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Hospital response to prospective payment: Moral hazard, selection, and practice-style effects

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Abstract

In response to a change in reimbursement incentives, hospitals may change the intensity of services provided to a given set of patients, change the type (or severity) of patients they see, or change their market share. Each of these three responses, which we define as a moral hazard effect, a selection effect, and a practice-style effect, can influence average resource use in a population. We develop and implement a methodology for disentangling these effects using a panel data set of Medicaid psychiatric discharges in New Hampshire. We also find evidence for the form of quality competition hypothesized by Dranove (1987).

JEL classification: I11; I18

Keywords: Hospital behavior; Moral hazard; Payment systems; Mental health; Medicaid

1. Introduction

Interpretation of changes in hospital behavior in response to new financial incentives, such as a shift to prospective payment, is difficult because of the multiple incentives created by payment changes. In this paper we focus on three possible responses by hospitals to changes in incentives. One response is that

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hospitals supply more or fewer services to a given type of patient, which we label here the supply side ''moral hazard'' effect. The second response by hospitals is to change the average severity of patients seen, what we call a ''selection'' effect. The third response is a change in market shares. Changes in the share of patients treated at different hospitals will have implications for average resource use if there are practice-style differences across facilities; hence we call this a ''practice-style'' effect. Based on a simple model of hospital behavior, these three effects fall out of a total derivative of average LOS (resource use) with respect to a reimbursement change, as we show below.

It is well documented that in the two years after 1983, Medicare's average length of stay (LOS) per discharge at hospitals paid under PPS (primarily short term, acute care general hospitals) fell sharply in relation to its trend (Coulam and Gaumer, 1991, Gold et al., 1993). Also notable is that the number of discharges at PPS facilities decreased, and that the market share of Medicare discharges at hospitals not paid by PPS increased (Hodgkin and McGuire, 1994). The concurrence of these effects makes it impossible to interpret the reduction in LOS as a simple moral hazard effect: the average severity of patients paid under PPS could have gone up or down after the change.

Much of the previous econometric research on PPS and similar policies for other populations has tried to estimate a moral hazard effect. Cutler (1991) and Hadley et al. (1989) study the effect of the level of prospective payment on resources per discharge, while Freiman et al. (1989) found that the shift to PPS reduced LOS for psychiatric patients in Medicare by about 15%. Frank and Lave (1989) used cross-sectional differences in state Medicaid programs to estimate a similar LOS reduction for psychiatric patients. Possible selection effects were not addressed in any of these studies.

Other research on Medicare populations has attempted to estimate selection effects. Newhouse and Byrne (1988) argue that some of the decline in LOS after PPS is due to the shift of more severe cases (proxied by cases with a LOS greater than 60 days) to facilities not paid by PPS. Carter et al. (1991), however, document that the average PPS-paid patient is getting sicker in terms of case mix as measured by the diagnosis-related group (DRG). Russell and Manning (1989) also present evidence that the average hospital patient actually got sicker after PPS as less severely ill patients were shifted to outpatient care; if this is the case, then the moral hazard effect of PPS would be understated by a simple pre/post comparison of LOS. Newhouse (1989) confirmed a selection effect by finding that PPS discharges for which the payment was relatively less generous began showing up in public hospitals (which Newhouse defined as ''last-resort'' hospitals) after PPS. Cutler (1991), however, found no evidence of changes in the aggregate number of admissions in one state in response to prospective payment. Dranove's model predicts that hospitals will expand their supply in the DRGs where they enjoy the largest price-cost margin, but this pattern has yet to be found empirically (Dranove, 1987).

For this paper we examine changes in hospital treatment patterns resulting from a natural experiment in which financial incentives were changed for a set of non-Medicare patients. The state of New Hampshire replaced a cost-reimbursement system with a per-discharge payment for psychiatric care in its Medicaid program in January, 1989. New Hampshire sought to divert patients from its state hospital (supported by a direct budget allocation) to private hospitals paid by Medicaid, and to simultaneously introduce incentives for efficiency in the private sector. We hypothesize that the changes in incentives may have all three of the effects on hospital behavior.

Section 2 describes the policy change in New Hampshire. Section 3 sets out the model we use to estimate separately the effects of moral hazard, practice-style, and selection. Section 4 describes the data, which include five years of New Hampshire Medicaid data spanning the payment system change, and pertinent data from related sectors of the health care system. Section 5 presents a series of regressions, first estimating the "total effect" of the payment system and then decomposing this change into that attributable to selection, moral hazard, and change in the composition of hospital practice style. In our most preferred specification, we include person-level fixed effects to control for unobserved patient characteristics, and provider fixed effects to control for practice style. We also investigate whether quality competition of the kind proposed by Dranove (1987) is evident in our data. Section 6 concludes the paper with a brief discussion of the main findings.

2. The policy change

In January 1989, New Hampshire Medicaid stopped reimbursing hospitals based on allocated costs, instead adopting a system of per-discharge payments according to the patient's Diagnosis Related Group (DRG). [1] For psychiatric DRGs, Medicaid divided hospitals into three peer-groups, aiming, after a phase-in period, to reimburse each hospital according to the average experience of its peer-group. The idea was for payments to recognize that there were systematic differences across types of hospital in the severity and costliness of patients treated that were not captured by the DRG classification. Furthermore, using peer-group averages with small numbers of hospitals in the peer group moderates the incentives associated with a prospective payment system, in a way we will explain.

[1] The New Hampshire system, in contrast to Medicare, is not fully prospective, but has an element of a "mixed system", paying partly prospectively and partly on the basis of costs. See McGuire et al. (1990) for a description of the rate setting methodology, and Ellis and McGuire (1993) for a discussion of "mixed systems".

The three peer-groups are:

- Designated Receiving Facilities (DRFs) are general hospitals or private psychiatric hospitals with units created under contract with New Hampshire's Department of Mental Health and Developmental Services (DMH). DRFs are secure units able to treat the most severely ill patients, and are capable of seeing virtually any patient formerly treated in the state hospital. There are three DRFs. [2]
- Distinct Part Unit hospitals (DPUs) are general hospitals with qualified psychiatric units. There are eight DPUs.
- Scatterbed hospitals treat psychiatric patients in general medical beds (scatterbeds). Seventeen hospitals treated Medicaid psychiatric patients only in scatterbeds over this period.

