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THE EFFECTS OF GOVERNMENT REIMBURSEMENT ON HOSPITAL COSTS: SOME EMPIRICAL EVIDENCE FROM WASHINGTON STATE

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ABSTRACT

We use a panel of hospitals from Washington state to examine the impact of government reimbursement on a provider's costs. We find that providers change their relative patient mix when Medicare and Medicaid lower reimbursement rates. On a percentage change basis, the magnitudes of these changes are small; however, the overall economic impacts are quite large. Additionally, our findings indicate that a number of other factors significantly influence a provider's costs, including patient demographics, initial illness severity and input market conditions facing the firm.

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I. INTRODUCTION

Beginning in the early 1980's, government health insurance programs attempted to control rapidly increasing costs by implementing fee controls on health care providers. These fee controls have taken a number of forms, including prospective payment, RBRVS and capitation reimbursement. As a result, providers lost the ability to set prices for government insured patients, although they retained this ability for other patients. Moreover, as government insurers cut their reimbursement over the next ten years, providers became increasingly constrained (Dranove and White 1998).

A common impression is that, as providers became more constrained, they responded by either raising prices to non-government insured patients or lowering service intensity to some or all patients. The former response has come to be called "cost shifting," while the latter has been termed "cost adjusting." See Dranove (1988) or Rosenman, Li and Friesner (2000) for an overview of cost shifting. Dor and Farley (1996) and Friesner (2002) provide a review of the cost adjusting literature. Note that the distinguishing feature of cost shifting and cost adjusting (as opposed to price and service intensity discrimination) is that providers are motivated by the revenue constraint, not the opportunity to increase profit and prestige.

Most analyses of cost shifting, and cost adjusting have concentrated on investigating how a provider's profit status affects its behavior. Hay (1983) concluded that declines in government reimbursement induce cost shifting only if a profit-maximizing provider incurs diseconomies of scale in production. Rosenman, Li and Friesner (2000) found that a nonprofit provider cost shifts only when declines in government reimbursement cut revenues proportionately more than costs. Rosenman and Friesner (2002) found a similar condition for nonprofit service intensity adjustment, while a for-profit firm's cost adjusting behavior depends on the presence of economies of scale and economies of scope.

With a fixed patient mix, the revenue implications of cost shifting, and cost adjusting are quite clear. Lower government reimbursement translates into lower total revenue for the firm. However, whether or not the patient mix is static, the effects of lower government reimbursement on the total costs of a provider are not so clear. While most experts would agree that the firm has an incentive to lower its total costs, the exact mechanism underlying this incentive is ambiguous. For example, lower government reimbursement may force the firm to change its relative input mix. Alternatively, the firm may respond by changing the patients it treats. One possibility is to treat fewer patients, thereby moving down its marginal cost curve(s). Another response, if the firm considers different patient groups as separate outputs, is to change its relative patient mix, rather than its choice of inputs. There is a substantial empirical literature supporting the assertion that health care producers treat different patient groups as different outputs. Two examples are Friesner (2002) and Dor and Farley (1996). Understanding this mechanism has important implications for health policy. Changing relative input mix will likely lower quality, especially if the firm was already cost efficient. However, if the firm is cutting costs by changing its relative patient mix, the quality effect is not clear, and there is the possibility of a welfare transfer across different patient groups, something that has not yet addressed in the literature.

An additional concern is the magnitude of this incentive. If decreases in government reimbursement have little or no effect on total costs, then it is likely that the firm will cost shift or cost adjust. However, if government reimbursement has a substantial effect on costs, then cost shifting and cost adjusting are less likely, because the firm may be able to offset the revenue (and profit) reduction through cost savings.

The purpose of this paper is to empirically examine the effects of government reimbursement on a provider's (total) cost structure. To do so, we estimate an industry cost function for hospitals in Washington state. We can then test the effects of government reimbursement changes on the industry cost function using a two step process. First, we test whether any government insurer's reimbursement has an overall effect on costs:

H_O: *Government reimbursement has no effect on total cost.*
H_A: *Government reimbursement has an effect on total cost*

This is equivalent to placing a set of joint linear restrictions on the efficiency parameters of the model. If a government insurer's reimbursement does have a statistically significant (overall) effect on the cost function, we move to the second step. At least one of the efficiency parameters should be statistically different than zero. Thus, if we reject the null hypothesis, it becomes interesting to explore the signs and magnitudes of these incentives. Such an examination is easily accomplished by looking at the elasticity of cost with respect to each government insurer's reimbursement proportion (or discount to charges).

The remainder of this paper proceeds in four parts. First, we present the econometric methodology that we use to explore not only how a provider attempts to lower its total cost in response to decreases in government reimbursement, but also to determine the magnitudes of these incentives via cost elasticities. Then we discuss our data, which consists of a panel of general, non-specialty hospitals from Washington state. Third, we present and discuss the results of our empirical analysis. We conclude the paper by discussing the implications of our findings for policy and also present some suggestions for future research.

II. EMPIRICAL METHODOLOGY

Consider an industry (total) cost function with the following form:

$$C_{it} = f\,(Y_{1,it},\ldots, Y_{N,it}, W_{1,it}, \ldots, W_{M,it}, Q_{1,it}, \ldots, Q_{L,it}) \quad (1)$$

where C_{it} is total cost, i indexes each firm, t represents time, $Y_{1, it}, \ldots, Y_{N, it}$, are the firm's outputs, $W_{1, it}, \ldots, W_{M, it}$ are the firm's (real) input prices and $Q_{1, it}, \ldots, Q_{L, it}$ are exogenous factors that affect the efficiency of the firm. Under the hypothesis that providers change cost structures in response to decreases in government reimbursement, the Q's can be interpreted as the proportion of charges reimbursed by the government insurer. Since different government insurers have different reimbursement methods, we would like to have one Q for each government insurance plan. Additionally, we use the proportion of hospital charges reimbursed by the government insurer as a measure of Q because, while firms can set charges for all patient groups, the government insurer's actual reimbursement is independent of these charges. Finally, we restrict our analysis to government reimbursement (as opposed to private insurers' reimbursement) for two reasons. Unlike government insurers, private third-party payers usually must contract with the provider to obtain discounts to charges. Consequently, a provider may exert a substantial amount of control over the average reimbursement received for treating privately insured patients. Changes in reimbursement may not specifically be intended to force the provider to become more cost efficient. Additionally, while it is true that some non-government third party payers are attempting to implement reimbursement systems that mimic those of Medicare or Medicaid, the data do not allow us to distinguish between these private insurers and those that reimburse on a traditional discounts-to-charges basis. Since adding the private discounts to charges to our analysis would force us to make this distinction, we chose to abstract from this issue for simplicity.

