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WORK OF MAYO AND MCFARLAND

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Regulation, Market Structure, and Hospital Costs:

A Comment on the Work of Mayo and McFarland

by

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I. Introduction

In a recent paper in the **Southern Journal of Economics**, Mayo and McFarland [12] claim to have shown that Certificate of Need (CON) regulation has successfully reduced both the number of hospital beds and hospital costs in recent years. If correct, this finding would be significant news. Over the past fifteen years, at least fifteen other studies have examined the effects of Certificate of Need regulation.[2] While a few of these studies have found that CON regulation has reduced the number of hospital beds, none has found that CON regulation was effective in reducing the costs of health care.[3] Indeed, the evidence that CON has not been effective is so pervasive that even proponents of health planning have begun to admit that CON has not reduced costs.[4]

Mayo and McFarland suggest that they are making two contributions to the analysis of the effects of CON regulation. First, they claim to have used a more general model of the effects of these regulations.

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[2] These studies are (1) Anderson and Kass [2], (2) Coelen and Sullivan [3], (3) Cohodes [4], (4) Eastaugh [5], (5) Farley and Kelly [6], (6) Hellinger [7], (7) Joskow [8], (8) Joskow [9], (9) Lee, Birnbaum, and Bishop [11], (10) Noether [13] and [14], (11) Policy Analysis, Inc., and Urban Systems Research and Engineering, Inc. [15], (12) Salkever and Bice [16] and [17], (13) Sherman [18], (14) Sloan [20], and (15) Sloan and Steinwald [21] and [22]. (Where the same research is reported in two places, I have counted this as a single study.)

[3] Studies finding a reduction in hospital beds include Salkever and Bice [16] and [17] and Joskow [8]. Sloan and Steinwald ([21] and [22]) on the other hand found that CON regulation resulted in an increase in the number of hospital beds, particularly during the period between enactment of the regulations and when they became effective.

[4] See Kimmey [10].

Second, they claim to have developed a novel dataset. In fact, the model used by Mayo and McFarland precludes the kinds of effects found by other researchers. Further, there are a number of problems with the dataset they use in their work. When these problems are corrected, we find results consistent with those reported by other researchers: CON regulation leads to an increase in costs, not a decrease.

In the next section, we discuss the problems with the Mayo-McFarland approach in greater detail. In section III, we present the results of our own estimation of the effect of CON regulation on hospital costs. Our conclusions are found in section IV.

II. Problems with the Model and Data Used by Mayo and McFarland

Because the hospital industry has not been in long run equilibrium in recent years, Mayo and McFarland use a two-equation model to estimate the effects of CON regulation, rather than estimating a long-run hospital cost function. Their model consists of a short-run cost function and a second equation, based on a queuing theory model, that explains the quantity of beds a hospital will operate.[5] The model they estimate is

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[5] One of the key variables in determining the number of beds a hospital will choose to operate is the average daily census of the hospital. Mayo and McFarland appear to use a hospital's current average daily census in estimating this equation. However, if the hospital industry is not in long-run equilibrium, current data on average daily census will not be equal to the average daily census for which the hospital was designed. As a result, there may be problems in the estimation of the beds equation similar to those that would result in estimating a long run cost function.

$$TVC_i = \alpha_0 + \alpha_1 \; PD_i + \alpha_2 \; PD_i^2 + \alpha_3 \; WAGE_i + \alpha_4 \; WAGE_i^2 + \alpha_5 \; BEDS_i$$
$$+ \alpha_6 \; BEDS_i^2 + \alpha_7 \; PD_i{*}BEDS_i + X\beta + \epsilon$$
$$BEDS_i = (ADC_i)^{1/2} \; (\delta_0 + \delta_1 \; REG_i + \delta_2 \; HERF_i + \delta_3 \; MDP_i) + \epsilon'$$

In the first equation, TVC_i is the variable costs of hospital i; PD is patient days of care -- the measure of hospital output; WAGE is a wage variable, BEDS is the number of beds in the hospital and is the measure of the hospital's capital stock; and X is a vector of other variables that may affect a hospital's costs. In the second equation, ADC is the hospital's average daily census, REG is a variable denoting the stringency of CON regulation, HERF is the Herfindahl index of concentration, and MDP is the number of doctors per capita.[6]

Note that, in these equations, any effect of CON regulation on costs must work through the number of beds the hospital operates. There is no way for CON to have a direct effect on the short run cost function. According to Mayo and McFarland this is desirable because they "more realistically recognize that any effects, if they exist, of CON regulation occur through the effects of the regulation on capital expansion." Formulating the effect of CON regulation in this way assumes that hospitals denied approval for a desired project will not substitute some other expenditure for the one denied. However, a hospital adds new beds or undertakes other capital projects in order to improve its quality and its ability to attract physicians and patients.