A large share of psychiatric discharges for Medicaid psychiatric patients took place at the state hospital before and after the payment change. The average LOS at the state hospital is much longer than the average LOS for the private facilities. There was no change in the manner in which the state hospital was paid for the discharges we study below.

New Hampshire calculated first-year rates such that the overall payment system would be roughly "budget neutral". In other words, historical allocated costs under the old payment system were used to set prospective rates for the new system. Experience with the Medicare system and subsequently in New Hampshire bears out the conclusion that this is a generous way to calculate hospital rates because hospitals respond to the change by reducing costs. Hospital rates for the same DRG differed by peer group. Because of historically different patterns of care and patient mix, payment to a DRF for a patient classified into a schizophrenia DRG were three times higher than payment for the same DRG in a scatterbed hospital (about $7,000 compared to $2,200). A DPU was paid at a rate falling between the DRFs and scatterbed hospitals.

The "generosity" of a price per discharge will differ for patients with a low expected cost and a high expected cost. Part of a hospital's change in supply might therefore be to make its service more attractive to patients with a low expected cost and less attractive to patients with a high expected cost. A larger moral hazard response should be expected in supply of LOS to patients with a longer LOS. [3]

Selection was an important and explicit element of the New Hampshire policy. By paying the private hospitals in a generous fashion, the state sought to encourage them to take patients who would have formerly been seen at the state

[2] The DRFs were the only peer group allowed a multi-year transition to prospective rates, during which each hospital would be paid partly based on its own historic costs, and partly on the peer-group average. The weight on own costs was 50% in 1989–90, 25% in 1991 and zero thereafter.

[3] Incentives that a prospective payment system creates for a hospital to engage in service competition of this type are discussed in Ellis (1993), Hodgkin and McGuire (1994), Ma (1994) and Rogerson (1994).

hospital. By paying DRFs and DPUs more than scatterbed hospitals, the state encouraged treatment for psychiatric patients in private hospitals with specialized (but more costly) facilities.

Based on this discussion, we hypothesize that the introduction of the discharge-based payment system in New Hampshire will have the following effects:

- Controlling for patient severity, the LOS of patients in the private hospitals will fall (moral hazard).
- The average (unmeasured) severity of patients in the private hospitals will increase (selection).
- The destination of some patients will shift from the public hospital to private hospitals and from less generously paid scatterbed hospitals to more generously paid DRFs and DPUs (practice-style).
- The fall in LOS will be greater for patients with a longer LOS (moral hazard in order to influence selection).

We now describe the approach that will be used to test these hypotheses.

3. Model

3.1. Decomposing the reimbursement impact

We decompose the impact of a reimbursement change on average resource use within a general model of hospital supply. Hospital j's supply is characterized by an admission policy, $A_j(R)$, and a treatment policy, $T_j(R)$, both elements of behavior affected by the reimbursement system, represented here by R. Admission policy might take the form of a decision rule about the severity of patients to accept, for example. A more "generous" reimbursement system might then lead the hospital to accept more severely ill patients. Treatment policy relates patient characteristics to treatment the hospital provides; it too may be affected by the form of reimbursement.

In data, we do not observe $A_j(R)$ or $T_j(R)$, or even the severity of patients. What we do see is the number of patients treated at a hospital, and the treatment they receive. At the hospital level, we relate these observables to their underlying determinants in the following way:

$$N_j = N_j\big(A_j(R), T_j(R)\big) \tag{1}$$

$$V_j = V_j\big(A_j(R)\big) \tag{2}$$

$$\mathrm{LOS}_j = L_j\big(V_j, T_j(R)\big), \tag{3}$$

where

N_j = number of patients at hospital j
V_j = average severity of patients at hospital j
LOS_j = average LOS at hospital j

Denoting hospital j's share of the discharges by S_j, the average LOS across all hospitals, ALOS, is:

$$\text{ALOS} = \sum_j S_j \, \text{LOS}_j \tag{4}$$

Noting Eqs. (1), (2) and (3), the total effect of a reimbursement change on ALOS, dALOS/dR, can be decomposed into three terms:

$$\frac{\text{dALOS}}{dR} = \underbrace{\left[\sum_j S_j \frac{\partial \text{LOS}_j}{\partial T_j} \frac{\partial T_j}{\partial R}\right]}_{\text{(moral hazard)}} + \underbrace{\left[\sum_j S_j \frac{\partial \text{LOS}_j}{\partial V_j} \frac{\partial V_j}{\partial R}\right]}_{\text{(selection)}} + \underbrace{\left[\sum_j \text{LOS}_j \frac{\partial S_j}{\partial R}\right]}_{\text{(practice style)}} \tag{5}$$

The term $\partial S_j / \partial R$ in the final set of brackets is the change in share of patients treated at hospital j due to the effect of the payment system change on j's and non-j hospital's admissions. [4]

Terms in Eq. (5) can be directly associated with the effects we have identified in the discussion. The moral hazard effect is the change in LOS due to the change in treatment policy, holding patient severity (V) constant. We estimate the moral hazard effect econometrically in a fashion to be described shortly. If the LOS change due to moral hazard differs by hospital, these changes must be weighted by the S_j's to determine the contribution to the total change in the ALOS.

The selection effect at each hospital can be estimated by the difference in pre/post LOS at that hospital after correcting for the moral hazard effect, since within a hospital, there are no practice-style effects (by definition). Both LOS_j and $(\partial S_j / \partial R)$ are directly observable, so the practice-style effect can be directly estimated. The "residual" remains after subtracting estimates of these effects from the observed left hand side changes could be due to interaction terms, or a general shift in the severity of patients in the pool. Most of the effort in this paper will be devoted to estimating the moral hazard effect.