Taking the log of (1), performing a second order Taylor series expansion and creating additive error terms, we derive a generalized version of the translog flexible functional form:

$$
\begin{aligned}
\ln(C_{it}) \;=\; & \alpha_0 + \sum_{n=1}^{N}\alpha_n \ln(Y_{n,it}) + \frac{1}{2}\sum_{h=1}^{N}\sum_{k=1}^{N}\alpha_{hk}\ln(Y_{h,it})\ln(Y_{k,it}) \\
& + \sum_{m=1}^{M}\beta_m \ln(W_{m,it}) + \frac{1}{2}\sum_{g=1}^{M}\sum_{f=1}^{M}\beta_{gf}\ln(W_{g,it})\ln(W_{f,it}) + \sum_{l=1}^{L}\gamma_l \ln(Q_{l,it}) + \frac{1}{2}\sum_{r=1}^{L}\sum_{s=1}^{L}\gamma_{rs}\ln(Q_{r,it})\ln(Q_{s,it}) \\
& + \sum_{n=1}^{N}\sum_{m=1}^{M}\delta_{nm}\ln(Y_{n,it})\ln(W_{m,it}) + \sum_{n=1}^{N}\sum_{l=1}^{L}\lambda_{nl}\ln(Y_{n,it})\ln(Q_{l,it}) \\
& + \sum_{m=1}^{M}\sum_{l=1}^{L}\pi_{ml}\ln(W_{m,it})\ln(Q_{l,it}) + \sum_{j=1}^{J}\phi_j X_j + \eta_i + \nu_t + u_{it}
\end{aligned}
\qquad (2)
$$

where X_j; j = 1, ..., J are a number of exogenous shifters, η_i is a firm specific effect, ν_t is a time specific effect and u_{it} is an error term with mean zero and constant variance. The Taylor expansion is taken around the points $\ln(Y_{n,it}) = 0$, $\ln(W_{m,it}) = 0$ and $\ln(Q_{l,it})$

= 0, for n = 1, ..., N; m = 1, ..., M and l = 1, ..., L. Specifying the firm specific effect is consistent with the notion that quality (which is unobservable and firm specific) has a substantial impact on a firm's total costs. Similarly, the time specific effect captures the mean level of technological progress (or regress). Given the nature of the data set we use, the time specific effect may also embody fluctuations in market conditions over the entire sample period. Cross symmetry implies that $\alpha_{hi} = \alpha_{ih}$, $\beta_{gf} = \beta_{fg}$ and $\gamma_{rs} = \gamma_{sr}$.

As noted in Christensen and Greene (1976), in order to correspond to a well-behaved production function, a cost function must be homogeneous of degree one in prices. This implies applying the following restrictions:

$$\sum_{m=1}^{M} \beta_m = 1 \tag{3}$$

$$\sum_{m=1}^{M} \sum_{l=1}^{L} \pi_{ml} = 0 \tag{4}$$

$$\sum_{g=1}^{M} \beta_{gf} = \sum_{f=1}^{M} \beta_{gf} = \sum_{g=1}^{M} \sum_{f=1}^{M} \beta_{gf} = 0 \tag{5}$$

We test the significance of imposing these restrictions and we fail to reject the null hypothesis that the restricted and unrestricted model parameter estimates are equal. In fact,
these restrictions are jointly insignificant at better than a 5 percent level of significance (F-test statistic 0.0001). Failing to reject this null hypothesis means that there is no reason to artificially impose their restrictions. Doing so is statistically irrelevant. Therefore, we present the unrestricted model.

We can test the effects of government reimbursement changes on the industry cost function using a two-step process. First, we must test whether any government insurer's reimbursement has an overall effect on costs. This can be accomplished via the following hypothesis test:

H_O: $\gamma_1 = \gamma_2 = ... = \gamma_L = \gamma_{11} = \gamma_{12} = ... = \gamma_{LL} = \lambda_{11} = \lambda_{12} = ... = \lambda_{NL} = \pi_{11} = \pi_{12} = ... = \pi_{ML} = 0$

H_A: At least one of these parameters does not equal zero.

That is, the null hypothesis that the government reimbursement plan has no effect on total cost is equivalent to placing a set of joint linear restrictions on the efficiency parameters of the model. If a government insurer's reimbursement does have a statistically significant (overall) effect on the cost function, at least one of those parameters should be statistically different than zero.

If we reject the null hypothesis, then it becomes interesting to explore the signs and magnitudes of these incentives. Such an examination is easily accomplished by looking at the elasticity of cost with respect to each government insurer's discount to charges:

$$\frac{\partial \ln(C_{it})}{\partial \ln(Q_{r,it})} = \in_{Q_r} = \gamma_r + \gamma_{rr}\ln(Q_{r,it}) + \sum_{s=1}^{L-1}\gamma_{rs}\ln(Q_{s,it}) + \sum_{n=1}^{N}\lambda_{nr}\ln(Y_{n,it}) + \sum_{m=1}^{M}\pi_{mr}\ln(W_{m,it}) \quad (6)$$

for every $r \neq s$.

However, because this is an aggregate compilation of estimated parameters (and data), it does not provide information concerning the effects of government reimbursement on specific inputs and outputs of the firm. Fortunately, the signs and magnitudes of these individual relationships can be calculated via second order effects on cost.

$$\frac{\partial^2 \ln(C_{it})}{\partial \ln(Y_{n,it})\partial \ln(Q_{l,it})} = \in_{Y_n Q_l} = \lambda_{nl} \quad (7)$$

for n = 1, ..., N and l = 1, ..., L

$$\frac{\partial^2 \ln(C_{it})}{\partial \ln(W_{m,it})\partial \ln(Q_{l,it})} = \in_{W_m Q_l} = \pi_{ml} \quad (8)$$

for m = 1, ..., M and l = 1, ..., L

A positive (negative) value for (7) indicates that decreasing the government reimbursement (i.e., increasing the discount) makes the firm more (less) cost responsive to changes in output $Y_{n,it}$. It is possible to interpret these impacts as changes in the slope of the marginal cost curve at any particular output. A positive (negative) value for (8) implies that decreases in the government reimbursement make the firm more (less) cost responsive to changes in input price $W_{m,it}$. This supplies some information about how changes in reimbursement affect how the cost curve shifts as input prices change.

As an alternative to equation (2), we employ a specification of the cost function that normalizes values around the sample mean. In estimating equation (2), the parameter estimates that contribute to the elasticities of cost in (3) may be insignificant. For example, if the estimate for γ_{ll} is not statistically different than zero, it is not clear whether the actual parameter value should be included in the elasticity calculation or whether a value of zero should be included in its place. In addition, since these elasticities are calculated as a linear combination of parameter estimates, they lack estimated standard errors, making it difficult, but not impossible, to determine their statistical significance. Normally, one can test for the joint significance of coefficient estimates by using an F-test. However, given the relatively large number of cost function parameters, this would require a large number of F-tests to be conducted, and much of this work is not automatically generated by standard statistical packages. Our approach provides results that are equivalent to those given by the F-test but does so in a way that allows standard statistical packages to automatically generate the results. We avoid these issues by re-specifying equation (2) as follows:

$$\begin{aligned}
\ln(\frac{C_{it}}{\overline{C}}) \;=\; & \alpha_0^* + \sum_{n=1}^{N}\alpha_n^* \ln(\frac{Y_{n,it}}{\overline{Y}_n}) + \frac{1}{2}\sum_{h=1}^{N}\sum_{k=1}^{N}\alpha_{hi}^* \ln(\frac{Y_{h,it}}{\overline{Y}_h})\ln(\frac{Y_{k,it}}{\overline{Y}_k}) \\
& + \sum_{m=1}^{M}\beta_m^* \ln(\frac{W_{m,it}}{\overline{W}_m}) + \frac{1}{2}\sum_{g=1}^{M}\sum_{f=1}^{M}\beta_{gf}^* \ln(\frac{W_{g,it}}{\overline{W}_g})\ln(\frac{W_{f,it}}{\overline{W}_f}) + \sum_{l=1}^{L}\gamma_l^* \ln(\frac{Q_{l,it}}{\overline{Q}_l}) + \frac{1}{2}\sum_{r=1}^{L}\sum_{s=1}^{L}\gamma_{rs}^* \ln(\frac{Q_{r,it}}{\overline{Q}_r})\ln(\frac{Q_{s,it}}{\overline{Q}_s}) \\
& + \sum_{n=1}^{N}\sum_{m=1}^{M}\delta_{nm}^* \ln(\frac{Y_{n,it}}{\overline{Y}_n})\ln(\frac{W_{m,it}}{\overline{W}_m}) + \sum_{n=1}^{N}\sum_{l=1}^{L}\lambda_{nl}^* \ln(\frac{Y_{n,it}}{\overline{Y}_n})\ln(\frac{Q_{l,it}}{\overline{Q}_l}) \\
& + \sum_{m=1}^{M}\sum_{l=1}^{L}\pi_{ml}^* \ln(\frac{W_{m,it}}{\overline{W}_m})\ln(\frac{Q_{l,it}}{\overline{Q}_l}) + \sum_{j=1}^{J}\phi_j X_j + \eta_i^* + \nu_t^* + u_{it}^*
\end{aligned}$$