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[6] Mayo and McFarland are somewhat unclear about whether this variable is the total number of doctors practicing in a market area or physicians per capita. In the text the variable is described as the number of doctors. However, in their Table 1, they define the variable as physicians per capita.

If the hospital finds it is not possible to improve its quality by undertaking certain projects because of CON constraints, they may seek other, perhaps more expensive or less effective, ways of achieving the same end.[7]

Certificate of Need regulation may also force hospitals to expend resources in complying with regulatory requirements in order to obtain project approvals. This could also affect a hospital's costs. Finally, if CON regulation reduces the competitive pressure on incumbent hospitals, some of these hospitals may not operate as efficiently as possible. Clearly, therefore, any study that hopes to capture the real effects of CON regulation needs to allow for the possibility that the costs of providing hospital care are affected in ways other than just through an effect on the number of beds.

Mayo and McFarland's measure of the stringency of Certificate of Need regulation poses another problem. Their stringency variable is based on the share of applications that are approved by the CON authorities. Such a measure would be useful if the total number of applications filed could be assumed to be exogenous. Unfortunately, this is not the case; the number of applications filed can be affected

[7] Indeed, previous studies of CON regulation have found evidence consistent with the existence of such substitutions. Salkever and Bice ([16] and [17]) found no significant relationship between total hospital assets and the presence of CON regulation. However, they found that CON was associated with lower levels of new bed construction and higher rates of investment in assets per bed. On net, this suggests a substitution from beds to other forms of capital. Sloan and Steinwald ([21] and [22]) found that hospitals subject to CON regulation tended to have higher employment levels than comparable unregulated hospitals, suggesting a substitution of labor inputs for restricted capital. Similarly, Sherman [18] found that variable costs were significantly higher where CON regulation was more stringent, while CON stringency had no significant effect on total costs.

by the CON review process. If hospitals realize that they are unlikely to receive approval, they may abandon a desirable project even before filing for CON approval or may withdraw plans prior to a final decision. Alternatively, an applicant may continually resubmit denied applications in the hope that the application eventually will be approved.[8] Several firms may also file competing applications where everyone knows that only one project will be approved, or even that the market can support only one project. When a regulatory system like CON means that the successful applicant will be able to earn rents -- or receive a "franchise value" -- from the project, it would not be surprising to see competition for project approvals.[9]

That Mayo and McFarland only consider hospitals in the State of Tennessee may create a related problem. Variation in the stringency of Certificate of Need is obtained by looking at the rate of project approvals in different health service areas (HSAs) in the state, as well as looking at variations across time. However, it is not clear that differences across HSAs in a state are indications of differences in regulatory stringency. All areas of the state are covered by the same state CON statute and indeed all CON approvals are made by the same state agency -- the Tennessee Health Facilities Commission (THFC). Further, the decisions of the THFC can be appealed in the courts,

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[8] See Joskow [9], p. 98.

[9] See In the Matter of Hospital Corporation of America, Opinion of the Federal Trade Commission, 106 F.T.C. 361 at 495 (1985).

requiring that the THFC make decisions in a consistent fashion if they wish to avoid being overturned.[10,11]

III. Respecification and Reestimation of the Mayo and McFarland model

In this section, we report the results of reestimating the Mayo-McFarland model allowing for the possibility that hospitals substitute other expenditures when the CON authority disallows a project. We use the same model as Mayo and McFarland, except where differences are

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[10] For a brief discussion of the CON approval process in Tennessee, see In the Matter of Hospital Corporation of America, Opinion of the Federal Trade Commission, 106 F.T.C. 361 at 490 (1985).

It is possible that local boards within each HSA made recommendations concerning project approvals to the THFC during part of the period covered by Mayo and McFarland's data. While neither the current Tennessee CON statute nor the statute in place in 1985 appear to provide a role for such local boards (106 F.T.C. 361 at 490 (1985) and Tenn. Code Annotated 68-11-101 to 111 (1987)), the federal statute mandating CON appears to have required such boards. (Joskow [9], p. 80) However, since final decisions were made by state agencies and were subject to court review, it is unlikely that the presence of these boards should have caused significant regional differences in final decisions.

