Z + \nu_1 [c_d - \left( c_d + \frac{(1 - a)Z}{D} \right)] \\
& + \nu_2 [\beta (P_L L_m + P_d D_m) - \frac{L_m}{L} (c_L L + aZ) - \frac{D_m}{D} (c_d + \frac{(1 - a)Z}{D})]
\end{align*}
\]

where

\( L_m \) = laboratory services of cost-paying patients, \( M \)
\( L_n \) = laboratory services of charge-paying patients, \( N \)
\( L = L_m + L_n \)
\( D_m \) = daily services of cost-paying patients
\( D_n \) = daily services of charge-paying patients
\( D = D_m + D_n \)
\( P_L \) = average charge for laboratory services
\( P_d \) = average charge for daily services
\[ Z = \text{overhead cost of nonrevenue producing centers} \]
\[ \alpha = \text{fraction of overhead allocated to laboratory} \]
\[ (1 - \alpha) = \text{fraction of overhead allocated to daily services} \]
\[ \beta = \frac{\text{charges collected}}{\text{charges billed}} \text{ from charge-paying patients} \]
\[ C_d = \text{per diem ceiling} \]
\[ \nu_1, \nu_2 = \text{Lagrange multipliers}. \]

Maximization of (1) with respect to \( P_L, P_d, \alpha, \nu_1, \) and \( \nu_2 \) yields the following first order conditions:

\[
\beta P_L \left( 1 + \frac{\epsilon}{L_n} \right) \left[ 1 + \frac{\epsilon}{P_L} \left( 1 + \frac{P_{D_n}}{P_L} \right) \right] = \alpha Z/L^2 \left[ L_m (1 - \nu_2) \right]
\]

\[
\nu_2 \beta L_m \left[ 1 + \frac{\epsilon}{P_L} \left( 1 + \frac{P_{D_m}}{P_L} \right) \right] \frac{\partial P_L}{\partial L_n} = c_L
\]

\[
\beta P_d \left( 1 + \frac{\epsilon}{D_n} \right) \left[ 1 + \frac{\epsilon}{P_d} \left( 1 + \frac{P_{D_n}}{P_d} \right) \right] = \frac{(1 - \alpha)Z}{D^2} \left[ D_m (1 - \nu_2) - \nu_1 \right]
\]

\[
\nu_2 \beta D_m \left[ 1 + \frac{\epsilon}{P_d} \left( 1 + \frac{P_{D_m}}{P_d} \right) \right] \frac{\partial P_d}{\partial D_n} = c_d
\]

\[
[L_m/L - D_m/D] (1 - \nu_2) + \nu_1 1/D = 0
\]

\[ \text{This formulation assumes that constraints on reimbursable costs apply as equality rather than inequality constraints. If the value of } \nu_1 \text{ and } \nu_2 \text{ so obtained are nonnegative, the associated optimum is also the optimum subject in inequality constraints. If the resulting values of } \nu_1 \text{ or } \nu_2 \text{ are negative, the associated constraint is not binding and the problem can be solved without it. The resulting optimum will usually satisfy the disregarded constraint and will be the solution to the problem.}
\]

\[ \text{This assumes that the demand for laboratory and day services are independent.} \]
\[ \bar{c}_D = \bar{c}_d + (1 - \alpha)Z/D \] (5)

\[ \beta(P_{L_m} + P_{d_m}) = L_m/L (c_{L_m} + \alpha Z) + D_m [c_d + (1 - \alpha)Z/D], \] (6)

where \( \varepsilon_{L_n} \) = charge elasticity of demand for laboratory services

\( \varepsilon_{D_n} \) = charge elasticity of demand for day services

\( \varepsilon_{\beta,P_L} \) = elasticity of collection ratio with respect to \( P_L \)

\( \varepsilon_{\beta,P_d} \) = elasticity of collection ratio with respect to \( P_d \).

Equations (2) and (3), which define the optimum charges \( \hat{P}_L \) and \( \hat{P}_d \), show how the RCCAC formula for cost-based reimbursement and the per diem and lesser of costs or charges constraint affect optimum charges to charge-paying patients. To isolate the effects of each of these aspects of Medicare reimbursement policies, consider first a situation where all patients pay charges. In this case, only the first term would appear on the left hand side of Eqs. (2) and (3). Optimum charges for laboratory and day services are those of a profit maximizing monopolist. The optimum markup over marginal cost depends only upon the charge elasticity of demand and the elasticity of the collection ratio:

\[ \left( \frac{\beta P_L - c_L}{\beta P_L} \right) = -\left[ 1 + \varepsilon_{\beta,P_L} (1 + P_d D/P_L L) \right]/\varepsilon_{L_n}. \]

Now introduce cost reimbursement for one group of patients, but without further constraints: i.e., \( \mu_1 = \mu_2 = 0 \). The first order conditions under these assumptions are:

\[ \beta P_L \left\{ 1 + \varepsilon_{L_n}^{-1} \left[ 1 + \varepsilon_{\beta,P_L} (1 + P_d D_n/P_L L_n) \right] \right\} - \alpha Z L_m/L^2 = c_L \] (2')
\[ \delta P_d \left\{ 1 + \epsilon_{L_n}^{-1} \left[ 1 + \epsilon_{\beta_d, P} \left( 1 + P_{d_n}/P_{L_n} \right) \right] - (1 - \alpha)Z_{D_m/D} \right\} = c_d \tag{3'} \]

\[ L_m/L - D_m/D = 0 \tag{4'} \]

Equations (2') and (3') show that introducing RCCAC cost reimbursement for a second group of patients raises the optimum markup to charge-paying patients. Rearranging Eq. (2'):

\[ \left\{ \delta P_d - \left[ (c_d + \alpha Z_{L_m/L}) \right]/\delta P_d \right\} \delta P_d = \left\{ 1 + \epsilon_{\beta_d, P} \left[ (1 + P_{d_n}/P_{L_n}) \right] \right\} \epsilon_{L_n}^{-1} \]

When charges are increased, the quantity of services demanded by charge-paying patients falls, while services demanded by Medicare are unaffected. The Medicare share of services therefore rises and reimbursement from Medicare increases, because it is computed by applying the Medicare share to departmental costs. The increase in revenue from Medicare partially offsets the loss in revenue from charge-paying patients. Optimum charges are therefore higher than in the absence of any cost-paying patients. They are also higher, the larger the Medicare share of services and the larger the allocated overhead cost.\(^1\)

Equation (4') shows that the profit maximizing allocation of overhead among departments requires that the Medicare share of services be the same in all departments. This is an intuitively obvious result. The Medicare share determines the fraction of each dollar of

\(^1\)Note that the result with respect to quantity does not depend on the assumption that the hospital has monopoly power. If the hospital is a price taker with respect to \( P_d \), its choice variable is \( L_n \), the quantity of services provided to charge-paying patients. The first order condition for an optimum is identical to Eq. (2') except that the elasticity terms drop out. Thus the optimum quantity supplied is less than in the absence of any cost-paying patients.

If decreasing (increasing) direct costs are assumed, there is an additional positive (negative) term in Eqs. (2') and (3') that represents the decrease (increase) in average direct cost and hence in Medicare reimbursement because of expanding services to patients who do not pay costs. This is the effect noted by Davis (1970).
overhead allocated to the department that can be recouped from Medicare. Alternatively stated, \( S_{M/L} \) is the marginal revenue of shifting a dollar of overhead to the laboratory, and \( S_{D/M} \) is the marginal cost of shifting a dollar of overhead from day services. The profit maximizing allocation of overhead requires equality of these marginal quantities. A further implication is that if for some reason the Medicare share is not uniform across departments, revenue maximization requires allocating all overhead to the department used most intensely by Medicare.\(^1\)

Consider now the effect of imposing a ceiling, \( \tilde{c}_d \), on allowable cost per day for day services. The first order conditions for \( P_d \) and \( \alpha \) now involve \( \mu_1 \):

\[
\begin{align*}
\frac{\partial P_d}{\partial \alpha} & = (1 + \mu_1 - \frac{1}{n} (1+ \frac{P_d N_o}{P_d N_0} \cdot (1+ \frac{L_n}{N_0}))) \\
- (1 - \alpha) Z/D^2 (D_m - \mu_1) & = c_d \\
L_m/L & = (D_m - \mu_1)/D.
\end{align*}
\]

(3'')

Assuming \( \mu_1 \) is nonnegative, marginal revenue from allocating overhead costs to day services is reduced. This implies an increase in \( \hat{\alpha} \), the fraction of overhead allocated to the laboratory. This in turn implies an increase in \( \hat{P}_d \), the revenue maximizing charge for laboratory services, whereas \( \hat{P}_d \) falls because of the reduction in the term \((1 - \alpha) Z/D^2 (D_m - \mu_1)\).