(9)

The advantage of (9) is that:

$\in_{Q_l} \;=\; \gamma_l^*$ for l = 1, ..., L

(10)

$\in_{Y_n Q_l} \;=\; \lambda^*_{nl}$ for n = 1, ..., N and l = 1, ..., L

(11)

$\in_{W_m Q_l} \;=\; \pi^*_{ml}$ for m = 1, ..., M and l = 1, ..., L

(12)

As long as both (2) and (9) are evaluated at the sample mean, they will provide equivalent values. Note that since we are evaluating our elasticities and second order effects at the sample mean, this analysis is examining the effects of government reimbursement on the costs of the "average" health care provider, rather than for the individual hospitals in our data.

A final issue of interest concerns the treatment of the group specific and time specific effects. If the regressors in equation (9) include all important causal effects of total cost, then the group and time specific effects should have a zero mean and be uncorrelated with the regressors. In this case, it is appropriate to use a random effects/FGLS model, which treats the individual effects as such. However, if equation (9) omits important time or firm specific effects (such as quality, time-based market fluctuations and time based technological change), then these individual effects will carry a nonzero mean and will be correlated with the regressors. In this case, the results produced by FGLS will be inconsistent, and so it is appropriate to use a fixed effect/LSDV estimator, which provides consistent estimates in the presence of such correlation. Dranove and Cone (1985) have also shown that correlation between the time-specific error terms and the regressors (in our case, the government reimbursement variables) may be indicative of regression to the mean in costs. Thus, if the LSDV estimator is the more appropriate model, regression to the mean may be present in our sample. However, specifying the LSDV estimator should reduce these effects of this bias in our results. Because we believe that quality and time-based effects are important determinants of total cost, we specify the LSDV estimator and use the Hausman test (1978) to confirm our choice. This test operates under the null hypothesis of no correlation between the error terms and the regressors (i.e., both the LSDV and the FGLS estimators provide consistent estimates, but FGLS is efficient). Under the alternative hypothesis, the LSDV estimator provides consistent estimates, whereas FGLS does not. The test is based on the following statistic:

$$T = (\beta_{LSDV} - \beta_{FGLS})'(\Omega_{LSDV} - \Omega_{FGLS})^{-1}(\beta_{LSDV} - \beta_{FGLS}) \quad (13)$$

where β_{LSDV} and β_{FGLS} are Kx1 vectors of parameter estimates produced by the LSDV and FGLS estimators, respectively, and Ω_{LSDV} and Ω_{FGLS} are the estimated covariance matrices for each estimator. Under the null hypothesis, the test statistic is distributed as chi-square with K degrees of freedom.

III. DATA

The data used in this study consist of hospitals in Washington state. Each hospital submits and certifies a quarterly report of financial and utilization data to the Washington State Department of Health. All of the data used in this analysis comes from these reports for the years 1998 through 2001. There were 87 non-specialty hospitals in the complete sample; however, missing data left 81hospitals available for use in the analysis. Missing data resulted primarily from a hospital not treating patients within a particular group, indicating that excluded hospitals were smaller, rural hospitals. Out of these 81 hospitals, 4 are for-profit- while the remaining 77 are classified as nonprofit. Two for-profit providers are present in every quarter. The remaining two firms are present in 13 of the 16 quarters. Our rationale for including both for-profit and nonprofit firms in the same sample is twofold. First, our goal is to look at mean impact of government reimbursement on costs *within the industry*, which naturally includes both types of firms. Moreover, our results should be consistent even if we include both types of firms, since any significant mean differences in behavior between for-profit and nonprofit firms will be captured by the firm and time-specific effects.

Outputs were measured as total outpatient visits and total patient days. In Washington state, there are two primary government insurers: Medicare and Medicaid, each with its own reimbursement system. Consequently, we divided total patient days into three categories, Medicare and Medicaid patient days, and a group denoted as "other" which included all remaining patient days. Although it would be advantageous to categorize total outpatient visits in a similar manner; data limitations made doing so impossible. Thus, all outpatient days are treated as a single group. Our data set allowed us to construct a number of input prices. The price of labor was calculated as payroll and benefit expenses per paid hour. The price of capital was measured as the sum of interest and depreciation expenses per square foot of each facility. Finally, the price of supplies was measured as the sum of purchased supplies per licensed bed. The method we use to calculate our input prices is commonly employed in the health services research literature (for example, see Vita (1990) and Gertler (1988)). One drawback to using hospital-wide input prices is that they may be too aggregated, and thus may not give an entirely clear indication about how changes in government reimbursement cause aprovider to change its relative input mix within different cost centers of each hospital. However, since our goal is to determine if those changes within the hospital exist, and if we find those changes to be significant using aggregated, hospital-wide data, it will most certainly be the case for specific cost centers within the hospital. As a result, this drawback should not significantly impact our analysis, although it does present an area for future research. All prices were deflated using the producer price index to real, 1982 dollars.

Government reimbursement for each patient group was measured as the proportion of total charges reimbursed by Medicare and Medicaid. We measure government reimbursement as a proportion to reduce the effects of heteroskedasticity. The Washington State Department of Health provides a casemix index (on a yearly basis) for each firm as a measure of inpatient illness severity. These data are disaggregated by payer: Medicare, Medicaid, and total for all inpatients. In our analysis, we include the ratio of each of the government casemix indices to the overall hospital casemix. We use these variables as ratios to underscore the fact that Medicare and Medicaid patients are believed to be relatively more (or less) sick, and thus utilize relatively more (or less) resources, than the average hospital inpatient admission.

We also created three Herfindahl-like indices to control for the distribution of inpatient services across each type of hospital, as measured by the number of inpatient days for each patient group. In general, the data report four types of inpatient services that a hospital can provide: acute care, skilled nursing services, swing beds, and other inpatient services (including rehabilitation, chemical dependency, and psych wards). Thus, an index value close to 0.25 indicates a relatively even mix of patient days (per group) across each of the four services. On the other hand, a value close to one implies that the hospital allocates most of its inpatient days for that group (and, by proxy, most of its resources) to a particular type of service (usually acute care).

Finally, we add a number of demographic variables (on a per county and year basis) to account for potential differences in market structure across hospitals. These include variables relating to age (the number of minors and elderly), race (white, black, Native American, Asian, and Hispanic), and income level (average wage per job, converted to real, 1982 dollars using the consumer price index).