3.2. Estimating the moral hazard effect

We specify regressions at the discharge level to estimate moral hazard. We proxy the level of resources devoted to patient i by provider j during a single admission at time t by the patient's length of stay, LOS_{ijt}. This length of stay is assumed to be a function of individual patient characteristics, the hospital's style

[4] In a well known paper, Oaxaca (1973) decomposes the make-female wage differential into differences in observed variables (such as experience), differences in the effects of these observed variables on earnings, and a residual. If all relevant variables determining LOS were observed by us, we could apply an analogous procedure here. As highlighted below, we use hospital and patient fixed effects to control for unobserved, unchanging variables. We are thus unable to detect the second of these three components. We think that our own decomposition provides new insights in the health context.

of practice, the effect of the reimbursement system, and an error term, ϵ_{ijt}, that is assumed to be independent of patient, hospital, and reimbursement system characteristics. Patient characteristics consist of observable characteristics, Z_{it}, and unobservable characteristics μ_{it}, both of which might change over time.

In health care, doctors and hospitals are often thought to have a clinical "signature" or "style of practice", terms that refer to systematic patterns of behavior, such as in rates of surgical procedures, which cannot be explained by differences in patient characteristics or financial incentives to the patients or the providers. [5]

Even in the RAND Health Insurance Experiment, which featured very extensive demand-side control variables, large differences in rates of use by comparable persons emerged in different locations which researchers at least partly attributed to differences in local "norms" of treatment (Newhouse, 1993). [6] The hospitals in our data are quite diverse, including a state psychiatric hospital, private hospitals with special facilities for the psychiatrically ill, and small community general hospitals with no special facilities. Differences in the goals and methods of treatment across these facilities may play a role in explaining variation in LOS. We express hospital j's style of practice before the payment system change as $D_j\gamma_j$, where D_j is a zero-one dummy variable for each facility j, and γ_j is the jth element in an unknown vector of practice-style parameters γ.

We use a straightforward parameterization of the payment system change, $R_t\delta$, where R_t is a dummy variable that takes on a value of one after the payment incentives change, and zero otherwise. The unknown parameter δ measures the pure moral hazard effect of the payment system, namely the change in length of stay for a given patient, holding constant patient and provider characteristics. As described below, for some specifications we allow δ to vary by type of facility.

Using this notation and assuming a linear specification, we write [7]

$$\begin{aligned}\mathrm{LOS}_{ijt} &= \underset{\substack{\text{individual}\\\text{characteristics}}}{(Z_{it}\beta + \mu_{it})} + \underset{\substack{\text{practice}\\\text{style}}}{D_j\gamma_j} + \underset{\substack{\text{payment}\\\text{system}}}{R_t\delta} + \underset{\substack{\text{random}\\\text{error}}}{\epsilon_{ijt}}\\ &= Z_{it}\beta + D_j\gamma_j + R_t\delta + \mu_{it} + \epsilon_{ijt} \qquad (6)\end{aligned}$$

Estimation of the parameters in (6) presents two econometric problems. One problem is that provider style of practice may have changed over the sample period for reasons other than the change in the payment system for Medicaid

[5] Baumgardner (1994) depicts "practice style" as a response to the costliness of information necessary to tailor treatment to individual cases.

[6] See Wennberg et al. (1987) and Wennberg and Gittelsohn (1975) for well-known examples of research emphasizing the practice-style explanation of differences in rates of health care use.

[7] LOS rather than some transformation of LOS was chosen as the dependent variable to facilitate interpretation of results in terms of a decomposition of the change in average LOS between two periods.

patients. We address this problem by comparing the changes in the average length of stay for our Medicaid sample with that of the non-Medicaid patients treated in the same set of hospitals over the same sample period. A finding of no change in the average length of stay for non-Medicaid groups at the same time as a significant drop in our Medicaid sample will be taken as evidence that the payment system change was responsible for the LOS change.

A second econometric problem is that the unobserved patient characteristics may be correlated with observed variables, particularly D_j or R_t. If the reimbursement system affects where patients are treated, as we expect it to do, then μ_{it} will be correlated with the hospital dummy variable, D_j, and possibly the payment system variable, R_t. We address this problem by using a patient-level fixed effect model to control for unobserved patient severity more directly. Because estimating patient fixed effects requires multiple observations on each patient, we restrict the sample to the group with the highest rates of multiple admissions: the Medicaid-eligible mentally disabled. The mentally disabled are a relatively homogeneous type from a clinical point of view, tend to remain on Medicaid for a long period of time, and account for two thirds of all Medicaid admissions in our sample. We thus observe use in both payment regimes for a large number of fairly homogeneous individuals. The total number of Medicaid eligible, mentally disabled was 2,478 at the beginning of our sample period, and grew steadily to 2,902 at the end. The frequency of admission for this group declined slightly over time. Using individual fixed effects to identify the moral hazard effect of the payment system change has another advantage. It also controls for any underlying trend in severity of the population. [8]

4. Data

The data for this study are drawn from several sources. The primary data set is a claims file with records for inpatient and outpatient services billed to New Hampshire Medicaid with dates of service between July 1, 1987 and June 30, 1992, one and one-half years prior to the payment system change and three and one-half years after the change. The data file is a complete description of the services paid for by Medicaid. Medicaid recipients may also have obtained mental health care at the state hospital which was not paid for by Medicaid. To capture a complete sample of all actual or potential Medicaid discharges in the state,

[8] In an earlier draft of this paper, we also corrected for this correlation by estimating models using a Heckman-style correction for the non-zero mean of μ_{it} given D_j and R_t. At the first stage, we modeled patient choice of facility using travel distances (i.e., the distance from the patient's town of residence to each provider's town) as the main set of variables identifying unobserved severity. The results of the Heckman models were consistent with the results shown here, and are available from the authors upon request.

information was extracted from medical records at the state facility, the New Hampshire Hospital (NHH). Since the NHH records do not reliably contain information about Medicaid eligibility, this eligibility information was obtained from the Medicaid sample. [9]

In addition to the combined Medicaid and NHH data sets, we also use information from New Hampshire state discharge files over the five year sample period. These discharge files have the advantage of including the universe of all discharges (except NHH) over the sample period for all payers, and for medical as well as psychiatric discharges. As discussed below, these ''All Payer'' files are used to control for general trends in treatment intensity, admissions, and eligibility over the sample period. Observed differences between the Medicaid and non-Medicaid psychiatric hospitalization experience are used to help identify impacts of the payment system changes. Each patient's town of residence contained on the Medicaid, NHH, and all-payer files was used to merge on the average per capita income for the patient's town.