Finally, introduce the additional constraint that reimbursement from Medicare is equal to the lesser of costs and collectible charges. The first order conditions are given by Eqs. (2)-(6). Equations (2) and (3) for \( \hat{P}_d \) and \( \hat{P}_d \) now contain additional terms involving \( \mu_2 \),

---

\(^1\)The argument is stated here in terms of the Medicare share of services. If a department produces multiple services, then the crucial variable is the Medicare share of total charges, computed by weighting each service by its charge.
which is nonnegative if the constraint is binding. The effect of this
constraint on optimum charges is ambiguous a priori. On the one hand
an increase in charge levels raises the ceiling on allowable reim-
bursement from Medicare. On the other hand, an increase in charge
levels may reduce the percentage of charges actually collected, $\beta$.
Because the partial derivative $\partial P_L / \partial L_N$ is negative, the sign of the
last expression in Eq. (2) is negative if the term in brackets is
positive. The necessary condition for this to be the case is:

$$|\epsilon_{\beta,P_L} | < \frac{P_L L_m}{P_L L_m + P_D N_m}.$$ 

That is, the elasticity of the collection ratio with respect to the
charge level is less than the laboratory share of total Medicare
charges. For services that are heavily insured with a service benefit
form of insurance, an increase in charge levels is borne largely by
third party payers. In this case, $\beta$ is close to unity and $|\epsilon_{\beta,P_L} |$ is
negligibly small. A high level of insurance coverage of charge-paying
patients increases the likelihood that the lesser of costs or charges
constraint leads to an increase in charge levels, in order to raise
the ceiling and hence Medicare reimbursement. If charge-paying
patients are not insured or have indemnity type of coverage, however,
an increase in charge levels above the indemnity limit is borne by
the patient. In this case, $|\epsilon_{\beta,P_L} |$ is likely to be larger, which re-
duces and may even reverse the incentive to raise charge levels in
order to increase reimbursement from Medicare.

Note that $\mu_2 > 0$ reduces the upward pressure on charges because
of the first effect (second term in Eqs. (2) and (3)), which derives
from the increase in the Medicare multiplier, $L_m / L$. However, the
sign is reversed—i.e., a lower optimum price—if $\mu_2 > 1$. This is
unlikely to be the case. The Lagrangian multiplier $\nu_2$ represents
the increment in revenue due to an increase in the charge ceiling.
If $\nu_2 = 1$ there is a dollar increase in revenue from Medicare for
each dollar increase in charge levels. However, there is also a
reduction in revenue from charge-paying patients, as charges increase
above the level that maximizes revenue from that group alone. This partially offsetting reduction in revenue from charge-paying patients implies that \( 0 < \mu_2 < 1 \).

In conclusion, RCCAC cost reimbursement, ceilings on per diem costs, and the lesser of costs or charges constraint all imply that profit maximizing charges to charge-paying patients exceed the simple profit maximizing level.\(^1\) Specifically, both charges and fully allocated costs in the laboratory are predicted to be positively related to the fraction of total laboratory services attributable to cost-paying patients, positively related to the laboratory share of total charges for cost-paying patients \( [P_{L_m}/(P_{L_m} + P_{d_m})] \), and negatively related to the ceiling on per diem costs for day services. Charge levels are expected to be negatively related to the elasticity of demand of charge-paying patients, \( \epsilon_{L_m} \), and the elasticity of the collection ratio, \( \beta \), with respect to charge levels.

**OWNERSHIP EFFECTS**

Many authors have argued that profit maximization does not accurately describe the objectives of decisionmakers in voluntary non-profit, government, and district hospitals, but there is no consensus on an alternative.\(^2\) Although the rights to residual profit in a non-profit hospital are not well defined, profit maximization is nevertheless an appropriate model provided the various claimants can agree on maximizing their joint gain. I therefore adopt as a hypothesis to be tested the presumption that all hospitals maximize profits.

Assuming profit maximization, if all types of hospitals function in the same factor and product markets, no systematic difference is expected in charge levels or economic costs by ownership status. Accounting costs might be expected to be higher in nonprofit hospitals, because potential profits must be captured by inputs other than

---

\(^1\)The only exception is that the lesser of costs or charges constraint may imply lower optimal prices if the fraction of billed charges actually collected is highly elastic with respect to the level of charges.

capital. The accounting cost differential would correspond to taxes plus accounting profit in for-profit hospitals. These conclusions must be modified in view of the incentives created by reimbursement policies. Reimbursement is based on accounting costs, so for-profit hospitals have an incentive to disguise profit over economic cost as higher accounting costs. Therefore, accounting costs are not expected to differ systematically by type of hospital. Moreover, if accounting cost is viewed as a price to Medicare, the profit maximizing accounting profit ratio is greater or less than unity as the elasticity of demand of charge-paying patients is less or greater than the elasticity of demand of Medicare patients. Therefore, if Medicare demand is less elastic, optimum accounting profits would be negative. However, because of the constraint that costs not exceed charges, optimum accounting profits are zero and the optimum accounting profit ratio is unity.

**MONITOR EFFECTS**

Blue Cross is the Medicare carrier for the great majority of hospitals in California.¹ A hypothesis to be tested is that the incentive of the Medicare carrier to monitor hospital costs for Medicare is greater where the intermediary pays costs for its private beneficiaries, as does Blue Cross of Southern California, than where the carrier pays charges for its private beneficiaries, as does Blue Cross of Northern California. If the hospital must at least break even, then to the extent it is reimbursed at less than cost by cost-paying patients, charges to charge-paying patients must be correspondingly higher. A carrier that pays charges for its beneficiaries has more incentive to allow questionable costs than one that also pays costs. To the extent disallowed costs generate higher charges, the burden falls on the charge-paying commercial insurers with whom

---

¹A Medicare "carrier" is the fiscal agent for the federal government. In most states this function is performed by one of the private insurance carriers. In California in 1976, the majority of hospitals used Blue Cross (North or South); the remainder used two commercial insurers.
Blue Cross competes in the private health insurance market.

The prediction is that, because of the incentives for the Medicare carrier, charges will be higher relative to costs in Southern than in Northern California.

COMPETITION IN THE MARKET FOR AMBULATORY CARE

Hospital laboratories may provide services not only to hospital inpatients and outpatients but also to office based physicians. In the latter market they must compete with independent laboratories and with physician office laboratories. Medicare reimbursement regulations require hospitals to use the same schedule of charges for inpatients as for outpatients. If hospitals compete for ambulatory laboratory business, the greater the number of hospital laboratories and independent laboratories in the locality, the lower will be optimum charges for laboratory services.
V. THE DATA

SOURCES

The sample consists of 274 short-term general, nonteaching hospitals in California.\textsuperscript{1} Data on these hospitals were derived from two sources. Medicare cost reports, which are the hospital accounting statements filed with Medicare for reimbursement purposes, were used for data on laboratory costs, charges, Medicare share of charges, remuneration of pathologists, day service costs, and ceilings on per diem costs for accounting years ending in 1976. Reports filed with the California Health Facilities Commission (CHFC) were used to obtain information on the number of units of service performed in the laboratory, the case mix of the hospital, the fraction of laboratory services provided to MediCal patients and to outpatients, hourly wage rates of laboratory personnel, day service costs and charges, and total operating costs and charges.\textsuperscript{2}

Data on the number of hospital and independent laboratories, by five and three digit zip code, were merged with the hospital file to test whether charges for laboratory services are affected by the number of geographically close competitors.\textsuperscript{3}

\textsuperscript{1}University teaching hospitals are excluded because they produce both teaching and patient care.

\textsuperscript{2}The CHFC was established and designed its data base for the purpose of setting rates for California hospitals. The accounting conventions differ slightly from those used for Medicare cost reports. Because I am interested in the effect of Medicare reimbursement policies on accounting costs, it is preferable to use costs as reported for reimbursement purposes. Day service charges and total operating costs and charges were not included in the pages of the cost reports I obtained, so these variables were taken from the CHFC. Because Medicare cost report data were not available for many hospitals, the final sample used in the regression analysis is substantially less than the full universe of short-term general hospitals in California and almost certainly underrepresents small hospitals.

\textsuperscript{3}These data were obtained from Laboratory Management.
DATA DEFICIENCIES

Measurement of laboratory output poses the intrinsic problem of defining a common unit for aggregating different types of tests. Medicare cost reports contain no measure of laboratory output. The CHFC reports a weighted aggregate of tests where weights are the units assigned by the College of American Pathologists (CAP). CAP units are minutes of technician time required to perform a test.¹ The total number of CAP units is therefore at best a rough measure of complexity-adjusted units of output. However, if the test mix of large laboratories is typically more (less) labor-intensive than the test mix of smaller laboratories, the estimate of economies of scale will be biased upward (downward). Hereafter, I refer to "units" as "tests," but the distinction must be borne in mind.²

To provide some control for bias in the measure of output because of differences in test mix, I considered various indicators of the hospital case mix. The specialty distribution of the physician staff was found to have greater explanatory power than the mix of patient days (long-term, acute, surgical, pediatric, etc.). After I controlled for medical staff, measures of hospital output--hours of surgery, hours of dialysis, number of EKGs, number of emergency outpatient visits--were insignificant.