Table 1 contains the definitions and descriptive statistics for each of the variables used in this analysis. The average number of licensed beds is approximately 164, while the mean hospital casemix index is 0.88. On average, hospitals treated about 27,500

Table 1: Descriptive Statistics - All Firms

Variable	Mean	Std. Dev.	Minimum	1stQuartile	Median	3rd Quartile	Maximum
Total outpatient visits	27472.99	39183.42	445	6067.25	13677.5	35213.25	274592
Medicare patient days	2908.16	3298.91	2	423	1220	4900	17330
Medicaid patient days	1565.32	2030.39	3	232.25	869	2175.25	14173
Other patient days	2823.76	3707.68	4	429.5	1350.5	3777	24533
Proportion of charges paid by Medicare	0.61	0.13	0.03	0.52	0.61	0.7	1
Proportion of charges paid by Medicaid	0.55	0.18	0.01	0.44	0.54	0.67	1
Real operating costs	28750206	40430450	395121.87	2837887.22	13296163	35035648.03	247907374
Real price for supplies	12910.33	8901.42	133.47	5455.89	11651.9	17164.24	51513.29
Real price of capital	5.37	2.58	0.08	3.59	4.95	6.46	15.82
Real price of labor	20.21	3	9	18.28	20.59	22.04	29.23
Overall casemix index	0.88	0.25	0.42	0.71	0.83	0.97	1.7
Medicare casemix index	1.11	0.28	0.62	0.87	1.09	1.25	2.34
Medicaid casemix index	0.66	0.23	0.33	0.51	0.6	0.77	1.59
Ratio of Medicare casemix to total casemix	1.28	0.17	0.9	1.19	1.27	1.37	1.96
Ratio of Medicaid casemix to total casemix	0.75	0.13	0.49	0.67	0.72	0.81	2.02
Medicare Herfindahl-type index	0.76	0.21	0.34	0.58	0.76	1	1
Medicaid Herfindahl-type index	0.85	0.18	0.41	0.71	0.96	1	1
Other Herfindahl-type index	0.83	0.18	0.34	0.68	0.86	1	1
Minor population	112607.59	138661.78	573	12253	40222	167678	388384
Elderly population	50957.59	65531.87	492	5645	14768	57060	182526
Total population	471180.67	621965.81	2317	47475.25	137844	623984	1752492
White population	397796.94	504032.19	2293	43796	131031	560500	1415805
African-American population	25694.38	42126.86	0	260	1667	15647	117816
Native American population	9154.14	10646.94	12	932	4179	14369	33912
Asian population	47519.6	81999.18	11	798.5	3968	47546	244324
Hispanic Population	28475.52	33344.46	37	2734	12162	39542	101980
Real average wage per job	18004.56	4747.84	12114.64	14703.89	16078.64	20364.11	27616.39
Number of Observations	1036						

patients on an outpatient basis. Of particular interest is the distribution of inpatient services across each of our three patient groups. Medicare and non-government-insured patients each account for approximately 40 percent of total patient days, while Medicaid patients account for only about 20 percent. Our casemix statistics also indicate that, on average, Medicare and non-government insured patients are more ill than Medicaid patients. Moreover, Medicaid reimburses providers, on average, a lower proportion of billed charges than does Medicare (0.55 versus 0.61, respectively). The implication of this finding is that hospitals may be more constrained by treating Medicare patients than Medicaid patients. However, it remains to be seen whether this implication is borne out in the empirical analysis when we control for all other specified determinants of a provider's costs.

Table 2 breaks down the descriptive statistics by hospital size (as designated by Washington State Department of Health Peer Groups) into small firms, mid-sized firms and large firms. Small and mid-sized firms account for approximately 400 each of our observations, while large hospitals account for 233 of the observations. However, large firms account for over two-thirds of all outpatient visits, and approximately two-thirds of all patient days as well. While the magnitude of this dominance is large, the fact that large firms dominate the amount of care given to patients in Washington state is not at all surprising. More interesting comparisons occur when looking at elements other than overall workload.

Small hospitals receive a larger portion of charges paid by Medicaid (0.65) than do mid-sized (0.58) and large (0.59) hospitals. This is also true for the proportion of charges paid by Medicaid, although large hospitals (0.56) are closer to small hospitals (0.59) in this case, while mid-sized firms (0.50) lag further behind. This is somewhat surprising since the casemixes, in all categories, for small hospitals are lower than mid-sized, which are lower than large hospitals. It would seem that Medicare and Medicaid pay proportionately more for less sick than more sick patients.

Price variables indicate that it is less costly for smaller hospitals to buy labor and capital than mid-sized and large firms. The real price of labor is $18.19 for small hospitals, $21.02 for mid-sized, and $22.38 for large. Capital price has a similar ordering ($3.99, $5.90, and $6.88). These prices likely reflect the greater complexity of care provided (to the sicker patients, as indicated by the casemix index) in progressively larger hospitals. Labor costs also reflect the higher real average wage per job in the catchments areas of the hospitals. As would be expected, smaller hospitals deal with smaller total populations, and have a larger proportion of elderly in their service areas. What is not necessarily expected is that the proportion of the population in the county that is minority does not differ greatly by hospital size, although the make-up of the minority population does.

Table 2: Descriptive Statistics - By Firm Size

Small Firms

Variable	**Mean**	**Std. Dev.**	**Minimum**	**1stQuartile**	**Median**	**3rd Quartile**	**Maximum**
Total outpatient visits	8071.81	8029.71	445	3316	5159	9868	61593
Medicare patient days	661.82	793.85	46	269	426	679	4368
Medicaid patient days	978.82	1297.29	3	93	255	1776	6069
Other patient days	608.27	574.29	4	196	417	861	3785
Proportion of charges paid by Medicare	0.65	0.12	0.12	0.57	0.65	0.73	1
Proportion of charges paid by Medicaid	0.59	0.2	0.01	0.47	0.59	0.73	1
Real operating costs	4372151.7	4188494.4	395121.87	2016411.81	2520441.1	4976543.07	21029966
Real price for supplies	7170.75	5343.15	133.47	3323.1	5003.6	10282.85	32067.75
Real price of capital	3.99	1.75	0.53	2.87	3.77	5.03	11.47
Real price of labor	18.19	2.79	9	16.36	18.26	20.1	28.03
Overall casemix index	0.73	0.12	0.45	0.65	0.71	0.79	1.1
Medicare casemix index	0.89	0.13	0.62	0.8	0.85	0.99	1.14
Medicaid casemix index	0.57	0.17	0.33	0.45	0.52	0.61	1.47
Ratio of Medicare casemix to total casemix	1.24	0.18	0.96	1.1	1.21	1.36	1.7
Ratio of Medicaid casemix to total casemix	0.78	0.15	0.51	0.68	0.74	0.84	2.02
Medicare Herfindahl-type index	0.75	0.23	0.34	0.51	0.79	1	1
Medicaid Herfindahl-type index	0.93	0.12	0.5	0.94	1	1	1
Other Herfindahl-type index	0.87	0.17	0.44	0.75	0.99	1	1
Minor population	12208.48	10823.76	573	5151	10798	18034	70263
Elderly population	6261.47	4519.95	492	2716	5174	8802	25118
Total population	44513.16	34575.1	2317	19530	39566	66869	223253
White population	42031.09	32513.62	2293	18572	34816	65300	206757
African-American population	400.3	581.54	0	71	195	545	3462
Native American population	1684.92	2128.9	12	577	860	1535	13100
Asian population	806.25	961.72	11	225	494	982	4765
Hispanic Population	6667.26	12634.98	37	733	1774	6762	82332
Real average wage per job	14280.03	1155.35	12114.64	13261.25	14422.25	15083.9	16819.38
Number of Observations	407						

Mid-Sized Firms (Table 2: Continued)