[11] Another, less serious, problem results from the approach used by Mayo and McFarland to account for changes in hospital utilization that resulted from the adoption of a prospective payment system (PPS) for hospital payments under Medicare in 1983. Mayo and McFarland introduce a dummy variable (DRG) into their short-run cost equation that shifts the total variable costs of each hospital by a constant amount. According to their estimated cost equation, the costs of each hospital increased by $1.7 million after the PPS system was introduced. However, it seems unlikely that the effect of such a change was independent of hospital size or the number of patients treated. Indeed, the evidence suggests that the greatest impact of the shift to PPS was a reduction in the average length of stay in the hospital. (See American Hospital Association [1]) Since patients probably require more intensive, and therefore more costly, care during the first days of hospitalization, the best way to treat the effect of PPS on hospital cost is to interact the dummy variable with the days of care provided. At a minimum, one should differentiate the effect based on the size of the hospital -- i.e., the number of beds in the hospital.

noted.[12] The most important difference is that we allow the short run cost function to be affected by CON regulation. Further, we examine the effects of CON using variations across states, where variations can clearly occur, and using a variable of CON stringency which avoids the problem of the endogeneity of the number of applications filed.

The cost data used here are for 3,680 short-term general acute care hospitals for the 12 month period ending September 1984.[13] Our measure of CON stringency is the number of years that CON had been in place in a state.[14] This variable is denoted CONAGE. We would readily admit that this measure does not capture all of the variation in the effects of CON across states. However, it does capture one important aspect of stringency: If CON regulation is restricting hospital behavior we would expect the effect to increase the longer the

[12] In particular, we follow their practice of using only a single measure of hospital outputs. This is done for consistency with their work rather than because we necessarily believe it is the appropriate way to measure hospital outputs.

[13] The dataset was developed by Sherman for his study of the effects of CON [18]. There were 3,716 hospitals included in the Sherman dataset. However, on examination, it appeared that data for a few hospitals was either misreported or miscoded. (Similar errors seem to arise in Mayo and McFarland's data, though nothing appears to have been done about the problem. Mayo and McFarland report the minimum value for their WAGE variable as $122.88, hardly a plausible value for an average annual wage.) Because such errors appeared to be present, we eliminated a few observations. Specifically, we eliminated hospitals where the reported average annual salary for nurses was less than $7,000 or more than $50,000. Similarly, we deleted observations where average variable cost per patient day was less than $100 or more than $900. Our results, however, would not have differed in any significant way if these observations had not been eliminated.

[14] This data is taken from Simpson [19]. While Idaho and New Mexico ended CON regulation of hospitals during 1983, the measure of CON stringency for hospitals in these states does not reflect this change since any repeal in CON laws would take several years to affect hospital performance.

regulations have been in effect. Further, our measure avoids the problems with the Mayo and McFarland measure discussed above.

We enter the effect of CON regulation into our cost function both linearly and multiplied by the number of patient days of care provided. It seems reasonable to assume that any effect of CON will be greater in larger hospitals. This formulation allows for such an effect.

Other variables in our model are generally defined similarly to those used by Mayo and McFarland, though they differ in minor ways. Our wage variable is the average wage of nurses in a particular institution, rather than the average wage of all employees.[15] By reducing the types of employees included in the wage measure, we should reduce the amount of variation resulting because different hospitals use types of employees in different proportions. Our beds variable is the average number of beds set up and staffed, rather than the number of licensed beds. Our variables differentiating types of hospitals follow Sherman [18] and differ from those used by Mayo and McFarland. These variables -- PROFIT, NONFED, TEACH1, TEACH2, and TEACH3 -- are defined, along with the other variables in our model in Table 1.

Our results are reported in Table 2 for the cost equation and in Table 3 for the beds equation. Looking first at the cost equation, CON regulation is found to have a significant effect on hospital variable costs. Variable costs are increased by more than $175,000 plus about

[15] Our wage variable is calculated as total nursing wages paid by the hospital divided by the sum of full time equivalent registered nurses (RNs) plus full time equivalent licensed practical nurses (LPNs). Full time equivalents are equal to the sum of full time nurses plus one-half of part time nurses.