Neither of the hospital data sets contains adequate data on input quantities or prices. Laboratory inputs include pathologist and

¹The personnel measured by the CAP technique may represent as little as 20 percent of total cost of operating a laboratory.  I am indebted to Dr. Donald Penner and Dr. George Westlake for emphasizing the limitations of CAP units as a measure of output.

²The CHFC reports four categories of tests: clinical, pathology, pulmonary function, and "other." The percentage of tests in each category was not significant, and therefore it was omitted from the regressions. Some hospitals may lack the sophisticated information system necessary to report CAP units and therefore use some ad hoc procedure to estimate laboratory output, such as dividing total laboratory costs by average charge per test. This would distort the estimated effects of scale and of any variables that are systematically associated with average charge per test. Even if the total units reported is an actual tally of units for tests billed, it underestimates direct manpower used in testing because it does not include controls, standards, and repeats, which in some sections can constitute up to 50 percent of the total workload.
technician time, supplies, and capital. In addition, many hospitals purchase complex or low priority tests from independent laboratories. Total remuneration of pathologists for time spent in direct patient care is reported, but without information on the corresponding number of hours it is impossible to calculate an hourly wage rate. The CHFC data do permit calculation of an average hourly wage rate for all laboratory personnel (including pathologist time spent on functions other than direct patient care). But if the average productivity of the personnel represented by this wage rate differs across hospitals, it is a very poor proxy for the supply price of labor of a homogeneous quality. To provide some control for the unmeasured variation in supply price of physicians and other laboratory personnel, I include the number of physicians per capita and the percentage of the county classified as urban, from the Area Resource File. These variables, together with the data on proximity of independent laboratories, also provide some control for unobserved variation in the price of purchased supplies and purchased tests. Differences in the price of capital should be captured by the indicators of ownership type: non-profit, for-profit, government, or district. Because all these variables are at best rough indicators of input supply prices, precise estimation of the elasticities of substitution between inputs is not possible.\(^1\)

The variety of contractual relations between hospitals and pathologists creates particular problems in estimating laboratory cost or charge functions. If the hospital bills for both hospital and physician services (combined billing), then the pathologist may be paid either a salary or a percentage of the gross or net departmental revenue. In other cases he may bill patients directly for his services and receive no compensation from the hospital (direct billing). With both billing arrangements, the pathologist may personally provide some of the other laboratory inputs. Thus his gross remuneration may reflect both the net remuneration for his time and the remuneration for the other inputs he supplies. Because hospital costs in Medicare cost reports are

\(^1\)The omission of interactions between the proxies for input prices is tantamount to imposing unitary elasticity restrictions.
net of the physician component (paid under Part B), they are a down-
ward biased measure of nonphysician costs where the physician himself
is supplying other inputs.

The potential distortion is greater where the pathologist bills
and pays the hospital for use of certain facilities. If such cost
sharing arrangements between pathologists and hospitals are not ran-
dom across hospitals but, for example, more common in small hospitals,
there will be a systematic underreporting of costs for small hospitals
and a downward bias in estimates of returns to scale.¹ Neither data
set identifies the contractual arrangements for remuneration, billing,
or cost sharing between hospital and pathologist.

In some cases the hospital contracts with an independent labora-
tory to provide laboratory services. Information on whether labora-
tory work is performed under contract was reported in the CHFC data
and the Laboratory Management data. In neither case is it clear pre-
cisely what type of cost and revenue sharing arrangements are covered
by the words "contracted out," and the correspondence between the two
sources was imperfect. The final specification includes a dummy vari-
able if Laboratory Management indicated that the laboratory was con-
tracted out. It is included as a control for possible reporting
differences in hospitals where the laboratory is not a fully inte-
grated unit of the hospital.

No good measures are available of the other parameters of the
theoretical model: the demand elasticity of charge-paying patients,
the collection ratio, or the elasticity of the collection ratio with
respect to charges. As a proxy for all of these I include the percent
of tests performed for outpatients.² Because outpatient services
typically have a higher copayment rate, the elasticity of demand and
the elasticity of the collection ratio are expected to be positively

¹Exploratory analysis of the ratio of the professional component
to total costs suggests that there is systematic variation in con-
tractual arrangements by size of hospital and ownership status.
²Per capita income in the county was tried but was insignificant.
related to the percent of tests performed for outpatients, whereas
the collection ratio is expected to be inversely related.

Means and standard deviations of all variables are reported in
Table 2.

Table 2
MEAN AND STANDARD DEVIATION OF VARIABLES

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Source^a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Units</td>
<td>13.87</td>
<td>1.25</td>
<td>CHFC</td>
</tr>
<tr>
<td>(Total Units)^2</td>
<td>193.84</td>
<td>31.39</td>
<td>CHFC</td>
</tr>
<tr>
<td>Lab Contracted</td>
<td>.17</td>
<td>.37</td>
<td>LM</td>
</tr>
<tr>
<td>Urban</td>
<td>90.47</td>
<td>14.55</td>
<td>ARF</td>
</tr>
<tr>
<td>North</td>
<td>.23</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>For-Profit</td>
<td>.33</td>
<td>--</td>
<td>CHFC</td>
</tr>
<tr>
<td>Government</td>
<td>.06</td>
<td>--</td>
<td>CHFC</td>
</tr>
<tr>
<td>District</td>
<td>.12</td>
<td>--</td>
<td>CHFC</td>
</tr>
<tr>
<td>Sum</td>
<td>.40</td>
<td>.49</td>
<td>MCR</td>
</tr>
<tr>
<td>%Tests, Outpatient</td>
<td>.21</td>
<td>.13</td>
<td>CHFC</td>
</tr>
<tr>
<td>%Lab Charges, Medicare</td>
<td>.29</td>
<td>.18</td>
<td>MCR</td>
</tr>
<tr>
<td>%Lab Charges, Medicaid</td>
<td>.16</td>
<td>.12</td>
<td>CHFC</td>
</tr>
<tr>
<td>Lab Share Medicare</td>
<td>.14</td>
<td>.09</td>
<td>MCR</td>
</tr>
<tr>
<td>Actual Limit Per Diem</td>
<td>.92</td>
<td>.21</td>
<td>MCR</td>
</tr>
<tr>
<td>%Staff, Surgeons</td>
<td>.15</td>
<td>.07</td>
<td>CHFC</td>
</tr>
<tr>
<td>%Staff, Internal Medicine</td>
<td>.17</td>
<td>.08</td>
<td>CHFC</td>
</tr>
<tr>
<td>%Staff, Pediatricians</td>
<td>.04</td>
<td>.04</td>
<td>CHFC</td>
</tr>
<tr>
<td>%Staff, Ob/Gyn</td>
<td>.07</td>
<td>.06</td>
<td>CHFC</td>
</tr>
<tr>
<td>%Staff, Family or General Practice</td>
<td>.21</td>
<td>.15</td>
<td>CHFC</td>
</tr>
<tr>
<td>Zero Dialysis</td>
<td>.72</td>
<td>.45</td>
<td>CHFC</td>
</tr>
<tr>
<td>Independent Labs in Zip (3)</td>
<td>26.97</td>
<td>23.57</td>
<td>LM</td>
</tr>
<tr>
<td>Hospital Labs in Zip (3)</td>
<td>12.20</td>
<td>8.09</td>
<td>LM</td>
</tr>
<tr>
<td>Days</td>
<td>10.25</td>
<td>.96</td>
<td>MCR</td>
</tr>
<tr>
<td>(Days)^2</td>
<td>105.66</td>
<td>19.14</td>
<td>MCR</td>
</tr>
<tr>
<td>%Days, Medicare</td>
<td>.38</td>
<td>.13</td>
<td>MCR</td>
</tr>
<tr>
<td>%Days, Medicaid</td>
<td>.16</td>
<td>.13</td>
<td>CHFC</td>
</tr>
<tr>
<td>MDs per capita</td>
<td>.002</td>
<td>.0008</td>
<td>ARF</td>
</tr>
<tr>
<td>Direct Lab Costs</td>
<td>12.99</td>
<td>.92</td>
<td>MCR</td>
</tr>
<tr>
<td>Fully Allocated Lab Costs</td>
<td>13.33</td>
<td>.94</td>
<td>MCR</td>
</tr>
<tr>
<td>Lab Charges</td>
<td>13.70</td>
<td>.97</td>
<td>MCR</td>
</tr>
<tr>
<td>Adjusted Lab Costs</td>
<td>13.43</td>
<td>.96</td>
<td>MCR</td>
</tr>
<tr>
<td>Adjusted Lab Charges</td>
<td>13.71</td>
<td>.98</td>
<td>MCR</td>
</tr>
<tr>
<td>Day Service Costs</td>
<td>14.69</td>
<td>.98</td>
<td>MCR</td>
</tr>
<tr>
<td>Day Service Costs</td>
<td>14.93</td>
<td>.98</td>
<td>CHFC</td>
</tr>
<tr>
<td>Day Service Charges</td>
<td>13.53</td>
<td>1.07</td>
<td>CHFC</td>
</tr>
<tr>
<td>Total Operating Costs</td>
<td>15.68</td>
<td>.96</td>
<td>CHFC</td>
</tr>
<tr>
<td>Total Operating Charges</td>
<td>15.68</td>
<td>.99</td>
<td>CHFC</td>
</tr>
<tr>
<td>Total Lab Costs</td>
<td>13.39</td>
<td>.95</td>
<td>CHFC</td>
</tr>
<tr>
<td>Total Lab Revenue</td>
<td>13.53</td>
<td>.96</td>
<td>CHFC</td>
</tr>
</tbody>
</table>