Variable	**Mean**	**Std. Dev.**	**Minimum**	**1stQuartile**	**Median**	**3rd Quartile**	**Maximum**
Total outpatient visits	22507.76	17123.06	1105	10942.75	18003	28230.75	135041
Medicare patient days	2755.05	2047.78	145	950.5	2607	4429.5	9389
Medicaid patient days	980.15	760.43	56	378.25	822	1309.25	4463
Other patient days	2269.51	1801.53	26	931	1946	3184.25	10577
Proportion of charges paid by Medicare	0.58	0.12	0.03	0.5	0.58	0.66	0.94
Proportion of charges paid by Medicaid	0.5	0.14	0.05	0.41	0.5	0.58	0.99
Real operating costs	22507431	17781362	1033624.5	9461587.27	20484249	29126910.95	116416095
Real price for supplies	12993.44	5637.93	1444.31	9519.8	12439.28	16247.32	29578.64
Real price of capital	5.9	2.65	0.08	4.02	5.22	7.21	14.94
Real price of labor	21.02	2.11	13.42	20.07	21.07	22.32	29.11
Overall casemix index	0.85	0.14	0.42	0.76	0.87	0.95	1.08
Medicare casemix index	1.12	0.15	0.73	1.02	1.14	1.21	1.43
Medicaid casemix index	0.61	0.13	0.35	0.51	0.6	0.66	0.97
Ratio of Medicare casemix to total casemx	1.34	0.15	1.03	1.26	1.31	1.39	1.96
Ratio of Medicaid casemix to total casemix	0.72	0.12	0.49	0.65	0.69	0.8	1.04
Medicare Herfindahl-type index	0.77	0.22	0.35	0.59	0.79	1	1
Medicaid Herfindahl-type index	0.86	0.18	0.41	0.75	0.96	1	1
Other Herfindahl-type index	0.82	0.2	0.34	0.64	0.91	1	1
Minor population	137132.26	133544.74	11516	26967	70063	183130	388384
Elderly population	60252.05	63983.76	4144	14075	25174	70983	182526
Total population	566274.26	604828.27	46511	103467	235033	675962	1752492
White population	482845.6	487603.23	42738	99086	210612	565368	1415805
African-American population	28292.9	42000.6	127	1520	6890	54569	117816
Native American population	10492.85	10095.56	393	2262	7514	15320	33912
Asian population	54333.8	81033.28	619	2388	12661	51494	244324
Hispanic Population	31952.18	31015.81	1614	9811	18830	39542	101980
Real average wage per job	19579.95	4155.34	14596.76	15878.2	18033.92	20836.78	27616.39
Number of Observations	396						

Large Firms (Table 2: Continued)

Variable	**Mean**	**Std. Dev.**	**Minimum**	**1stQuartile**	**Median**	**3rd Quartile**	**Maximum**
Total outpatient visits	69801.35	61119.68	4733	36415.5	53395	88278	274592
Medicare patient days	7092.27	3719.33	2	4907	6083	8993.5	17330
Medicaid patient days	3584.36	3029.77	313	1340	2789	4661.5	14173
Other patient days	7635.72	4778.59	647	4379.5	7746	9409.5	24533
Proportion of charges paid by Medicare	0.59	0.15	0.15	0.49	0.59	0.68	1
Proportion of charges paid by Medicaid	0.56	0.18	0.04	0.45	0.53	0.68	1
Real operating costs	81943371	52655157	11985145	44309438.9	64348649	116629665.8	247907374
Real price for supplies	22794.87	9668.29	8476.79	15847.94	20305.67	27414.11	51513.29
Real price of capital	6.88	2.51	1.87	5.07	6.32	8.17	15.82
Real price of labor	22.38	2.45	16.87	20.73	22.05	23.55	29.23
Overall casemix index	1.19	0.26	0.76	1	1.14	1.43	1.7
Medicare casemix index	1.48	0.25	0.96	1.38	1.48	1.59	2.34
Medicaid casemix index	0.91	0.27	0.51	0.76	0.82	1.05	1.59
Ratio of Medicare casemix to total casemix	1.27	0.15	0.9	1.2	1.29	1.36	1.51
Ratio of Medicaid casemix to total casemix	0.76	0.11	0.51	0.68	0.74	0.8	1
Medicare Herfindahl-type index	0.74	0.17	0.39	0.61	0.74	0.86	1
Medicaid Herfindahl-type index	0.7	0.15	0.5	0.58	0.67	0.79	1
Other Herfindahl-type index	0.76	0.14	0.39	0.69	0.76	0.84	1
Minor population	246301.45	136182.27	52751	107077	194070	387132	388384
Elderly population	113235.34	67859.89	23041	52036	72832	182073	182526
Total population	1054857.1	651081.4	202264	418673	718521	1738916	1752492
White population	874695.79	513721.6	184163	396382	607376	1411131	1415805
African-American population	65461.22	46808.18	3447	9667	63601	115041	117816
Native American population	19925.99	10333.79	3323	10381	19919	33855	33912
Asian population	117536.4	99920.98	4050	12661	61909	237072	244324
Hispanic Population	60660.96	33876.63	9032	34669	70888	96258	101980
Real average wage per job	21833	5053.48	14596.76	17630.63	18531.94	27549.36	27616.39
Number of Observations	233						

Table 3 three breaks down the descriptive statistics by profit status into for-profit firms, private, nonprofit firms, and government firms. Private nonprofit hospitals are the largest in terms of workload, both for outpatients and inpatients. This is to be expected, given that most of the largest firms are in this category. For profit hospitals are larger on average than government hospitals, which tend to be in the smallest size category. For-profit and private nonprofit have similar overall casemix indices (0.95 and 0.97) compared to government hospitals (0.78). Private nonprofit and for-profit firms also have similar Medicare and Medicaid casemix indices, but government hospitals tend to treat less-sick patients in these categories as well as overall. Government hospitals also get a larger portion of billed charges paid by government insurers than do the other two categories, with for-profit hospitals lagging especially in payment for billed charges by Medicaid. Government firms have lower real price of capital ($4.49) than do private nonprofits ($6.04) or for-profit firms ($7.63). Labor costs are lower for government firms ($19.26) and for-profit firms ($19.82) than for private, nonprofit firms ($21.28). Government firms serve patients in areas that are more white and smaller than do the other two types of hospitals.

Table 3: Descriptive Statistics - By Profit Status

For-Profit Firms

Variable	Mean	Std. Dev.	Minimum	1st Quartile	Median	3rd Quartile	Maximum
Total outpatient visits	27876.81	17708.01	12293	13980	19708.5	49404.5	62413
Medicare patient days	2673.02	1600.36	312	1866.5	2602	4315.75	5499
Medicaid patient days	701.98	407.89	169	309.75	618	1037.75	1729
Other patient days	1430.4	741.66	26	668	1681	2004	2514
Proportion of charges paid by Medicare	0.54	0.09	0.34	0.47	0.54	0.6	0.78
Proportion of charges paid by Medicaid	0.44	0.16	0.05	0.38	0.45	0.55	0.91
Real operating costs	20226968	9583277.3	4724531.6	17523000.4	20792593	25325892.5	38557891
Real price for supplies	11477.08	3876.01	4836.21	9466.63	12028.17	14788.39	17165.74
Real price of capital	7.63	3.43	2.93	4.35	7.68	10.64	14.12
Real price of labor	19.82	1.61	17.39	18.66	19.59	20.13	24.65
Overall casemix index	0.95	0.23	0.56	0.93	0.98	1.16	1.22
Medicare casemix index	1.2	0.2	0.86	1.09	1.22	1.38	1.42
Medicaid casemix index	0.76	0.15	0.48	0.72	0.84	0.86	0.92
Ratio of Medicare casemix to total casemix	1.29	0.15	1.13	1.18	1.24	1.32	1.6
Ratio of Medicaid casemix to total casemix	0.81	0.1	0.64	0.71	0.85	0.88	0.98
Medicare Herfindahl-type index	0.64	0.18	0.41	0.51	0.56	0.67	1
Medicaid Herfindahl-type index	0.93	0.12	0.59	0.89	1	1	1
Other Herfindahl-type index	0.91	0.13	0.47	0.85	1	1	1
Minor population	151707.02	142227.85	52751	69388	70063	371288	388384
Elderly population	67953.4	71029.77	23041	24679	24956	181627	182526
Total population	626999.66	670124	202264	218808	222710	1654329	1752492
White population	526504.5	536039.38	184163	198857	206232	1359991	1415805
African-American population	32736.98	46886.93	3447	3462	3972	97734	117816
Native American population	14868.43	8976.63	3323	12297	13020	19919	33912
Asian population	62924.28	93246.69	4050	4153	7339	176685	244324
Hispanic Population	64089.29	30911.19	9032	69654	72561	82332	101980
Real average wage per job	18887.77	5198.47	14596.76	14703.89	16374.33	25860.63	27616.39
Number of Observations	58						