The independent variables considered for this paper are of three types: demographic variables, provider dummies, and time dependent variables. The demographic variables are the patient's sex, age group (classified into four categories), race (coded using a dummy for nonwhite), and the average per capita income in the patient's town in 1990 (a proxy for the patient's own average income). The payment system change is parameterized by a zero/one dummy (PMTSYS) taking on the value of zero for admissions starting before the change in the payment system, one thereafter.

5. Descriptive overview of payment effects

Figs. 1 and 2 provide a graphical picture of changes in numbers of admissions and average length of stay by facility type and by six month semester over the five

[9] Some state hospital services were eligible for Medicaid payment, and records for these services do appear on the Medicaid claims file. In New Hampshire, persons 65 or over or under 21 could be paid for by Medicaid in a certified psychiatric hospital. The New Hampshire Hospital (NHH) became certified for children in 1989. Partly for this reason, we excluded all patients over age 65 or under age 21. NHH patients were classified as Medicaid eligible using two sets of eligibility criteria. The weaker condition was to classify a patient as eligible at the time of a specific admission if they were reimbursed for a Medicaid service *either* before or after the admission during our five year sample period. The stronger condition was that a patient be reimbursed for Medicaid services *both* before and after the admission to NHH. Preliminary regressions suggested that both eligibility criteria give similar results, hence we focus on the weaker criterion for Medicaid eligibility for this paper. To allow for the likely possibility that patients might be eligible for Medicaid only after being discharged from NHH and receiving follow up treatment, or might receive Medicaid reimbursed services prior to but not after treatment at NHH, we extended the sample window of Medicaid eligibility by adding 30 days to the beginning and end of the Medicaid eligibility period defined as spanning the first and last dates of Medicaid reimbursed services.

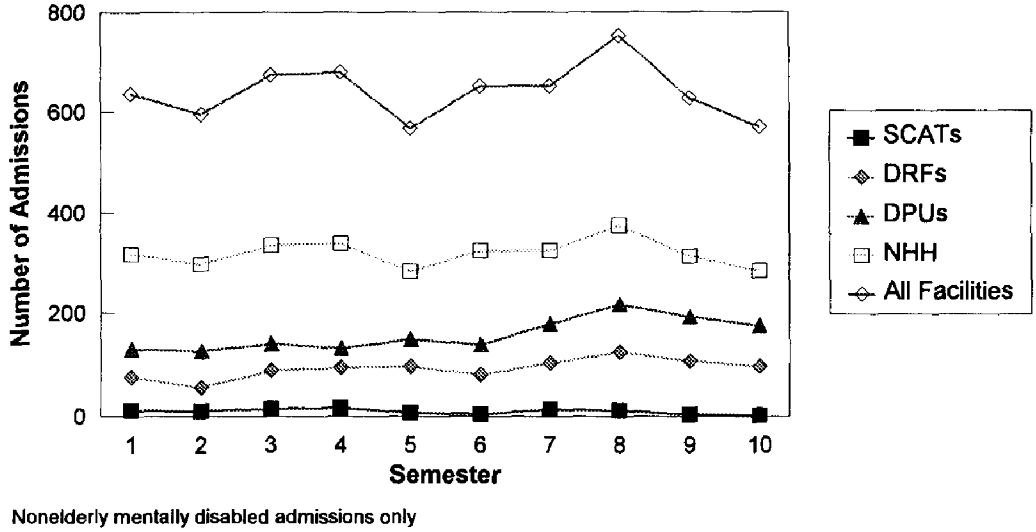

Fig. 1. Number of admissions by type of facility New Hampshire Medicaid psychiatric inpatients.

year sample period, August, 1987 through July, 1992. The total number of admissions per semester for the mentally disabled was relatively stable over the five-year period, with no clear trend up or down in the first set of bars in Fig. 1. There was, however, a major shift during this period away from NHH, the state facility, to the private hospitals. The number of admissions to the state hospital fell by 50 percent, with commensurate growth occurring at the DRF and DPU facilities. Scatterbed hospitals saw only a few patients during all periods of the study. In the first two semesters, about two thirds of all admissions were to NHH, while in the last two semesters, the NHH share had fallen to about one third.

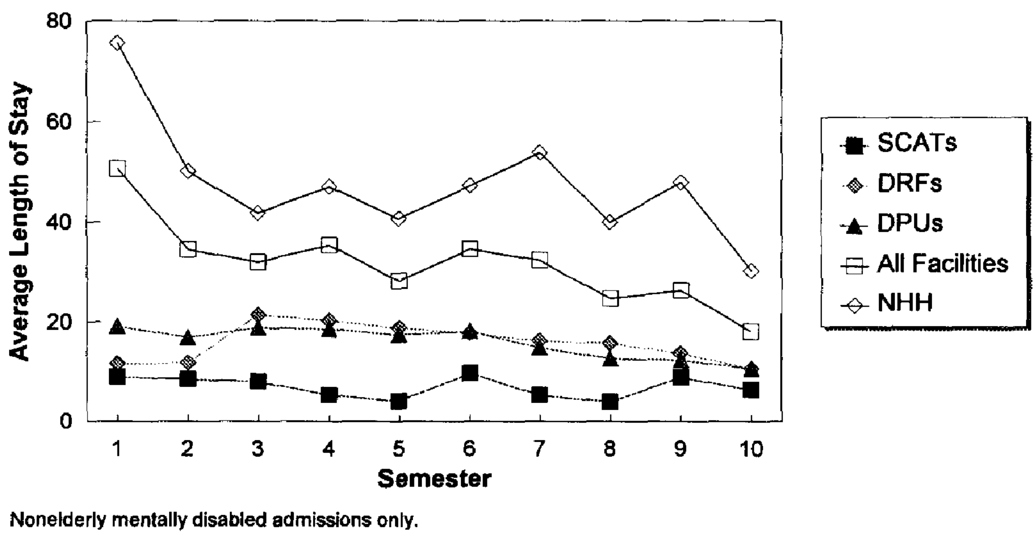

Fig. 2. Average length of stay by type of facility New Hampshire Medicaid psychiatric inpatients.