^aCHFC = California Health Facilities Commission.
LM = Laboratory Management.
ARF = Area Resource File.
MCR = Medicare Cost Reports.
-- = Not relevant.
VI. EMPirical estimates: Laboratory costs and charges

The approach taken here to estimating the effect of reimbursement and ownership variables on costs is to include these variables in an equation that would correspond to a cost function. The null hypothesis is that accounting costs reflect economic costs and only those variables expected to affect economic cost--scale and mix of output and input prices--should be significant. Because the theory

\[ \ln C = \alpha_0 + \alpha_y \ln Y + 1/2 \gamma_{yy} (\ln Y)^2 \]
\[ + \sum \alpha_i \ln P_i + 1/2 \sum \gamma_{ij} \ln P_i \ln P_j \]
\[ + \sum \gamma_{yi} \ln Y \ln P_i \]

permits tests for homotheticity ($\gamma_y = 0$), homogeneity ($\gamma_{y1} = \gamma_{yy} = 0$) and unit elasticities of substitution ($\gamma_{ij} = 0$). See Christensen and Greene (1976). Interactions between the proxies for input prices used here are omitted. This is tantamount to imposing unitary elasticity restrictions.

The equations estimated are of the form:

\[ \ln C = \beta_0 + \beta_1 \ln Y + \beta_2 (\ln Y)^2 + \beta_3 P + \beta_4 Z + u , \]

where $\ln C =$ total costs or charges. $\ln Y =$ total output (laboratory units or days). $\ln P =$ vector of proxies for input prices.
$ Z =$ vector of other exogenous variables (reimbursement, case mix, ownership, monitor, independent laboratories, etc.).

The assumption here is that output and input prices are exogenous. This is not consistent with the theoretical model, in which output is a function of charges and accounting input prices may include rents. Potential simultaneous determination is an additional reason for mistrusting the estimates of economics of scale. Specifically, simultaneous determination of charges and output would lead to an overestimate of economies of scale in the charge equation.
refers in part to the allocation of overhead costs, I first compare direct and fully allocated costs in the laboratory.\(^1\) A similar functional form is then estimated for laboratory charges. Because dependent variables are in logs, tests for significant differences between coefficients in the cost and charge equations are equivalent to tests for significant effects on the profit ratio. Costs and charges are compared both net and gross of the professional component, to the extent the data permit this distinction. In order to determine whether observed effects are merely shifts in costs and charges among departments, with no effect on the total, the next section reports similar analysis for day services and total operating costs and charges.

Table 3 reports the cost function estimates for direct and fully allocated laboratory costs. Two equations are reported for both direct cost and allocated cost. The first includes only the Medicare and Medicaid share of laboratory charges (%Charges, Medicare, and %Charges, Medicaid) as reimbursement variables; the second adds the fraction of total Medicare charges incurred in the laboratory (Laboratory Share, Medicare) and the limit on day service costs (Actual Limit Per Diem).

The estimated coefficients imply economies of scale of .5 at the sample mean.\(^2\) Alternatively stated, a 10 percent increase in output

---

\(^1\)Direct cost includes interest and depreciation costs of capital in the laboratory but excludes the remuneration of pathologists for direct patient care (the professional component) and excludes all hospital overhead cost. Fully allocated cost is direct cost plus the share of the nonrevenue producing departments that is allocated to the laboratory, but still excludes the professional component. Cost functions inclusive of the professional component are reported in Table 5.

\(^2\)Economies of scale are defined as follows:

\[
ESC = 1 - (\hat{\beta}_1 + 2\hat{\beta}_2 \ln \text{Total Units})
\]

where \(\hat{\beta}_1\) is the estimated coefficient of Total Units and \(\hat{\beta}_2\) is the estimated coefficient of (Total Units)\(^2\). Positive values imply increasing returns to scale, negative values imply decreasing returns to scale. Inserting the coefficients from the first equation for direct cost into this formula yields .50.
Table 3
LABORATORY DIRECT COSTS AND FULLY ALLOCATED COSTS
(n = 274)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Direct Costs (log)</th>
<th>Fully Allocated Costs (log)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient (t)</td>
<td>Coefficient (t)</td>
</tr>
<tr>
<td>Intercept</td>
<td>20.79 (8.68)</td>
<td>21.664 (9.27)</td>
</tr>
<tr>
<td>Total Units</td>
<td>-1.80 (-4.81)</td>
<td>-1.871 (-5.25)</td>
</tr>
<tr>
<td>(Total Units)²</td>
<td>.083 (5.80)</td>
<td>.086 (6.29)</td>
</tr>
<tr>
<td>Lab Contracted</td>
<td>.136 (1.79)</td>
<td>.110a (1.52)</td>
</tr>
<tr>
<td>Urban</td>
<td>.004 (1.79)</td>
<td>.004 (1.71)</td>
</tr>
<tr>
<td>North</td>
<td>.276 (3.61)</td>
<td>.259 (3.56)</td>
</tr>
<tr>
<td>For-Profit</td>
<td>-.297 (-3.9)</td>
<td>-.261b (-3.6)</td>
</tr>
<tr>
<td>Government</td>
<td>-.333 (-2.43)</td>
<td>-.268b (-2.05)</td>
</tr>
<tr>
<td>District</td>
<td>.020 (.21)</td>
<td>-.01 (-.11)</td>
</tr>
<tr>
<td>Sum</td>
<td>.214 (3.53)</td>
<td>.197 (3.41)</td>
</tr>
<tr>
<td>%Tests, Outpatient</td>
<td>-.597 (-2.31)</td>
<td>-.495b (-2.01)</td>
</tr>
<tr>
<td>%Charges, Medicare</td>
<td>.830 (4.62)</td>
<td>.821 (4.8)</td>
</tr>
<tr>
<td>%Charges, Medicaid</td>
<td>1.01 (3.56)</td>
<td>.859b (3.18)</td>
</tr>
<tr>
<td>Lab Share Medicare</td>
<td>-- --</td>
<td>1.319 (2.94)</td>
</tr>
<tr>
<td>Actual$Per Diem</td>
<td>-- --</td>
<td>.056 (.39)</td>
</tr>
<tr>
<td>%Staff, Surgeons</td>
<td>.814 (1.74)</td>
<td>.787 (1.77)</td>
</tr>
<tr>
<td>%Staff, Internal Medicine</td>
<td>1.167 (2.38)</td>
<td>1.058 (2.27)</td>
</tr>
<tr>
<td>%Staff, Pediatricians</td>
<td>2.815 (3.03)</td>
<td>2.6 (2.94)</td>
</tr>
<tr>
<td>%Staff, Ob/Gyn</td>
<td>.195 (.34)</td>
<td>.283 (.52)</td>
</tr>
<tr>
<td>%Staff, Family or General Practice</td>
<td>.025 (.08)</td>
<td>-.022 (-.07)</td>
</tr>
<tr>
<td>Zero Dialysis</td>
<td>-.163 (-2.63)</td>
<td>-.142 (-2.13)</td>
</tr>
<tr>
<td>Independent Labs</td>
<td>-.002 (-.89)</td>
<td>-.002 (-.79)</td>
</tr>
<tr>
<td>Hospital Labs</td>
<td>.004 (.52)</td>
<td>.003 (.43)</td>
</tr>
<tr>
<td>R²</td>
<td>.7918</td>
<td>.8001</td>
</tr>
</tbody>
</table>

---

*Significant difference, at ≥ 10 percent level, between coefficients in Direct and Fully Allocated Cost equations.

bSignificant difference, at ≥ 5 percent level, between coefficients in Direct and Fully Allocated Cost equations.

**Variable not included in regression.**
leads to only a 5 percent increase in direct cost. If correct, these estimates suggest there would be substantial savings in production costs if smaller hospitals pooled facilities or purchased tests from larger hospitals or independent laboratories.\(^1\) However, because CAP units are a measure of technician time input rather than a homogeneous output, the apparent economies of scale may simply reflect a more labor-intensive test mix in larger hospitals.