Private, Nonprofit Firms (Table 3: Continued)

Variable	Mean	Std. Dev.	Minimum	1stQuartile	Median	3rd Quartile	Maximum
Total outpatient visits	39309.17	49613.05	1329	12962.25	23425	45950	274592
Medicare patient days	4678.12	3756.25	2	1309.75	4301	6217.5	17330
Medicaid patient days	1942.91	1701.36	13	664.5	1321	2818.5	7775
Other patient days	4337.12	4340.45	67	1279.5	2887	6704.75	24533
Proportion of charges paid by Medicare	0.57	0.13	0.15	0.49	0.57	0.64	1
Proportion of charges paid by Medicaid	0.51	0.15	0.02	0.41	0.5	0.58	1
Real operating costs	45224497	47536924	1033624.5	15272101.4	28825315	56314264.48	247907374
Real price for supplies	15445.09	8352.33	2280.47	9744.58	14218.68	19312.28	51513.29
Real price of capital	6.04	2.29	1.87	4.58	5.3	7.15	15.82
Real price of labor	21.28	2.53	14.66	20.26	21.3	22.46	29.23
Overall casemix index	0.97	0.21	0.63	0.83	0.94	1.09	1.6
Medicare casemix index	1.25	0.27	0.73	1.08	1.19	1.42	2.34
Medicaid casemix index	0.71	0.22	0.36	0.55	0.64	0.82	1.56
Ratio of Medicare casemix to total casemix	1.29	0.12	0.98	1.23	1.29	1.35	1.6
Ratio of Medicaid casemix to total casemix	0.73	0.11	0.49	0.66	0.7	0.79	1.02
Medicare Herfindahl-type index	0.76	0.22	0.35	0.6	0.78	1	1
Medicaid Herfindahl-type index	0.8	0.18	0.41	0.62	0.85	1	1
Other Herfindahl-type index	0.77	0.19	0.34	0.63	0.78	1	1
Minor population	152656	143585.44	5021	19145.25	106918	326983.5	388384
Elderly population	69308.81	68646.64	3208	10714	50707	154428.25	182526
Total population	640830.24	652564.78	20487	68990	409736	1420377	1752492
White population	539323.85	524431.54	20076	67195	385450	1171837.25	1415805
African-American population	36960.19	45665.99	57	1141	7494	89200.75	117816
Native American population	12239.66	11148.51	327	2750	10112	20191	33912
Asian population	65225.86	89875.85	118	1417	12661	147991	244324
Hispanic Population	35467.65	35025.17	388	8704	15176	70888	101980
Real average wage per job	19315.02	4694.79	13085.63	15556.33	17718.75	24645.78	27616.39
Number of Observations	472						

Government Firms (Table 3: Continued)

Variable	Mean	Std. Dev.	Minimum	1stQuartile	Median	3rd Quartile	Maximum
Total outpatient visits	16385.84	23694.61	445	3669	7577	14416.75	113672
Medicare patient days	1284.09	1810.7	46	295.75	483.5	1058.5	8050
Medicaid patient days	1312.07	2333.96	3	121.75	355	1650.5	14173
Other patient days	1571.8	2570.42	4	279	636	1441.75	15196
Proportion of charges paid by Medicare	0.66	0.12	0.03	0.58	0.66	0.74	1
Proportion of charges paid by Medicaid	0.6	0.19	0.01	0.48	0.6	0.74	1
Real operating costs	14359856	27616639	395121.87	2145096.27	3762111.3	10832734.16	140792019
Real price for supplies	10710.17	9194.63	133.47	3664.3	7843.42	14926.02	47258.3
Real price of capital	4.49	2.38	0.08	2.86	3.95	5.57	14.94
Real price of labor	19.26	3.2	9	17.31	19.39	21.34	28.03
Overall casemix index	0.78	0.24	0.42	0.66	0.75	0.83	1.7
Medicare casemix index	0.97	0.24	0.62	0.81	0.92	1.09	1.97
Medicaid casemix index	0.6	0.23	0.33	0.47	0.54	0.63	1.59
Ratio of Medicare casemix to total casemix	1.28	0.21	0.9	1.15	1.25	1.4	1.96
Ratio of Medicaid casemix to total casemix	0.77	0.15	0.51	0.68	0.73	0.82	2.02
Medicare Herfindahl-type index	0.77	0.21	0.34	0.58	0.77	1	1
Medicaid Herfindahl-type index	0.89	0.16	0.5	0.83	1	1	1
Other Herfindahl-type index	0.87	0.16	0.44	0.74	0.93	1	1
Minor population	70768.42	120272.28	573	5648	16970	40941	388384
Elderly population	31891.32	55899.13	492	3883.75	8760	14882	182526
Total population	295069.8	533114.7	2317	20944	64690	137844	1752492
White population	251026.71	435341.15	2293	19930	60062	131031	1415805
African-American population	14378.3	34517.48	0	86	545	1783	117816
Native American population	5620.94	9063.83	12	671	1502	4607.5	33912
Asian population	29237.34	67898.3	11	290	982	4207	244324
Hispanic Population	17871.01	26882.82	37	1496	5678	21598	101980
Real average wage per job	16680.91	4375.19	12114.64	13921.31	15031.98	20055.83	27616.39
Number of Observations	506						

IV. EMPIRICAL RESULTS

The results from the cost function estimation are shown in Table 4. Of primary interest are the effects of government reimbursement on the cost function. We first tested the joint restriction (as stated in the empirical methodology) that these variables have no overall effect on the industry cost function using a standard F-test. The calculated F-statistic takes a value of 7.51, which rejects the null hypothesis at a 5% level of significance (The restricted model carries an R^2 value of .997918 with 144 estimated parameters (892 degrees of freedom). Thus, we can conclude with at least 95% certainty that the cost of the average provider in this sample responds to changes in government discounts to charges.

Table 4: Cost Function Estimation

Coefficient	Est. Value	Std. Error	T-Ratio
Panel A. Cost Function			
Total outpatient visits	0.0541***	0.0193	2.79
Medicare patient days	0.0893***	0.0236	3.77
Other patient days	0.0318*	0.0167	1.90
Medicaid patient days	0.0509***	0.0152	3.34
Proportion of charges reimbursed by Medicare	-0.1143***	0.0227	-5.04
Proportion of charges reimbursed by Medicaid	-0.0258**	0.0130	-1.98
Real price for supplies	0.2439***	0.0252	9.67
Real price for capital	0.0321**	0.0158	2.03
Real price for labor	0.3230***	0.0599	5.39
Panel B. Output/Discount Cross Products			
Medicaid patient days * Proportion of charges reimbursed by Medicare	0.0077	0.0179	0.43
Medicare patient days * Proportion of charges reimbursed by Medicare	-0.0133	0.0138	-0.95
Medicaid patient days * Proportion of charges reimbursed by Medicaid	-0.0274***	0.0083	-3.29
Medicare patient days * Proportion of charges reimbursed by Medicaid	0.0057	0.0114	0.49
Total outpatient visits * Proportion of charges reimbursed by Medicaid	-0.0051	0.0122	-0.41
Total outpatient visits * Proportion of charges reimbursed by Medicare	-0.0274	0.0240	-1.14
Panel C. Price/Discount Cross Products			
Real price of labor * Proportion of charges reimbursed by Medicare	0.0869	0.1181	0.73
Real price of labor * Proportion of charges reimbursed by Medicaid	0.0624	0.0646	0.96
Real price of supplies * Proportion of charges reimbursed by Medicare	-0.0761***	0.0287	-2.64
Real price of supplies * Proportion of charges reimbursed by Medicaid	-0.0259	0.0202	-1.27
Real price of capital * Proportion of charges reimbursed by Medicare	0.0383*	0.0224	1.70
Real price of capital * Proportion of charges reimbursed by Medicaid	-0.0075	0.0177	-0.42
Panel D. Price/Output Cross Products			
Real price for supplies * Other patient days	0.0304**	0.0139	2.19
Real price of capital * Total outpatient visits	-0.0023	0.0126	-0.17