Table 1
Description of Variables

Variable	Description	Mean	Minimum	Maximum	Standard Deviation
ADC	Average daily census of the hospital.	125.80	2	1306	143.22
BEDS	The average number of beds staffed and operated by the hospital.	183.21	6	1846	179.03
CONAGE	The number of years since a state enacted its first CON statute.	9.98	0	20	4.13
HERF	The Herfindahl measure of concentration in a Health Service Area (HSA), based on the average number of beds set up and staffed during the year.	0.1137	0.0228	1.0000	0.0739
MDP	Physicians per capita.	0.0019	0.0011	0.0056	0.0005
NONFED	A variable equal to one if a hospital is operated by a state or local government; otherwise equal to zero.	0.2696			
PD	Adjusted patient days of care provided by the hospital.	53926.33	721	54117	61028.77
PROFIT	A variable equal to one if a hospital is operated by a for-profit firm; otherwise equal to zero.	0.1196			
TEACH1	A variable equal to one if a hospital has an approved residency program but is not affiliated with a medical school; otherwise equal to zero.	0.0144			
TEACH2	A variable equal to one if a hospital is associated with a medical school but is not a member of the Council of Teaching Hospitals (COTH); otherwise equal to zero.	0.0927			

Table 1 (Continued)

Variable	Description	Mean	Minimum	Maximum	Standard Deviation
TEACH3	A variable equal to one if a hospital is a member of COTH; otherwise equal to zero.	0.0679			
TVC	Total variable cost.	21465016.79	312141	350918385	28873169.09
WAGE	Nursing wage paid by the hospital.[1]	2102.89	7083	49715	5929.82

[1] WAGE is calculated as total nursing wages divided by full time equivalent registered nurses (RNs) plus full time equivalent licensed practical nurses(LPNs).)

Table 2
Estimated Coefficients of Hospital Short Run Cost Function[a]

Dependent Variable - TVC

Independent Variable	Coefficient	t-Statistic
Constant	-7813630	
PD	34.0779	1.63
PD^2	-0.000728	-2.37 **
WAGE	114.063	1.09
$WAGE^2$	0.003494	1.63 *
BEDS	100038	14.72 ***
$BEDS^2$	-234.181	-6.35 ***
PD*BEDS	1.0274	4.84 ***
PROFIT	554487	1.31
NONFED	805684	2.56 **
TEACH1	1620380	1.47
TEACH2	2799120	5.36 ***
TEACH3	18698900	26.63 ***
CONAGE	176874	3.96 ***
PD*CONAGE	0.798	1.57
R^2	0.927	
F	3348.61 ***	

[a] Significance levels are denoted as follows:
* denotes a coefficient is significant at the 10 percent level,
** denotes a coefficient is significant at the 5 percent level, and
*** denotes a coefficient is significant at the 1 percent level.

Table 3
Estimated Coefficients of Hospital Beds Equation[a]

Dependent Variable = BEDS

Independent Variable	Coefficient	t-Statistic
$ADC^{1/2}$	19.896	42.83 ***
$ADC^{1/2}$*HERF	5.038	3.35 ***
$ADC^{1/2}$*CONAGE	0.0500	1.47
$ADC^{1/2}$*MDP	379.931	1.37
R^2	0.812	
F	5287.79 ***	
n	3680	

[a] Significance levels are denoted as follows:
* denotes a coefficient is significant at the 10 percent level,
** denotes a coefficient is significant at the 5 percent level, and
*** denotes a coefficient is significant at the 1 percent level.

$0.80 per patient day for each year CON has been in effect.[16] Evaluating these effects at the average value of CONAGE and PD for hospitals in our sample, the average effect of CON is found to be an approximately 11 percent increase in average variable cost.

Other coefficients in the cost equation are generally significant and consistent with those found by Mayo and McFarland. The coefficient on the linear PD term and the coefficients on the linear and quadratic WAGE variables are not significant at conventional five or one percent levels. However, F-tests for the joint significance of the linear and squared terms show that both PD and WAGE are significant at the one percent level.[17] In addition, hospitals that have greater teaching responsibilities have higher costs.

Looking at the beds equation, we see greater differences between our results and those obtained by Mayo and McFarland. Most notably, our results suggest no relationship between CON regulation and the number of beds a hospital has. In addition, we find no relationship, controlling for average daily census, between number of beds and the number of doctors per capita.