The estimates of scale economies for fully allocated cost are similar to those for direct cost. This implies that the apparent economies of scale arise from spreading joint costs within the laboratory either because of decreasing costs of specific tests with increasing volume (economies of scale strictly defined) or from jointness of production of different types of tests (economies of scope). By contrast there appear to be no economies of scale in hospital overhead departments. The equivalence of estimates of scale economies for direct and fully allocated costs implies that the allocated component increases in proportion to direct costs of the laboratory.\(^2\)

Several of the indicators of case mix of the hospital—whether measured by characteristics of hospital days or of the medical staff—are significant in the cost function equations. It is unclear what interpretation to place on this finding. To the extent accounting costs reflect economic costs, the significance of the case mix variables implies that the CAP units do not accurately capture differences in the cost of performing different tests: if CAP units were strictly proportional to the production cost of different tests, the total cost of the weighted sum of a mix of tests, using CAP weights, would be independent of the mix. However, if the ratio of technician time to other inputs is not uniform across tests, CAP units will not be proportional to production cost. To the extent accounting costs reflect optimum pricing decisions, rather than economic production

---

\(^1\)These production savings would be partially offset by higher costs of transportation, delay, etc.

\(^2\)By accounting conventions, capital equipment used in the laboratory is assigned to overhead and allocated with other overhead costs. Therefore direct costs underestimate and fully allocated costs overstate the costs of operating the laboratory.
costs, and CAP units accurately reflect production costs, the correct interpretation of the significant case mix variables is that the optimum price markup over cost is high for tests associated with these case mix variables. This interpretation gains credence from the comparison of charges and costs reported in Table 4. In general, there is no significant difference in the effect of these case mix variables on total charges and total costs. If charges for different types of tests reflect unconstrained optimum charges, the similarity of case mix coefficients in the charge and cost equations is consistent with the hypothesis that costs are to be interpreted as prices.\(^1\)

The various proxies for input supply prices were generally insignificant, with the exception of urbanization, which is positive. Controlling for urbanization, all measures of the supply price of physicians were insignificant: number of physicians per capita, number of pathology interns and residents per pathologist on the medical staff, percentage of hospital based pathologists. The average wage rate per hour in the laboratory was also insignificant.\(^2\) Costs appear to be 10–14 percent higher in hospitals where the laboratory is contracted out. However, little weight should be attached to this finding because the coefficients are only marginally significant by conventional standards and the observed difference may be due to different reporting conventions. The data do not permit separation of the percentage of tests purchased from independent laboratories from those performed in house (under various contractual arrangements). Therefore, I cannot comment on the common allegation that reimbursement practices induce an inefficient substitution of in-house testing for lower cost purchased tests.\(^3\)

\(^{1}\) If CAP units were adopted as a basis for reimbursement or rate setting for tests, it would create incentives to adopt labor intensive techniques.

\(^{2}\) As noted above, this average wage rate does not adjust for quality so its insignificance is not surprising. Per capita income in the county was tried but was insignificant.

\(^{3}\) As a proxy for underreporting of nonphysician inputs in hospitals where the pathologist contracts to supply some of these inputs, I tried including the ratio of the amount paid by the pathologist to the
The evidence in Table 3 strongly supports the conclusion that cost reimbursement results in higher laboratory costs. A 10 percent increase in the Medicare share of charges is associated with an 8.3 percent increase in direct costs and an 8.2 percent increase in fully allocated costs; a 10 percent increase in the Medicaid share is associated with a 10.1 percent increase in direct cost and an 8.6 percent increase in fully allocated cost. This suggests that the increase in costs associated with cost reimbursement is not confined to a reallocation of a given level of overhead across departments: coefficients of the Medicare and Medicaid variables are not only significantly positive but larger for direct cost than fully allocated cost. However, this result may be due in part to the Medicare rules for allocating overhead costs, which tend to require an increase in reported accounting direct cost in a department as a necessary condition of increasing the allocation of overhead to that department.\footnote{The issue of shifting versus overall increase is addressed below.}

When the other two reimbursement variables (laboratory share of total Medicare charges and the per diem cost limit) are added in the second equation of each pair, the effect of the Medicaid share of laboratory charges is slightly reduced but still statistically significant. However, the Medicare share of laboratory charges becomes insignificant once the laboratory share of total Medicare charges is added, because of collinearity. The per diem ceiling has no effect. The per diem ceilings were not binding on most hospitals at this time, so this is not a valid test of the hypothesis that binding constraints on per diem costs will be at least partially offset by reallocating costs from the day services department to the laboratory.

There are significant differences in laboratory costs by ownership status of the hospital, although estimates of the precise differential are sensitive to the specification. For-profit hospitals
have 30-33 percent lower direct cost, 21-26 percent lower fully allocated costs than nonprofit hospitals; government hospitals have 33-41 percent lower direct costs, 27-36 percent lower fully allocated costs than nonprofit hospitals. District hospitals show no significant difference. It is not possible to distinguish whether the higher costs of nonprofit hospitals are due to less efficient use of inputs or higher prices of inputs. However, the nonprofit differential appears to be greater in the direct costs of operating the laboratory than in the overhead departments.

Laboratory costs per unit are approximately 25 percent higher in Northern than in Southern California, controlling for demographic factors such as percent urban and physicians per capita. This is consistent with the hypothesis that Blue Cross South has a greater incentive to monitor costs. However, these conclusions based on the laboratory alone require modification when we consider total operating results below.

Table 4 presents a comparison of fully allocated cost and total charges for laboratory services. Because both dependent variables are in logs, tests for significant differences between coefficients in the two equations are equivalent to tests for a significant effect on the profit ratio.

As predicted by the net revenue maximization model developed above, charges are significantly positively related to the fraction of laboratory charges attributable to cost-paying patients. This finding is evidence against the allegation that the high degree of insurance coverage of hospital services eliminates the demand constraint on the level of charges, by making demand totally inelastic. The elasticity of laboratory charges with respect to Medicare is .93, and the elasticity with respect to Medicaid is 1.17. This is the gross effect, without controlling for the laboratory share of

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1Total charges is the hypothetical revenue the hospital would receive if all patients paid charges. Whereas costs exclude the pathologist professional component, charges may include the corresponding charges in some hospitals. These charges cannot be netted out with the data available.
Table 4
LABORATORY FULLY ALLOCATED COSTS AND CHARGES

<table>
<thead>
<tr>
<th>Variable</th>
<th>Fully Allocated Costs</th>
<th>Total Charges</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient (t)</td>
<td>Coefficient (t)</td>
</tr>
<tr>
<td>Intercept</td>
<td>21.664 (9.27)</td>
<td>22.03 (9.55)</td>
</tr>
<tr>
<td>Total Units</td>
<td>-1.871 (-5.25)</td>
<td>-1.909 (-5.42)</td>
</tr>
<tr>
<td>(Total Units)$^2$</td>
<td>.086 (6.29)</td>
<td>.087 (6.42)</td>
</tr>
<tr>
<td>Lab Contracted</td>
<td>.110 (1.52)</td>
<td>.108 (1.51)</td>
</tr>
<tr>
<td>%Urban</td>
<td>.004 (1.71)</td>
<td>.003 (1.35)</td>
</tr>
<tr>
<td>North</td>
<td>.259 (3.56)</td>
<td>.239 (3.31)</td>
</tr>
<tr>
<td>For-Profit</td>
<td>-.261 (-3.6)</td>
<td>-.286 (-3.95)</td>
</tr>
<tr>
<td>Government</td>
<td>-.268 (-2.05)</td>
<td>-.361 (-2.7)</td>
</tr>
<tr>
<td>District</td>
<td>-.01 (-.11)</td>
<td>-.041 (-.44)</td>
</tr>
<tr>
<td>Sum</td>
<td>.197 (3.41)</td>
<td>.195 (3.41)</td>
</tr>
<tr>
<td>%Tests, Outpatient</td>
<td>-.495 (-2.01)</td>
<td>-.465 (-1.91)</td>
</tr>
<tr>
<td>%Lab Charges, Medicare</td>
<td>.821 (4.8)</td>
<td>.399 (1.82)</td>
</tr>
<tr>
<td>%Lab Charges, Medicaid</td>
<td>.859 (3.18)</td>
<td>.715 (2.63)</td>
</tr>
<tr>
<td>Lab Share Medicare</td>
<td>--</td>
<td>1.238 (2.95)</td>
</tr>
<tr>
<td>Actual Limit Per Diem</td>
<td>--</td>
<td>.143 (1.06)</td>
</tr>
<tr>
<td>%Staff, Surgeons</td>
<td>.787 (1.77)</td>
<td>.522 (1.16)</td>
</tr>
<tr>
<td>%Staff, Internal Medicine</td>
<td>1.058 (2.27)</td>
<td>1.151 (2.49)</td>
</tr>
<tr>
<td>%Staff, Pediatricians</td>
<td>2.6 (2.94)</td>
<td>2.16 (2.44)</td>
</tr>
<tr>
<td>%Staff, Ob/Gyn</td>
<td>.283 (.52)</td>
<td>.047 (.09)</td>
</tr>
<tr>
<td>%Staff, Family or General Practice</td>
<td>-.022 (-.07)</td>
<td>-.035 (-.12)</td>
</tr>
<tr>
<td>Zero Dialysis</td>
<td>-.142 (-2.13)</td>
<td>-.157 (-2.35)</td>
</tr>
<tr>
<td>Independent Labs</td>
<td>-.002 (-.79)</td>
<td>-.001 (-.27)</td>
</tr>
<tr>
<td>Hospital Labs</td>
<td>.003 (.43)</td>
<td>.000 (.001)</td>
</tr>
</tbody>
</table>

$^a$Charge and Cost coefficients significantly different at 10 percent level.