Fig. 2 describes trends in our measure of resource use, LOS, in the four types of hospitals. The first set of bars illustrates a clear downward movement in LOS for all facilities taken together. The average LOS for the first two periods for all facilities was about 40, falling to around 20 for the last two periods. All private facilities have a lower LOS than NHH. The LOS at the DRFs declines over time, and rises then falls at the DPUs. The scatterbed hospitals exhibit no clear pattern.

A shift in the discharges among different facilities with different patterns of care can alter the average LOS for the population. As shown in Fig. 1, NHH was seeing a much higher portion of the patients in the early periods than in the later periods. The payment system was successful in moving patients out of the state hospital and into the private sector. Given the large differences in resource use, it is tempting to assume immediately that large savings in resources were achieved. This conclusion would be correct, however, only if there are no selection effects: if the observed differences in LOS are due to differences in patient severity across different facilities (in our notation, differences in the average μ_{it} across facilities) rather than differences in practice styles (in our notation, differences in the γ_j) then the resources saved could be much smaller.

One distinctive pattern of Fig. 2 is that the average LOS for patients admitted during the first semester in the NHH is much higher than for patients admitted later. We have reviewed these data with officials at the DMH in New Hampshire, and they assert that this drop in LOS is due to a change in management of the NHH which occurred in 1989, when the state contracted with Dartmouth Medical School to provide clinical services to NHH, resulting in a change in clinical approach. NHH data confirm a large reduction in LOS for all patients, Medicaid and non-Medicaid, at the hospital at this time.

6. Multivariate results

6.1. The overall effect of the payment system

We first ask, what is the total change in LOS to be attributed to the payment system change? Sample means and standard deviations are shown in Table 1 for two samples: the full Medicaid sample of non-elderly, mentally disabled, including those treated at New Hampshire Hospital; and the sample of non-Medicaid discharges for individuals aged 15 through 64. [10] Both samples correspond to the sample period 1988 through 1992. These means show that the overall average length of stay (LOS) in the Medicaid sample is 31.81 days, versus 11.45 days in the non-Medicaid sample. Of central interest to this paper is the observation that

[10] To ensure comparability of the two samples, children were excluded from the non-Medicaid sample, since individuals under age 15 are not eligible under the Medicaid Mentally Disabled category.

Table 1
Means and standard deviations

	Medicaid mentally disabled		Non-Medicaid sample	
	Mean	Standard deviation	Mean	Standard deviation
Dependent variables:				
LOS (87:2–92:1)	31.81	80.64	11.45	12.74
Avg LOS pre-period	39.07	113.86	11.37	13.50
Avg LOS post-period	28.74	61.16	11.49	12.41
Difference 'post-pre'	−10.33		+0.12	
Independent:				
Female	0.6170	0.4862	0.6334	0.4819
Nonwhite	0.0384	0.1922	0.1550	0.3619
Income per capita, patient town (1000s)	16.384	3.0279	15.675	2.8754
Age 15–21	0.1339	0.3406	0.1334	0.3401
Age 22–30	0.3474	0.4762	0.2371	0.4253
Age 31–45	0.3521	0.4777	0.4049	0.4909
Age 46–64	0.1667	0.3727	0.2246	0.4173
Payment system dummy	0.7026	0.4572	0.6996	0.4584
Main payment source:				
Blue Cross/Blue Shield			0.2938	0.4556
Commercial ins			0.2541	0.4354
Medicare			0.1794	0.3837
Self-pay/free care			0.1770	0.3817
HMO			0.0661	0.2485
Other government			0.0072	0.0848
Workers compensation			0.0025	0.0497
Other			0.0198	0.1394
Sample size	3,204		10,500	

Note: Female, nonwhite, age group, payment system and payment sources are 0/1 dummy variables with a value of one for the indicated group. All means and regressions exclude patients aged 65 and over and children age 15 and under.

the average LOS in the Medicaid sample declined by 10.33 days between the pre and post periods, while the average in the non-Medicaid sample actually increased by 0.12 days over the same period. Also of interest is that there was an appreciable reduction in the standard deviation of LOS over the sample period. This change in the distribution of LOS is explored below. [11]

Table 2 presents OLS results on the two samples to demonstrate that the observed overall reduction in average length of stay in the Medicaid sample before

[11] In comparison to the non-Medicaid sample, the Medicaid patients have a higher proportion of females, are more likely to be nonwhite, live in towns that have slightly higher average town per capita incomes, and are on average younger.

Table 2
Comparison of Medicaid and non-Medicaid coefficients (standard errors shown in parentheses)