Table 2. Cost Function (Continued)	Est. Value	Std. Error	T-Ratio
Real price of capital * Medicare patient days	0.0006	0.0168	0.03
Real price of capital * Medicaid patient days	0.0329***	0.0121	2.72
Real price of capital * Other patient days	-0.0392***	0.0137	-2.84
Real price of labor * Total outpatient visits	0.0396	0.0589	0.67
Real price of labor * Medicare patient days	0.1492***	0.0473	3.15
Real price of labor * Medicaid patient days	-0.1202***	0.0363	-3.31
Real price of labor * Other patient days	0.0604	0.0466	1.29
Real price of supplies * Total outpatient visits	-0.0211	0.0176	-1.19
Real price of supplies * Medicare patient days	-0.0303**	0.0141	-2.14
Real price of supplies * Medicaid patient days	0.0511***	0.0111	4.58
Panel E. Price Cross Products			
Real price of labor * Real price of supplies	-0.0567	0.0698	-0.81
Real price of Labor * Real price of capital	0.2544***	0.0743	3.42
Real price of supplies * Real price of capital	-0.1049***	0.0215	-4.87
Panel F. Output Cross Products			
Total other patient days * Medicare patient days	0.0397*	0.0222	1.78
Total other patient days * Medicaid patient days	0.0381***	0.0122	3.11
Total outpatient visits * Medicaid patient days	-0.0242***	0.0092	-2.63
Total outpatient visits * Total other days	0.0266***	0.0095	2.79
Medicare patient days * Medicaid patient days	-0.0289***	0.0076	-3.79
Medicare patient days * Total other patient days	-0.0501***	0.0092	-5.40
Medicare patient days * Total outpatient visits	0.0000	0.0000	0.73
Medicaid patient days * Total other patient days	-0.0445***	0.0067	-6.68
Panel G. Discount Cross product			
Prop. reimbursed by Medicare * Prop. reimbursed by Medicaid0.0731*	0.0375	1.95	
Panel H. Control Variables			
Ratio of Medicare CMI to hospital-wide CMI	0.0497	0.0690	0.71
Ratio of Medicaid CMI to hospital-wide CMI	-0.0386	0.0342	-1.13
Medicare Herfindahl type index	0.0391	0.0239	1.63
Medicaid Herfindahl type index	0.0299	0.0321	0.93

Table 2. Cost Function (Continued)	Est. Value	Std. Error	T-Ratio
Other patient days Herfindahl type index	-0.0703**	0.0284	-2.47
Average wage per job per county divided by annual cpi	0.3303**	0.1437	2.29
Number of minors	0.1412	0.1827	0.77
Number of elderly	0.2529***	0.0950	2.66
White population	-0.7780**	0.3642	-2.13
Black population	-0.1424***	0.0211	-6.73
Native American population	0.1119***	0.0277	4.03
Asian population	0.1054***	0.0256	4.12
Total Hispanic population	-0.0331	0.0261	-1.26
Constant	0.9749	2.9110	0.33
Panel I. Second Order Conditions			
Total outpatient visits squared	0.0192	0.0168	1.14
Medicare patient days squared	0.0318***	0.0084	3.77
Other patient days squared	0.0593***	0.0081	7.36
Medicaid patient days squared	0.0266***	0.0094	2.84
Proportion of charges reimbursed by Medicare squared	-0.1470***	0.0446	-3.29
Proportion of charges reimbursed by Medicaid squared	-0.0251*	0.0139	-1.79
Real price for supplies squared	0.1243***	0.0256	4.86
Real price for capital squared	0.1055***	0.0276	3.82
Real price for labor squared	-1.0017***	0.2885	-3.47

Notes: ***denotes significance at the 1 percent level, **5 percent level, and * 10 percent level.
R-squared = 0.998224; Adjusted R-squared = 0.99789;
number of observations = 1036; parameters estimated = 164.

In this model, there are 16 time-specific estimates, 81 group-specific estimates, an overall intercept estimate and 66 slope coefficient estimates (165 total estimated parameters). However, this specification also leads to perfect multicolinearity because the time-specific effects and the firm-specific effects each sum to one. To avoid this problem, we impose the restriction that the sum of the group specific effects equals the sum of the time specific effects equals zero: $\sum_{l=1}^{81} \eta'_i = \sum_{l=1}^{16} \nu'_t = 0$. Thus, the number of estimated parameters is reduced by one, to 164.

Having determined that government reimbursement, on aggregate, does have a significant, average impact on hospital costs, we can go further to examine how individual variables impact costs. Of particular interest for policy reasons are the elasticities of cost with respect to Medicare and Medicaid reimbursement. The results from Table 4, Panel A show that each has a significant, negative effect on total cost, and the magnitude of the effect is nearly 4 times greater for Medicare compared to Medicaid (-0.1143 and -0.0258, respectively). These results give two important findings. First, lower government reimbursement as a proportion of total charges actually leads to *higher* total hospital costs, holding all other specified regressors constant. And while the magnitudes of these elasticities are quite small, they actually result in very large changes in costs, on total. For example, a one percent reduction in Medicare reimbursement (as a percentage of total charges) increases total hospital costs by 11.43%. However, since real costs, on average, are approximately $28.75 million, this results in a total increase in expenses of almost $3.3 million. This implies that not only is cost shifting occurring, but the magnitude of cost shifting is quite large. (Friesner and Rosenman (2003, 2004) found evidence of cost adjusting and cost shifting in Washington state hospitals, although their panels covered a different time period than the one used in this study.) Second, hospital costs are much more responsive to changes in Medicare reimbursement than Medicaid reimbursement. The latter implies that the magnitude of cost shifting is much more pronounced for Medicare than for Medicaid patients. Given the fact that hospitals are more reliant on Medicare patients and are reimbursed a smaller proportion of billed charges, this finding is not surprising.

From a policy perspective, this finding has far reaching implications. Government policy makers, often concerned about the direct costs of the programs they administer, ratchet down (prospective) reimbursement rates. Hospitals, concerned about revenue, raise overall charges, so the government proportion of billed charges might fall. But total costs go up, so from a global perspective, rather than from the perspective of the individual government program, the policy is ineffective. More insightful government policymaking should be concerned with the external effects of decisions made within their programs, and our findings indicate some other policy avenues could be more effective. But clearly, just lowering the proportion of billed charges reimbursed by government insurance does not lead to lower overall hospital costs. The elasticities of cost with respect to the patient day variables are all statistically significant, but quite modest. These elasticities range from 0.0318 for other patient days to 0.0893 for Medicare. Again, however, these elasticities translate to large real total operating cost effects for the average firm, ranging from $914,256 for other patient days to $2,567,392 for Medicare. The elasticity of cost with respect to outpatient visits is also statistically significant, with an elasticity of 0.0541. With the exception of capital, the elasticities of cost with respect to the input prices are much greater: supplies 0.2439 ($7,012,173); capital 0.0321 ($922,881); and labor 0.3230 ($9,286,314).