$^b$Charge and Cost coefficients significantly different at 5 percent level.
total Medicare charges or the Medicare ceiling on per diem costs. The gross effect of \%Medicare and \%Medicaid on laboratory charges is greater than their gross effect on laboratory costs. The differentially higher effect on charges is greater and more significant in the case of Medicaid (23 percentage points greater effect on charges) than in the case of Medicare (11 percentage points greater effect on charges). One possible explanation for this is that Medicare patients pay charges for outpatient tests, with a 20 percent coinsurance rate, whereas Medicaid pays for outpatient tests according to a schedule, with zero coinsurance. Medicare demand will therefore be more elastic.

Including the other two Medicare reimbursement variables adds only .7 of a percentage point to the explanatory power of the cost equation and 1.7 percentage points to the explanatory power of the charges equation because of the high correlation between the Medicare share of laboratory charges and the laboratory share of total Medicare charges (.62). The positive effect of the laboratory share of total Medicare charges on total laboratory charges suggests that the lesser of costs and charges constraint is binding and tends to raise the optimum level of charges. This was predicted if the elasticity of the collection ratio with respect to charges is low. By contrast, the limit on per diem costs has no significant effect on charges, as expected if it was not a binding constraint.

The differential effects of ownership status on charges relative to costs are interesting. Whereas for-profit hospitals have 26-29 percent lower laboratory costs per unit than nonprofit hospitals, their charge levels are only 0-13 percent lower, with marginal significance. In the case of government hospitals, however, the 27-36 percent cost differential compared with nonprofits is fully reflected in an equivalent charge differential. One explanation of this is that for-profit and nonprofit hospitals serve a similar charge-paying market so are constrained by competition, whereas government hospitals operate in a separate market. An alternative but not mutually exclusive interpretation is that property rights over potential profit, hence the incentive structure facing administrators, is different in government hospitals.
Laboratory charges are higher in Northern California than Southern California, as are costs. However, the charge differential is significantly less than the cost differential. This is consistent with the hypothesis that the carrier who pays charges has a weaker incentive to monitor costs than the carrier who pays costs.

The returns to scale parameters individually are significantly different in the cost and charge equations but the net effect is almost identical: The implied elasticity of charges with respect to scale is .42 and the elasticity of costs with respect to scale is .50.¹

Finally, the elasticity of charges with respect to percent of laboratory tests performed for outpatients is significantly more negative than the elasticity of costs. The elasticity of costs with respect to percent outpatient tests may reflect variations in the mix of tests. The difference between cost and the charge elasticities suggests that hospital charges are sensitive to the elasticity of demand: Less extensive insurance coverage of outpatient services implies more elastic demand, hence lower profit maximizing charge levels. The same conclusion is implied by the evidence that charge levels are negatively related to the number of independent laboratories in the area, as predicted if they compete for the office based physician market. The number of hospital laboratories in the area has no significant effect.

The analysis so far has examined the hospital component of total laboratory costs—i.e., laboratory costs net of pathologist costs attributable to direct patient care (professional component).² In the case of charges, total charges used so far may be either gross or net of the physician component. To investigate the effect of this measurement error, Table 5 reports the same analysis using estimates of costs and charges constructed to include both hospital and physician components. The procedure for computing charges is described

¹ This is consistent with greater simultaneous equations bias in the charge equation, because the demand of charge-paying patients is more elastic.

² This could bias the other parameter estimates if the physician share of costs differs systematically across hospitals because of
in footnote 1 below.¹ To obtain a measure of total costs, inclusive of all physician costs, the pathologist remuneration was added to fully allocated hospital costs.²

Total gross cost and charge equations are reported in Table 5 and are to be compared with the corresponding equations for the hospital component only in Table 4. The unexplained variance of costs is slightly decreased by adding in the pathologist remuneration, whereas the unexplained variance of charges is increased by the attempt to adjust for omitted charges for pathologists' services. The elasticity of total gross costs (hospital plus professional

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¹ According to Medicare regulations, a hospital may compute the Medicare share of charges using either gross (for the hospital plus professional components) or net charges (for the hospital component only). For the Medicare share of the professional component, if gross charges are used for the hospital component, they must also be used for the professional component; if net hospital charges are used for the hospital component, charges for physician services only must be used for the professional component. Whether gross or net charges are being used is not explicitly reported in the cost reports. However, it should be possible to classify hospitals by comparing the totals reported in two places. If gross charges are used, total charges to be applied to the hospital and professional components of costs should be identical. If net charges are being used, total charges to be applied to the hospital component should differ from total charges to be applied to the professional component. The ratio of these two measures of charges should therefore have a bimodal distribution, with one peak at unity and another substantially less than unity. This turned out to be approximately true. To obtain a measure of total charges, inclusive of both hospital and physician components, I adopted the following arbitrary decision rule: If the ratio of the two charge measures fell below .7, I assumed net charges were being used and summed the two to obtain total gross charges. If the ratio exceeded .7, I assumed gross charges were being used and that the deviation from unity was a random error, and I used total charges reported for computing reimbursement for the hospital component as the measure of gross charges.

² Remuneration of pathologists is reported in two places in the cost reports. These two differed by more than 25 percent in 33 percent of cases. To reduce estimation bias due to either reporting error or judgment error, I examined normal plots of estimates of total costs and charges, gross of physician component, and eliminated a few obvious outliers from the sample. The remaining sample was approximately normally distributed.
### Table 5

**Laboratory Costs and Charges with Professional Component**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Fully Allocated &amp; Pathologist Costs</th>
<th>Total &amp; Pathologist Charges</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient (t)</td>
<td>Coefficient (t)</td>
</tr>
<tr>
<td><strong>Intercept</strong></td>
<td>22.363 (9.57)</td>
<td>22.803 (9.95)</td>
</tr>
<tr>
<td><strong>Total Units</strong></td>
<td>-1.981 (-5.56)</td>
<td>-2.011 (-5.74)</td>
</tr>
<tr>
<td>(Total Units)^2</td>
<td>.090 (6.61)</td>
<td>.090 (6.74)</td>
</tr>
<tr>
<td><strong>Lab Contracted</strong></td>
<td>.117 (1.61)</td>
<td>.117 (1.64)</td>
</tr>
<tr>
<td><strong>NUrban</strong></td>
<td>.005 (2.04)</td>
<td>.004 (1.6)</td>
</tr>
<tr>
<td><strong>North</strong></td>
<td>.214 (2.94)</td>
<td>.190 (2.66)</td>
</tr>
<tr>
<td><strong>For-Profit</strong></td>
<td>-.246 (-3.39)</td>
<td>-.279 (-3.87)</td>
</tr>
<tr>
<td><strong>Government</strong></td>
<td>-.290 (-2.22)</td>
<td>-.385 (-2.9)</td>
</tr>
<tr>
<td><strong>District</strong></td>
<td>-.031 (-.33)</td>
<td>-.062 (-.68)</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td>.211 (3.64)</td>
<td>.207 (3.64)</td>
</tr>
<tr>
<td><strong>%Tests, Outpatient</strong></td>
<td>-.427 (-1.74)</td>
<td>-.388 (-1.61)</td>
</tr>
<tr>
<td><strong>%Charges, Medicare</strong></td>
<td>.987 (5.77)</td>
<td>.495 (2.27)</td>
</tr>
<tr>
<td><strong>%Charges, Medicaid</strong></td>
<td>.770 (2.85)</td>
<td>.588 (2.17)</td>
</tr>
<tr>
<td><strong>Lab Share Medicare</strong></td>
<td>--</td>
<td>1.486 (3.51)</td>
</tr>
<tr>
<td><strong>Actual Limit Per Diem</strong></td>
<td>--</td>
<td>.093 (.70)</td>
</tr>
<tr>
<td><strong>%Staff, Surgeons</strong></td>
<td>.780 (1.75)</td>
<td>.462 (1.04)</td>
</tr>
<tr>
<td><strong>%Staff, Internal Medicine</strong></td>
<td>.979 (2.10)</td>
<td>1.078 (2.35)</td>
</tr>
<tr>
<td><strong>%Staff, Pediatricians</strong></td>
<td>2.877 (3.25)</td>
<td>2.412 (2.74)</td>
</tr>
<tr>
<td><strong>%Staff, OB/Gyn</strong></td>
<td>.232 (.43)</td>
<td>-.019 (-.04)</td>
</tr>
<tr>
<td><strong>%Staff, Family or General Practice</strong></td>
<td>-.065 (-.22)</td>
<td>-.094 (-.33)</td>
</tr>
<tr>
<td><strong>Zero Dialysis</strong></td>
<td>-.142 (-2.13)</td>
<td>-.165 (-2.48)</td>
</tr>
<tr>
<td><strong>Independent Labs</strong></td>
<td>-.002 (-1.04)</td>
<td>-.001 (-.34)</td>
</tr>
<tr>
<td><strong>Hospital Labs</strong></td>
<td>.002 (.40)</td>
<td>-.001 (-.15)</td>
</tr>
<tr>
<td>R^2</td>
<td>.8103</td>
<td>.8193</td>
</tr>
</tbody>
</table>