	Medicaid sample			Non-Medicaid		
	(1)	(2)	(3) *	(4)	(5)	(6)
Intercept	39.0693	21.4530	19.9720	11.3716	13.8478	15.3429
	(2.608)	(8.9409)	(8.3455)	(0.227)	(0.830)	(0.875)
PMTSYS	−10.3287	−10.7444	−4.8185	0.1182	0.2565	0.2513
	(3.112)	(3.1108)	(3.1175)	(0.271)	(0.271)	(0.269)
Female	.	−5.5855	−4.0753	.	2.0118	2.0563
		(2.9422)	(2.6667)		(0.257)	(0.259)
Nonwhite	.	−3.2615	−2.1807	.	−1.1683	−1.0489
		(7.4509)	(6.7165)		(0.352)	(0.350)
Town income per	.	0.8893	0.7564	.	−0.2094	−0.1563
capita (000's)		(0.4704)	(0.4276)		(0.044)	(0.044)
Age 22–30	.	4.4749	0.7688	.	−1.0399	−1.3358
		(4.5776)	(4.1768)		(0.425)	(0.426)
Age 31–45	.	8.4289	5.1713		−0.6995	−1.1592
		(4.5953)	(4.2083)		(0.393)	(0.395)
Age 46–64	.	14.3298	9.7227	.	0.6489	−0.0980
		(5.2414)	(4.8165)		(0.431)	(0.436)
Main payment source:						
Blue Cross/Blue Shield			.	.	−1.1130	
		(0.376)				
Commercial ins				.	.	−2.1642
		(0.385)				
Self-pay/free care			.	.	−2.7403	
		(0.420)				
HMO				.	.	−6.5190
		(0.570)				
Other government			.	.	−3.3711	
		(1.476)				
Workers compensation			.	.	−1.1623	
		(2.484)				
Other				.	.	−6.3574
						(0.923)
Sample size	3204	3204	2886	10,500	10,500	10,500
R^2	0.0034	0.0083	0.0048	0.0000	0.0109	0.0276
MSE	6482.797	6463.351	4800.351	162.41	160.74	158.13

* Sample omitting period 1 (July–December 1987).

and after the payment system change is not explained by changes in observed demographic variables. Using a payment system dummy for before and after the payment system change as an independent variable, Column (1) shows that the overall LOS declined by 10.33 days from the pre to the post periods. The second column illustrates that observed demographic variables do not account for the observed decline. Since the graphical analysis of average LOS by semester reveals that a major change in treatment practice took place in the first semester of 1988 at

NHH which cannot be explained by the payment system change, we also estimated the model while omitting the first six months of the data (Column (3)). This reduces the estimated impact of the payment system from -10.33 days to -4.82 days.[12]

In contrast with the results for the Medicaid sample, OLS regression results on the non-Medicaid sample provide no evidence of any decline in the average LOS: the coefficient on the payment system dummy is slightly positive (although insignificantly different from zero), and is estimated precisely enough that we can reject that as much as a 0.5 day decline in average LOS took place. We estimated a similar model for discharges in the non-Medicaid sample with diagnoses of Major Depression and Psychoses only in order to match more closely the severity of disease in the Medicaid sample. Results were similar: in the non-Medicaid sample, LOS was slightly higher in the post period.

6.2. *Moral hazard effect in aggregate*

In order to estimate the magnitude of the moral hazard effect, we conducted a series of regressions using the subsample of only patients hospitalized in general hospitals, i.e., omitting patients treated in NHH. This is appropriate since for the reasons discussed above, NHH faced no changes in its financial incentives over the sample period, and hence any changes in its LOS should not be due to moral hazard. In contrast, the three types of private hospitals are subject to both moral hazard and selection effects, which in aggregate may tend to work in opposite directions with moral hazard reducing and the selection possibly increasing the average LOS. Our objective in this estimation is to quantify the magnitude of the moral hazard effect.

Alternative approaches to estimating the moral hazard effect are presented in Table 3. Column (1) presents OLS estimates showing that the average LOS in general hospitals declined by only 1.2 days after the payment system change, and this change is not statistically significantly different from zero. Column (2) shows a smaller (and insignificant) estimate of the reduction in average LOS even after controlling for observed patient demographics. Neither of the first two models explains a significant proportion of the total variability in LOS across patients, with R^2's of 0.02 or less.

These first two columns are reduced form models that do not control for differences in hospital practice style and the fact that the number and types of patients at different classes of facilities was changing. Observed demographic

[12] Omitting NHH first period observations changes the share of observations at NHH, and hence the overall mean LOS in the first period. Removing the first period but adjusting market shares for this bias results in an estimate of the overall LOS of -4.5 days. We take -4.5 rather than -4.8 days as the total effect to be explained in our analysis.

variables do a poor job controlling for patient severity, and hence we are not capturing important aspects of changes in the composition of patients at private hospitals over the sample period which tended to increase the average LOS. This is clearly signalled by the extremely low R^2 achieved even when adding the observable patient variables and hospital fixed effects, as in Column (3) ($R^2 = 0.08$).

To better control for patient severity, we further restrict the sample to include only people with two or more admissions in private hospitals ($N = 1265$), and use a model with patient- and hospital-level fixed effects to estimate the moral hazard effect of the payment system. As described in Section 3, this approach attempts to estimate the μ_i directly under the assumption that μ_i is constant over time.[13]

Column (4) in Table 3 presents the results of using both patient and hospital fixed effects. The estimated coefficient on the payment system dummy has increased to -2.2 but is only marginally significant ($t = -1.42$). We note that with patient and hospital fixed effects the R^2 increases to 0.41, a substantial improvement over Column (3).

The moral hazard response estimated in (5) at 2.2 is an average response taken over all types of facilities and over both short and long-staying patients. We now pursue the question of whether there was a differential moral hazard effect at the three facility types.

6.3. *Moral hazard effect by type of facility*

From the graphical analysis of patterns of admissions and average length of stay at different classes of facilities, it is apparent that not all three types of general hospitals experienced the same change in average LOS. Therefore we examined whether the payment system had differential effects on each of the three different types of facilities. The model underlying Columns (5) of Table 3 is identical to Columns (4) except that the payment system variable is interacted with dummy variables for each of the three types of facilities: DRFs, DPUs, and scatterbeds. Confirming the graphical results, the three payment system dummy coefficients suggest that the overall reduction at general hospitals, on the order of two days, reflects an aggregation of diverse patterns at the three types of facilities. DRFs are

[13] The average number of admissions per patient is only 2.9, which is small. Monte Carlo studies have shown that individual fixed effects are inconsistent and typically remove too much of the variation when the panel sizes are small, however, we know of no attractive alternative given the nature of our data. To test the constancy of the μ_i over time, we also estimated an alternative specification of Models (4) and (6) that included dummy variables for whether the admission was the second, third, fourth, fifth or more observed in our sample. These four additional variables, which are highly collinear with the payment system variable, were jointly significant [$F(4,1555) = 5.87$, and $F(4,900) = 3.97$] and affected the statistical significance of the payment system variables, but displayed similar magnitudes and general patterns.