Since the joint restriction indicated that overall government reimbursement affected cost, we looked further. Government reimbursement may have an indirect effect on costs through its impact on the way providers respond to changes in either their relative patient mix or relative input prices. Table 4, Panel B details the cross effects of output variables with respect to the proportion of charges reimbursed by the government. There are two, mathematically symmetric ways to look at these cross effects. The first is to suppose that costs respond to government reimbursement and use the estimates to see how changes in other variables, for example, the number of Medicare patient days, affects that responsiveness. But since we are looking for indirect effects, we choose to interpret the estimates from the alternative perspective -- how changes in the government reimbursement affect the response of cost to patient days.

With this interpretation, the cost elasticity with respect to Medicaid days is smaller when the portion of charges reimbursed by Medicaid is larger. Increases in Medicaid reimbursements induce hospitals to be less cost responsive to changes in Medicaid patient days. However, the magnitude of this effect is quite small (-0.0274), indicating that providers are not very responsive in this way. In contrast, the corresponding elasticities for Medicare were statistically insignificant, as well as the effect of both forms of government reimbursement on total patient visits.

It is interesting to pause and consider why Medicaid reimbursement has a significant effect on Medicaid patient days, while Medicare did not. From Table 1 we see that total Medicare patient days are, on average, almost twice as large as total Medicaid days, while the proportion of charges reimbursed by Medicaid is less than that of Medicare. Thus, we suggest two effects. The larger number of Medicare patients makes it more difficult for hospitals to adjust costs, regardless of the magnitude of the Medicare reimbursements, and since Medicare reimbursements are higher, there is less incentive to do so.

Table 4, panel C, presents the cross elasticities of cost with respect to the government reimbursement variables and the input prices. The cross elasticity with respect to the Medicare reimbursement is significant for real price of capital. Although this effect is again small (0.0383), it does indicate that responsiveness of cost to the price of capital increases with Medicare reimbursement. In addition, hospitals are less responsive to higher real prices for supplies as Medicare reimbursements increase, as evidenced by a cross elasticity of -0.0761. The cross elasticities of cost with respect to Medicaid reimbursement and the input prices were not significantly different than zero (at a 95% level of confidence or better).

Table 4, panel I, presents the second order conditions for the primary variables. Of particular interest in this set of estimates is how the influences of charge reimbursement by Medicare and Medicaid changes on the margin. Both of these parameter estimates are negative and statistically significant (although Medicaid is only significant at the 10 percent level). Thus, although lowering the reimbursement rate increases costs, it does so at a decreasing rate, indicating that the ability to cost shift diminishes as the reimbursement rate falls.

Table 4, panel H summarizes the effects of our demographic control variables on cost. Larger elderly, Asian and Native American populations (on a percentage basis) increase hospital costs, while larger white populations reduce hospital costs. Higher income levels within the county and year also lead to higher costs, presumably because higher income communities are less reliant on Medicare and Medicaid insurance. A one-percent increase in the number of minors has no significant impact on hospital costs, while, somewhat surprisingly, a one percent increase in the black population causes significantly lower hospital costs.

Important other estimates in Table 4, Panel H provide evidence about how the mix of services and patient illness severity impacts costs. The illness severity of Medicare and Medicare patients (relative to all patients) did not significantly impact costs. Additionally, the distribution of beds across the four types of inpatient services was insignificant for all but the non-government insured group. This indicates that the distribution of services provided to Medicare and Medicaid patients has no impact on costs after controlling for the other regressors in the cost function. However, a more skewed distribution of services actually reduces costs for non-government patients.

A final issue of interest is the significance of the group specific and time specific effects. As stated in the empirical methodology, if these effects are not correlated with the regressors, then the random effect model provides efficient estimates and should be utilized. However, if there is correlation between the individual effects and the regressors, then the random effect model provides inconsistent estimates, and the fixed effect (LSDV) model should be used. This is an important issue in our study, because if quality and time-based market fluctuations (which are unobserved and included in the fixed effects) are important determinants of a provider's cost, then they should be correlated with input prices, outputs and (possibly) the government reimbursement variables. We used the Hausman test to check. The calculated test statistic takes a value of 293.10, which easily rejects the null hypothesis of no correlation at better than a 5% level of significance.

Consequently, these results support (but do not prove) our assertion that quality and time do matter in a provider's total cost structure. Additionally, this result raises the possibility that regression to the mean in costs may still be a substantial problem in Washington state hospitals. We also tested whether the time-specific effects were statistically significant determinants of a firm's total costs. Employing an F-test (under the null hypothesis of no time-specific effects) we obtained an $F_{15,873}$-statistic of 7.55, which easily rejects the null hypothesis at a 5% level of significance. Thus, if there is correlation between the regressors and the error terms (as shown by the Hausman test), the results of the F-test provide supporting evidence that the time-specific effects are contributing to this result, possibly because of regression to the mean in costs. In any case, our decision to use the LSDV estimator was a correct one.

V. CONCLUSIONS

An estimated cost function for hospitals in Washington state allowed us to examine the individual effects of government reimbursement on the behavior of the hospitals. We found that, overall, changes in Medicare and Medicaid reimbursement have a statistically significant impact on costs in Washington state hospitals. Using cross-effects of cost with respect to outputs and input prices separately with government reimbursements, we were able to develop some understanding of the nature of the relationship between changing reimbursements and costs. Increasing the Medicaid reimbursement rate makes hospitals less cost responsive to Medicaid inpatient days. We would expect, given these findings, that changes in government reimbursement, especially by Medicaid, may induce hospitals to try to change their patient mix.

We also found that changes in Medicare reimbursement made costs less responsive to the prices of supplies, but more responsive to the price of capital. This indicates that hospitals may respond to changes in Medicare reimbursement by altering their relative input mix, particularly their capital and purchased materials. The ability to do so in response to changes in Medicare reimbursements but not to changes in Medicaid reimbursements may be attributable to the greater share of hospital business that is paid by Medicare.

In addition, we found the magnitudes of our elasticities to be quite small; however, given the large total costs of a hospital, our findings are economically significant. For example, the effect of a change in the proportion of charges reimbursed by Medicaid on Medicaid patient days is -0.0761. This translates to a reduction in total real operating costs for the average hospital of $2,187,890.

Our findings have some important policy implications. The empirical analysis implies that decreases in government reimbursement increase total hospital costs, indicating the likelihood of cost shifting. Thus, as a policy tool, government enforced discounts to charges should be used with caution. Government policy makers concerned may impose a detrimental incentive on health care costs in general. From a societal perspective the policy is undesirable. Because of the changes in patient mix that also accompanies changes in government reimbursement, the overall effect is uncertain, and it may be that total costs fall if government insurance pays a greater share of the billed charges because less cost shifting is more efficient, and the patient mix also allows hospitals to increase efficiency, lowering total costs.

A bigger question arises as managed care and other institutional structures in the private insurance market push for similar discounts to charges. If we extrapolate from what was found for Medicare discounts, which has approximately the same share as private payers, this is a failed policy for controlling overall hospital costs, although the managed care providers may achieve cost savings. But our findings indicate the gain comes from cost shifting. As a greater share of charges are prospective, the ability to cost shift falls. As a result, hospitals will simply become less financially viable, putting at risk the current healthcare system.

While our analysis provides some useful implications for public policy, it is intended as a first step, and our results should be viewed with caution. Our study is exploratory in nature and should be considered only as a partial correlation analysis. Thus, it is important that future research develop (and test) a theory governing the *causal* relationship between government reimbursement and a provider's cost structure. Another drawback of our analysis is that we utilize hospital-wide data. As a result, our study may suffer from the aggregation bias described in Dranove (1988). Repeating this same analysis at the level of the cost center would provide an invaluable contribution to the literature.

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