^a Charge and Cost coefficients significantly different at 5 percent level.

--: Variable not included in regression.
component) with respect to the Medicare share of charges is 17 percentage points greater than the elasticity of the hospital component alone. This suggests that the Medicare reimbursement policy, which requires separation of these two components and separates the monitoring of these costs between the Part A and Part B carriers, results in a higher total cost. Medicaid does not make this distinction between pathologist and other costs. The elasticity of total costs with respect to the Medicaid share falls 9 percentage points when the professional component is added in. The changes in the charge elasticities are less than 3 percent. None of the other coefficients changes significantly when the professional component is added to the hospital component.
VII. DAY SERVICES AND TOTAL OPERATING COSTS AND CHARGES

The theoretical model predicts that charge levels in all departments will be positively related to the Medicare and Medicaid shares; that overhead costs will be shifted toward departments used relatively intensively by Medicare patients; and that total operating costs would increase or decrease relative to total charges, depending on whether the Medicare elasticity of demand was less or greater than that of charge-paying patients. The results so far show that the Medicare and Medicaid shares do tend to increase costs and charges in the laboratory, with the increase in charges being significantly greater than the increase in costs. Table 6 reports a similar analysis of day service costs and charges and total operating costs and charges. The coefficients of reimbursement and ownership variables, by department, are summarized in Table 7. In the case of day service costs, data are available from both CHFC and Medicare cost reports.\(^1\) Unfortunately, data on day service charges and total operating costs and charges are available only from CHFC reports, which are designed for rate setting rather than reimbursement and use slightly different accounting conventions.

The two sources of data yield significantly different estimates. With CHFC data, the Medicare and Medicaid shares are associated with significantly lower day service costs (26 percent and 35 percent, respectively), whereas the estimated coefficients are insignificantly different from zero with Medicare data. This suggests that hospitals with a relatively large share of cost-paying patients report relatively higher day service costs to Medicare than to CHFC. Assuming that it is costly to modify accounting costs reported to the two systems, it is reasonable that the cost of modification would be

\(^{1}\) Regressions not reported here show that for the laboratory, CHFC and Medicare data yield similar estimates of the effects of Medicare and Medicaid shares on costs and charges.
### Table 6

**Day Services and Total Operating Costs and Charges**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Day Services</th>
<th></th>
<th></th>
<th>Total Operating</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Costs (MCR)</td>
<td>Costs (CHFC)</td>
<td>Charges (CHFC)</td>
<td>Costs (MCR)</td>
<td>Charges (CHFC)</td>
</tr>
<tr>
<td></td>
<td>Coefficient</td>
<td>Coefficient</td>
<td>Coefficient</td>
<td>Coefficient</td>
<td>Coefficient</td>
</tr>
<tr>
<td></td>
<td>(t)</td>
<td>(t)</td>
<td>(t)</td>
<td>(t)</td>
<td>(t)</td>
</tr>
<tr>
<td>Intercept</td>
<td>6.06 (3.31)</td>
<td>5.55 (6.51)</td>
<td>2.037 (2.50)</td>
<td>7.453 (5.80)</td>
<td>6.138 (4.63)</td>
</tr>
<tr>
<td>Days</td>
<td>.737 (2.00)</td>
<td>.820 (4.78)</td>
<td>1.456 (8.87)</td>
<td>.616 (2.42)</td>
<td>.879 (3.35)</td>
</tr>
<tr>
<td>Days^2</td>
<td>.0078 (.41)</td>
<td>.0078 (.88)</td>
<td>-.022 (-2.61)</td>
<td>.015 (1.20)</td>
<td>.003 (.22)</td>
</tr>
<tr>
<td>%Staff, Surgeons</td>
<td>.053 (.16)</td>
<td>-.0044 (-.03)</td>
<td>.116 (.81)</td>
<td>.109 (.57)</td>
<td>.175 (.88)</td>
</tr>
<tr>
<td>%Staff, Internal Medicine</td>
<td>.392 (1.10)</td>
<td>.240 (1.45)</td>
<td>.320 (2.01)</td>
<td>.284 (1.36)</td>
<td>.266 (1.24)</td>
</tr>
<tr>
<td>%Staff, Pediatricians</td>
<td>.451 (.67)</td>
<td>.227 (.73)</td>
<td>-.066 (-2.22)</td>
<td>.688 (1.74)</td>
<td>.287 (.70)</td>
</tr>
<tr>
<td>%Staff, Ob/Gyn</td>
<td>-.433 (-1.11)</td>
<td>-.144 (-.79)</td>
<td>-.063 (-.36)</td>
<td>.287 (1.20)</td>
<td>.643 (2.61)</td>
</tr>
<tr>
<td>%Staff, Family or General Practice</td>
<td>-.435 (-2.03)</td>
<td>-.152 (-1.59)</td>
<td>-.011 (-.87)</td>
<td>-.096 (-.72)</td>
<td>-.096 (-.72)</td>
</tr>
<tr>
<td>Zero Dialysis</td>
<td>-.030 (-.58)</td>
<td>-.009 (-1.21)</td>
<td>-.049 (-2.13)</td>
<td>-.076 (-2.45)</td>
<td>-.104 (-3.25)</td>
</tr>
<tr>
<td>%Urban</td>
<td>.002 (.97)</td>
<td>.003 (3.23)</td>
<td>.003 (3.28)</td>
<td>.002 (2.23)</td>
<td>.002 (1.64)</td>
</tr>
<tr>
<td>North</td>
<td>.142 (2.43)</td>
<td>.083 (3.04)</td>
<td>.127 (.488)</td>
<td>.087 (2.69)</td>
<td>.098 (2.73)</td>
</tr>
<tr>
<td>For-Profit</td>
<td>-.007 (-.12)</td>
<td>.012 (.45)</td>
<td>-.009 (-.38)</td>
<td>.039 (1.15)</td>
<td>.084 (.424)</td>
</tr>
<tr>
<td>Government</td>
<td>-.215 (-2.02)</td>
<td>.070 (1.41)</td>
<td>-.021 (-.43)</td>
<td>.074 (1.19)</td>
<td>-.023 (-.35)</td>
</tr>
<tr>
<td>District</td>
<td>-.019 (-.28)</td>
<td>-.043 (-1.36)</td>
<td>-.072 (-2.38)</td>
<td>-.053 (-1.28)</td>
<td>-.111 (-2.60)</td>
</tr>
<tr>
<td>%Day Charges, Medicare</td>
<td>-.051 (-.27)</td>
<td>-.255 (-2.84)</td>
<td>-.128 (-1.49)</td>
<td>-.116 (-1.04)</td>
<td>-.122 (-1.07)</td>
</tr>
<tr>
<td>%Day Charges, Medicaid</td>
<td>.165 (.80)</td>
<td>-.348 (-3.62)</td>
<td>-.393 (-4.27)</td>
<td>-.239 (-1.95)</td>
<td>-.352 (-2.77)</td>
</tr>
<tr>
<td>Actual/limit Per Diem</td>
<td>.285 (2.88)</td>
<td>.228 (4.95)</td>
<td>.094 (.213)</td>
<td>.230 (3.83)</td>
<td>.134 (.821)</td>
</tr>
<tr>
<td>Hospital Labs in Zip</td>
<td>.006 (.27)</td>
<td>-.009 (-.86)</td>
<td>-.008 (-.76)</td>
<td>-.020 (-1.43)</td>
<td>-.011 (-.75)</td>
</tr>
<tr>
<td>MDs per capita</td>
<td>-11.88 (-.36)</td>
<td>9.299 (.61)</td>
<td>13.93 (.96)</td>
<td>2.663 (.14)</td>
<td>-0.886 (-.05)</td>
</tr>
<tr>
<td>Occupancy</td>
<td>-.0005 (-1.08)</td>
<td>-.0008 (-3.65)</td>
<td>-.0002 (-.86)</td>
<td>-.0005 (-1.79)</td>
<td>-.00001 (-.038)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.8993</td>
<td>.9781</td>
<td>.9832</td>
<td>.9600</td>
<td>.9595</td>
</tr>
</tbody>
</table>

*a Charge and cost coefficients significantly different at 5 percent level.