Table 3
Regressions results using Medicaid mentally disabled sample General Hospital admissions only (standard errors shown in parentheses)

Model:	OLS	OLS	Hospital fixed effects	Hospital and person fixed effect models		
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	15.86	8.89	−1.19	.	.	.
	(0.76)	(2.35)	(10.84)			
PMTSYS	−1.25	−0.932	−1.28	−2.17.	.	
	(0.877)	(0.874)	(0.871)	(1.53)		
DRF * PMTSYS	.	.	.	.	−6.34	6.50
					(1.99)	(1.92)
DPU * PMTSYS	.	.	.	.	2.22.	.
					(2.21)	
SCAT * PMTSYS	.	.	.	.	4.71	.
					(4.44)	
Female	.	2.55	2.52	.	.	.
		(0.830)	(0.823)			
Nonwhite	.	7.49	8.29	.	.	.
		(2.08)	(2.03)			
Town income per capita (000's)	.	0.283	0.124	.	.	.
		(0.118)	(0.178)			
Age 22–30	.	0.602	0.246	.	.	.
		(1.173)	(1.155)			
Age 31–45	.	−0.917	−1.201	.	.	.
		(1.208)	(1.200)			
Age 46–64	.	0.732	0.212	.	.	.
		(1.332)	(1.344)			
Sample size	1590	1590	1590	1265	1265	1265
R-square	0.001	0.021	0.078	0.413	0.420	0.411

estimated to have experienced a roughly six day reduction in average LOS due to moral hazard, a difference which is statistically significant ($t = -3.19$). In contrast, DPUs and scatterbeds are not estimated to have had any statistically significant changes due to moral hazard. Medicaid is a relatively small payer in DPUs and scatterbeds, perhaps accounting for the lack of response. The DRFs receive a much higher share of their patients from Medicaid.

Column (6) presents our final preferred specification, with only the DRF dummy variable interacted with the payment system dummy variable. The estimated coefficient on this variable is changed very little, −6.5 days, with a t-ratio of −3.38. Our conclusion from this analysis is that only the DRFs appear to have had a statistically significant moral hazard effect.

6.4. Moral hazard, selection, and practice-style effects

We can now decompose the effects of the payment system change according to the total derivative, (5). The results of this decomposition are shown in Table 4.

Table 4
Decomposition of overall change in LOS into moral hazard, selection and practice style effects

	Average LOS		LOS change	Moral hazard	Selection effect	Practice style
	pre	post				
	(1)	(2)	(3)	(4)	(5)	(6)
DRFs	18.6	14.8	−3.8	−6.5	+2.7	
DPUs	14.6	15.6	1.0	0.0	+1.0	
Scatterbeds	8.6	5.6	−3.0	0.0	−3.0	
NHH	45.8	44.6	−1.2	0.0	−1.2	
Total	33.2	28.7	−4.5	−1.8	+0.3	−3.0

The first two columns of the table show the average LOS at each of the four different types of facilities, and in aggregate, before and after the payment system change. The third column shows the difference between the first two rows, and gives the overall effect on LOS at each type of facility. The differences in means between the first two columns show that the average LOS changed by −3.8 days at DRFs, +1.0 days at DPUs, −3.0 days at scatterbeds, and −1.2 days at NHH (this latter difference omits the period one change at NHH). For the entire Medicaid sample, LOS fell 4.5 days between the pre and post periods.

We examined changes in LOS for non-Medicaid populations to see if there were any trends in LOS unrelated to the payment system change. From the regressions contained in Table 2 for the non-Medicaid samples, we concluded that there was no exogenous trend in LOS at the private hospitals. Hence, the "practice style" at private facilities can be assumed to be constant over time. We also examined aggregate trends in average LOS at NHH over the five year sample period for the all psychiatric discharges, including non-Medicaid patients. Examining the LOS for patients treated in earlier and later periods at NHH, we found no evidence of significant trends. From this we conclude that any change in LOS at each facility must be due only to moral hazard or selection.

Column (4) of Table 4 presents the estimated moral hazard effects, based on Model (6) in Table 3. Note that we have assumed no moral hazard effect for DPUs and scatterbeds (which were positive but statistically insignificant in Model (5), Table 3). We also assumed no moral hazard effect at NHH, since by assumption there was no change in incentives at NHH. In aggregate, the moral hazard effect explains an overall reduction of −1.8 days in the average LOS. This number is calculated as the sum of the shares of each facility (in the post period) multiplied by the moral hazard effect for each.

Column (5), the difference between Columns (3) and (4), presents our estimates of the selection effect at each facility type, i.e., the change in the average LOS at that type of facility not due to the moral hazard effect. The selection effects are estimated to be +2.7 days at DRFs and +1.0 days at DPUs, both in the direction of change that could be anticipated. According to our estimates, the average severity of patients at the scatterbed hospitals fell after the payment innovation. The selection effect at NHH is estimated to be small. We will discuss the estimate of the overall selection effect after explaining how we calculate the contribution of practice-style effects to the total change.

Column (6) in Table 4 presents our estimates of the aggregate practice-style effect, calculated, following Eq. (5) above as the change in market shares of each of the four types of facilities, multiplied by their initial LOS. Over all facilities combined, a decline of 3.0 days is predicted just because of the changes in market shares.

6.5. Moral hazard for short and long LOS patients

We investigate one final issue. A positive effect of the payment system on LOS is consistent with a model in which hospitals engage in quality competition for profitable patients. If quality competition is important, a shift to prospective payment may be accompanied by an increase in the intensity of treatment offered to profitable (i.e., short-LOS) patients and a decrease in the intensity of treatment offered to unprofitable patients. A tightening of the distribution of LOS after prospective payment has been noted in other research. The usual interpretation is that a DRG system introduces a "norm" of treatment which providers tend to follow. Frank and Lave (1989) found this pattern of compression in a cross section of Medicaid payment systems and interpreted it as a norms effect, while Cutler (1991) did not find such evidence at the aggregate level, but only within individual hospitals. The norms hypothesis and the quality competition hypothesis both predict that the fall in LOS following prospective payment should be less for patients with a shorter LOS. The fall could be so much less for the short-LOS patients that LOS for this profitable group could rise. We examined the distributions of LOS for different types of facilities before and after the payment system change in order to see whether the theoretical predictions are supported empirically.