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[16] While the coefficient of PD*CONAGE is not significantly different from zero, we have continued to use it in our analysis because it seems likely that the effects of CON should be greater in larger institutions. Further, the lack of significance may be the result of multicollinearity between this variable and the variables PD, BEDS, and PD*BEDS. The correlation between PD and PD*CONAGE is 0.88. The correlation between BEDS and PD*CONAGE is 0.82, while that for PD*BEDS and PD*CONAGE is 0.81. Finally, some preliminary evidence suggested that the effect of CON may rise more rapidly at lower levels of PD. The total effect of CON is not significantly changed, however, in the more complicated model.

[17] The value of the F-statistic for the joint significance of PD and PD^2 is 6.57. The value for WAGE and $WAGE^2$ is 80.87.

There is one other aspect of the effect of CON regulation that deserves consideration. To this point, we have presented evidence that CON regulation increases a hospital's costs of providing any quantity of care. That is, looking at Figure 1, the average cost curve is shifted upward from AVC_1 to AVC_2. However, the objective of CON regulation was to reduce excess capacity in hospitals. Thus, a test of whether CON regulation has achieved its goals should involve a test of whether CON is associated with a movement along the average cost curve with firms operating closer to the bottom of their average cost curves. For example, if CON is effective, a firm subject to CON regulation should be expected to be at a point like A rather than B in Figure 1.[18]

To examine this question, we look at the reduction in average variable cost (AVC) that would result if a hospital had a 10 percent increase in the number of patient days of care offered, holding constant the number of beds. For many of the hospitals in our dataset, such an increase in output would be associated with a significant decline in AVC. For example, a 10 percent increase in quantity of care provided would cause an approximately five percent decline in AVC for the average hospital in our sample.[19]

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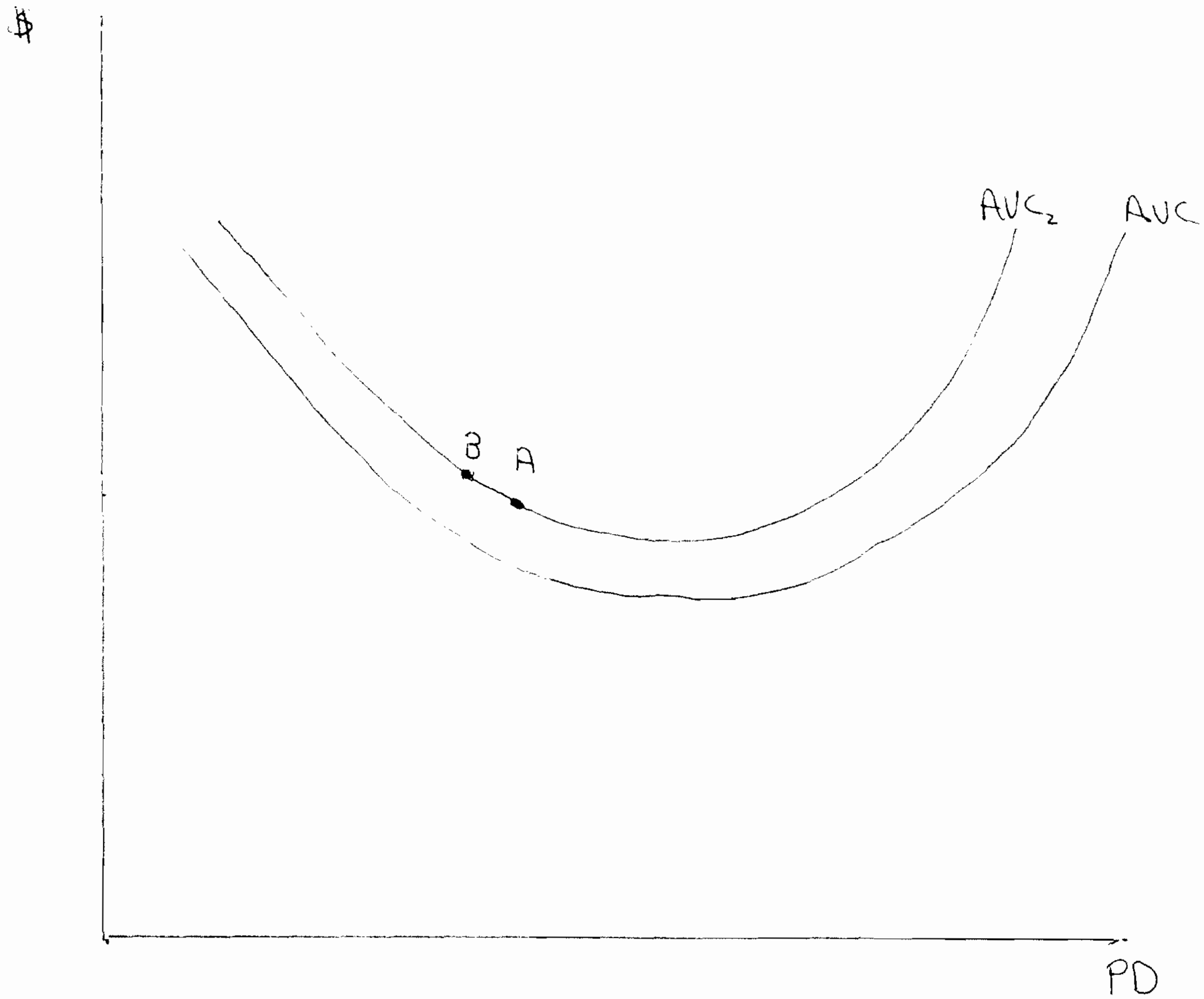
[18] This point seems to have been missed by most economists studying CON regulation. With the exception of Anderson and Kass [2], none of the existing studies examine this issue.