*b Charge and cost coefficients significantly different at 10 percent level.
Table 7
SUMMARY OF REIMBURSEMENT AND OWNERSHIP COEFFICIENTS
(Parentheses indicate coefficients are not significant at the 10 percent level)

| Variable | Laboratory<sup>a</sup> | | | | Day Services | | | | | | Total Operations | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Medicare Data | CHFC Data | Medicare Data | CHFC Data | Medicare Data | CHFC Data | CHFC Data | |
| %Medicare | .821 | .921 | .739 | .696 | (-.051) | -.255 | (-.128) | (-.116) | (-.122) |
| %Medicaid | .859 | 1.173 | .474 | .719 | (.165) | -.348 | -.393 | -.239 | -.352 |
| For-Profit | -.261 | (-.079) | -.179 | (-.055) | (-.007) | (.012) | (-.009) | (.039) | .084 |
| Government | -.268 | -.267 | (.215) | (.215) | -.215 | (.070) | (-.021) | (.074) | (-.023) |
| District | (-.01) | (-.139) | (-.110) | -.207 | (-.019) | (-.043) | -.072 | (-.053) | -.111 |
| North | .259 | .206 | .280 | .251 | .142 | .083 | .127 | .087 | .098 |

<sup>a</sup>Coefficients from equations including only %Medicare and %Medicaid as reimbursement variables.
incurred only where the payoff is large—i.e., where a large fraction of reimbursement is at stake.\(^1\)

Charges for day services (CHFC data) are significantly negatively related to the Medicare and Medicaid shares, contrary to predictions. The markup of charges over cost for day services is significantly positively related to the Medicare share, as predicted by the theory and found in the laboratory, but unrelated to the Medicaid share.

Aggregating over day services and all ancillary departments, CHFC data show no effect of the Medicare share, whereas the Medicaid share has a significant negative effect, greater for charges (-35 percent) than for costs (-24 percent). The difference between effects of Medicare and Medicaid suggests that factors other than simply the RCCAC cost reimbursement formula are being picked up by these variables, because the formula is identical except for pathologist remuneration. Other possible factors include difference in case mix, income, and other demographic characteristics of charge-paying patients in hospitals frequented by Medicare and Medicaid patients.\(^2\)

The pattern of ownership effects is also not the same in day services and total operations as in the laboratory. For day service costs, the CHFC data show no statistically significant differences by ownership type, whereas Medicare data show 21 percent lower costs in government hospitals. For day service charges, CHFC data show only district hospitals having significantly different (lower)

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\(^1\) Some difference in costs between the data sources is expected, because of differing accounting conventions. However, if hospitals respond uniformly or randomly to this difference, it would be reflected in the intercept of the regression and should not affect the coefficients of reimbursement variables.

\(^2\) The simple correlation between percent Medicare and percent Medicaid for laboratory charges is -.31, which confirms that Medicare and Medicaid patients are not randomly distributed across hospitals. The Medicaid share of day services is 38 percent in government hospitals, compared with 12 percent in nonprofit, 18 percent in for-profit hospitals. Corresponding Medicare shares are 27, 41, and 35 percent.
charges. For total operating costs, CHFC data show no significant
differences by ownership type, whereas for total operating charges,
for-profit hospitals have 8 percent higher charges and district
hospitals have 11 percent higher charges than nonprofits. Thus, the
markup of charges over costs is significantly positive in for-profits
and negative in government and district hospitals. To the extent the
difference in accounting profits is due to differences in charges,
not in costs, it is evidence against the hypothesis that all types
of hospitals compete in the same market for charge-paying patients
and that not-for-profit hospitals (including voluntary government
and district hospitals) disguise their potential profits in the form
of higher accounting costs.

Similarly, the effect of the North dummy on day services and
total operations does not support the conclusions suggested by the
laboratory data alone. Day service costs are only 8 percent higher
in the North, compared with 28 percent higher laboratory costs. Day
service charges are 13 percent higher in the North, compared with
23 percent higher laboratory charges. Total operating costs and
charges are 8-9 percent higher in the North, with no significant
effect on the markup of charges over costs. Thus, for the hospital
as a whole, there is no support for the hypothesis that a Medicare
carrier that pays charges has less incentive to hold down costs and
more incentive to hold down charges than a carrier that pays costs.
The cause of the real differences in hospital costs and charges
across departments in the North and South requires some other
explanation.
VIII. CONCLUSIONS

This study provides a theoretical and empirical analysis of the effects of Medicare reimbursement policies on hospital costs and charges. If reimbursement is based on costs, accounting costs reported for reimbursement purposes should be viewed as prices to cost-paying patients. Like any price, accounting costs will be optimized to maximize revenue. Accounting profits—the ratio of charges to costs—are not a measure of economic profit but simply the relative prices to charge-paying and cost-paying patients. If the demand of cost-paying patients is less elastic than the demand of charge-paying patients, then the unconstrained, profit maximizing hospital would report negative accounting profits. If the marginal cost of serving cost- and charge-paying patients is equal, an accounting profit ratio different from unity implies some cross subsidy between patient groups. However, it contains no information about economic profit or cross subsidy among services. For example, the fact that the laboratory typically reports positive accounting profits where the day service department typically reports an accounting loss, does not warrant the commonly drawn conclusion that the laboratory is being run at an economic profit to subsidize the day services. That may be true, but it cannot be inferred in the absence of data on economic costs.

The theoretical model of a profit-maximizing hospital serving both cost- and charge-paying patients yields the conclusion that charges to charge-paying patients for laboratory services will be higher than the simple profit-maximizing level on account of (1) the basic formula for determining Medicare's share of costs, (2) the ceiling on per diem rates, and (3) the constraint that Medicare pay the lesser of costs and charges. Reimbursement from Medicare is maximized by allocating as large a fraction of overhead cost as possible to departments in which the Medicare share of services is largest.
The empirical tests of these predictions are marred by data deficiencies. However, they support the general conclusion that costs are affected by reimbursement concerns and that the larger the fraction of laboratory services provided to Medicare and Medicaid patients, the higher are laboratory charges. This and the finding that laboratory charges are negatively related to the fraction of tests provided to outpatients are evidence that the demand for tests performed in hospital laboratories is not totally inelastic. The evidence from the day services department was not consistent, possibly because insurance coverage of day services is sufficient to make demand totally inelastic.\footnote{Data on insurance coverage are not available to test this hypothesis.}

The cost function estimates imply significant economies of scale in hospital laboratories (0.5). If that is accurate, there might be significant production cost savings if small hospitals pooled facilities or purchased tests from independent or large hospital laboratories. A net evaluation of the case for more pooling must await better data on laboratory output and some measure of the benefits, in terms of convenience and timeliness, of testing in-house. None of the hospitals in our sample reported pooling facilities. The data do not permit estimating the relative cost of purchased and in-house tests. It is also impossible to estimate the substitution parameters of the laboratory production function and the effects of different contractual arrangements with pathologists. There is some evidence that the measures of total costs and charges are affected by the types of contractual arrangements with HBPds. Because it is reasonable to expect the choice of contractual arrangements to be correlated with hospital size, reimbursement incentives, and ownership type, estimates of the effects of all these variables may be biased because HBP contractual arrangements cannot be accurately identified.

Ownership status does not affect total operating costs but does affect the allocation of the total among departments. In particular,
laboratory costs are significantly lower in for-profit than non-profit hospitals. For day services and total operating costs, there are no significant differences between for-profit and nonprofit hospitals. Because cost-based reimbursement creates incentives for all hospitals to report potential economic profit as accounting cost, accounting cost data cannot be used to compare the efficiency of different types of hospitals.

There are two main policy conclusions of this study. First, despite detailed reporting requirements by Medicare and the CHFC, the data available are inadequate to answer many simple questions relevant to reimbursement and analysis of hospital performance, even assuming reported data reflected economic reality. More fundamentally, the inevitable discrepancies between accounting and economic constructs are exacerbated by cost reimbursement. Cost reimbursement is intended to limit payment to economic cost, but accounting costs thereby become the price to cost-paying patients and subject to optimization. In the absence of prohibitively costly surveillance, basing reimbursement on "costs" rather than charges is unlikely to limit the amount billed to the opportunity cost of providing the services.
BIBLIOGRAPHY