The results of this analysis are summarized in Fig. 3. This figure shows the percentage change in the LOS for patients at different percentiles of the LOS distribution for all hospitals, for DPUs and for DRFs. If the LOS of all hospitalizations had decreased at the same rate from the pre to the post periods, then the figure would show only horizontal lines. The fact that the curves are downward sloping and initially positive, indicates that for short stay patients, the LOS has increased, while for long stay patients the LOS has decreased. The large negative values for the highest ten percent of the distribution highlights that virtually all the change in average LOS is accounted for by changes in treatment for the longest stays. The LOS has actually increased for short stayers, suggesting that hospitals have competed to attract profitable, short stay patients. The smooth pattern in the aggregate distribution is also reflected in declining curves for DRFs and DPUs, as shown in Fig. 3. Kolmigorov–Smirnov tests of whether the distributions are the

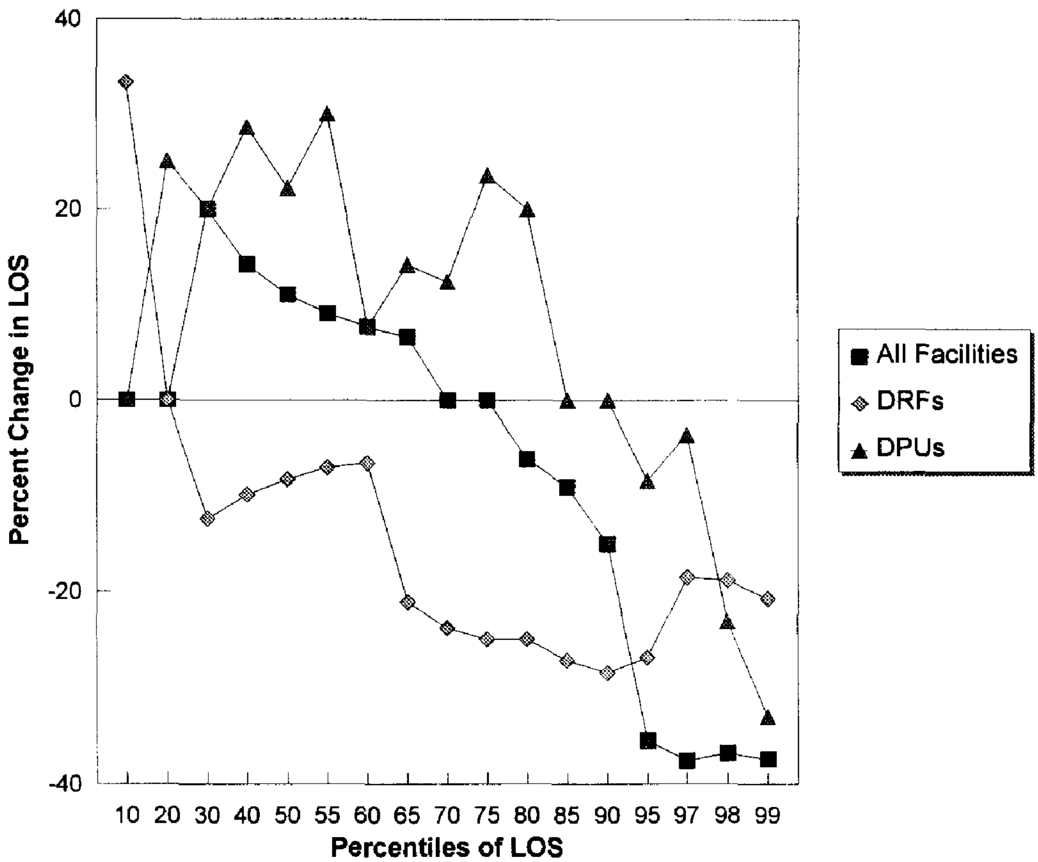

Fig. 3. Comparison of percent changes in LOS for patients at different percentiles.

same before and after the payment system change reveal that only the distribution of DPUs has changed in statistically significant manner ($p = 0.06$). F-tests using the before and after samples reveal that the assumption of equal variances can be rejected for all but the scatterbed samples.

7. Discussion

Reimbursement systems affect average resource use at providers and at a system-wide level in several ways. We identify and label the three effects as a moral hazard effect, a selection effect, and a practice-style effect. All three types of effects have been discussed previously, but ours is the first paper to attempt to identify the magnitude of each in the response to a payment system change.

The problem of controlling for unobserved patient severity is a formidable one. We are fortunate in this paper to have a five-year panel of individuals who are classified as "mentally disabled" and who therefore represent a fairly homogeneous set of patients. Furthermore, based on evidence that individual severity does not rise or fall systematically over time for this population, we exploit the repeated observations on the same persons in our sample to identify the moral hazard effect of the payment change. With the moral hazard effect in hand, the decomposition of the total effect can apply a simple formula for the total derivative of the payment system on average LOS in a population.

Overall, a 4.5 day reduction in LOS (14%) for non-elderly, mentally disabled psychiatric patients appears to be attributable to payment system reform. There is no evidence of a similar trend among the non-Medicaid population in New Hampshire. Our analysis suggests that -1.8 days of this change can be attributed to a pure moral hazard effect, and -3.0 days to what we have called the practice-style effect. The overall population may be getting slightly sicker, increasing average LOS by $+0.3$ days.

A further result of interest is that the distribution of LOS in the pre and post periods suggests a possible increase in average LOS for short LOS patients and a reduction in LOS for long LOS patients, a finding consistent with Dranove's plausible hypothesis that a prospective payment system ought to induce hospitals to engage in quality competition for patients likely to be profitable to the hospital (Dranove, 1987).

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