[19] AVC declines from an estimated value of $346.93 to $328.83. The t-ratio for the significance of this change in AVC is 12.84. In this computation, we assume the hospital has the average values of PD and BEDS, pays the average value of nursing wages and has had CON regulation for 9.98 years. In addition, we assume that the hospital is not a teaching hospital nor is it for-profit or operated by a state or local government.

That there should be significant cost savings associated with output expansion is not surprising given the decline in hospitalization

Figure 1

Average Variable Cost



To determine whether more stringent CON regulation is associated with hospitals operating at a more efficient point on their AVC curve, we estimated the change in predicted AVC that would result from a 10 percent increase in output for each hospital in the sample (dAVC). These estimated changes were then correlated with our measure of CON stringency (CONAGE). If CON is effective in inducing hospitals to operate at a more efficient point on their AVC curves, there should be a significant negative correlation between CONAGE and dAVC, as hospitals that had been subject to CON regulation for a longer period of time would have smaller gains from increases in output. However, the correlation between CONAGE and dAVC is a positive 0.163. On average, hospitals in states that have had CON laws longer would gain more, not less, from an increase in the number of patient days of care provided. Thus, our data provides no support for the hypothesis that stringent CON regulation is effective in achieving more of available short run economies of scale in hospitals.

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in the United States in the last ten years. Between 1975 and 1986, per capita days of hospital care fell by more than one-third. As a result, hospital occupancy rates are quite low. The average occupancy rate for the hospitals in our sample is only 59.1 percent. Less than two percent of the hospitals were operating at more than 90 percent of capacity.

The low occupancy rates may be responsible for one strange attribute of our estimated cost function. Because of the negative sign on the coefficient of the square of patient days, the estimated cost function has no minimum value. Rather, it continues to fall as output rises. (The cost function estimated by Mayo and McFarland also has a negative coefficient on this parameter.) The failure to estimate a function with a minimum may be the result of the few observations in the range where capacity constraints would cause average variable costs to turn upward.

IV. Conclusion

In this paper, we have pointed out several problems with the approach used by Mayo and McFarland in attempting to estimate the effectiveness of Certificate of Need regulation. When we attempt to rectify these problems and reestimate the effects of these regulations, we get results that differ substantially from those reported by Mayo and McFarland: Rather than finding that CON is effective in containing health care costs, we find that costs are higher where CON is more stringent. Further, we find no evidence that more stringent CON regulation is associated with greater realization of available economies of scale.

Our finding that variable costs are higher where CON regulation is more stringent is consistent with earlier findings and therefore we have no reason to doubt the correctness of this result. On the other hand, there may be some reason to question our finding that CON has not been effective in reducing the number of hospital beds. As we noted, hospitalization rates have fallen dramatically in recent years and therefore hospital occupancy rates are generally quite low. In such an environment, it is unlikely that the majority of hospitals would be seeking approval to add new capacity. Thus, while CON may be limiting bed construction in particular areas where hospitals wish to undertake new construction, there may be no general effect detectable with a cross-sectional regression analysis. This may explain why we find no effect of CON stringency on the quantity of beds, whereas earlier researchers have found that CON may be effective in this area.

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