Payment levels and hospital response to prospective payment

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Received March 1993, final version received October 1993

Abstract

Nearly ten years after the implementation of Medicare's Prospective Payment System (PPS), some of its major impacts remain hard to explain using existing economic models. We develop a simple model of the hospital's choice of intensity of care, which affects demand for admissions. The model suggests an important role for the level of prospective payment, independent of the effect of marginal incentives. Predictions from the model are compared first with aggregate utilization data from Medicare's PPS experience, and then with various hospital-level studies which control for interhospital differences in reimbursement rates.

Key words: Hospitals; Medicare; Supply response; Prospective payment

JEL classification: 11

1. Introduction

After ten years of experience, there is no consensus about some major effects of Medicare's Prospective Payment System (PPS), particularly the decrease in hospital admissions. Early observers predicted that the number of Medicare admissions would increase. For example, Lave (1984) expected that

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Research for this paper was supported by the Robert Wood Johnson Foundation and grant K05-MH00832 from the National Institute of Mental Health. The paper benefited by support for complementary research at Boston University by the Management Sciences Group of the Veterans' Administration. We are grateful to Randy Ellis, Richard Frank, Jacob Glazer, Albert Ma, Will Manning, Joseph Newhouse, Greg Pope, Mike Riordan, Doug Staiger and Ingo Vogelsang for helpful comments on an earlier version. The paper was presented at the First Annual Northeast Regional Research Symposium in Health Economics, Newport, RI, September 2–4, 1992.
‘the number of admissions and readmissions will likely increase. Some patients who could be treated as outpatients may be treated as inpatients.’ Guterman and Dobson (1986) noted the widespread belief that PPS ‘would provide an incentive for hospitals to increase the volume of admissions’, although they were already finding contrary evidence. In their comprehensive review of the effects of PPS, Coulam and Gaumer (1991) describe the admissions decline as a ‘surprise’, the reasons for which are ‘not well understood.’

This paper reviews hospital response to changes in payment systems, from both a theoretical and an empirical perspective. We briefly review previous models of hospital response to reimbursement (Section 2), and present a simple model of hospital behavior in which the number of admissions and intensity of care per case respond to the incentives in payments systems (Section 3). The aim of the model is to provide an interpretive framework for reviewing empirical work.

The empirical part of the paper begins with a review of aggregate trends under Medicare’s PPS (Section 4), drawing on work by researchers at the Health Care Financing Administration (HCFA) and the Prospective Payment Advisory Commission (ProPAC). Coulam and Gaumer (1991) recently provided a useful review of the accumulated evidence about how PPS has affected hospital finances, utilization patterns and the US health care system in general. However, they did not relate the evidence back to debates in economic theory about hospital objectives and the explanation of hospital responses. Our aim is to make this connection, drawing also on the econometric literature (Section 5).

2. What do hospitals want?

Market forces fail to discipline US hospitals with the same severity as these forces apply to other firms. Regulation impedes entry and exit. The nonprofit organizational form insulates hospital management from the capital market. Struggling hospitals appeal successfully to governments and to private philanthropy for help. And historically, cost-based payment systems limited losses (and profits). Hospitals have scope to pursue goals other than profit.

Economists have theorized about hospital objectives since hospital behavior and health costs drew policy interest. Models proposed in the post-supply-side cost sharing era, 1983 to the present, look quite different than the pre-supply-side cost sharing models. Pre-1983 papers generally focused on the special role of the physician in hospitals. In Pauly and Redisch (1973) and Pauly (1980), the hospital is run for the economic benefit of the physicians on staff, a ‘doctor’s workshop’ in Pauly’s term. A less extreme
form of physician influence appears in models in which a hospital maximizes a utility function with quality and quantity of output as arguments, motivated in part by a professional interest in helping patients and a commercial concern with attracting physicians [Newhouse (1970), Feldstein (1971)]. Harris (1977, 1979) stresses the importance of the physician-controlled medical staff in making resource allocation decisions in hospitals.

Assumptions used in these models reflected broad features of the US hospital industry during the 1970s. Physicians were scarce and were in a strong bargaining position vis-à-vis hospitals. It was unimportant to know how hospitals would respond to potential profits or losses because payment systems kept revenues close to costs. No distinction was made in "output" between the number of discharges and the quantity of services per discharge, a distinction that would become key in the later period.

Medicare's TEFRA system in 1983, followed a year later by the Diagnosis-Related Group (DRG)-based PPS, made two changes that would be reflected in subsequent models of hospital behavior: (1) hospitals could make profits (and losses), and (2) the unit of payment was the discharge. Dranove (1987) analyzes a model based on the volume and selection effects in PPS. Hospitals maximize profits. They differ in costs of production for different DRGs and seek to expand supply in DRGs in which their margin is relatively high. This simple view of hospitals opens up a rich potential set of questions such as quality competition, dumping onto public institutions, acceptance of transfers, hospital specialization, and optimal DRG-price setting by regulators.

Ellis and McGuire (1986) introduced the analogy between prospective payment and supply-side cost sharing, and focused on the moral hazard effect of prospective payment. The hospital in their model maximizes profits, but the physician determining patient care in the hospital has a utility function which depends on hospital profits and patient benefit from treatment during a discharge. (Patients are fully insured and passive.) Maximization of this utility function in the presence of various supply-side cost sharing rules generates an upward sloping supply curve for services per discharge. The position of the supply curve depends on the "need" of the patients (more sickly patients benefit more from a given unit of care). The slope of the supply curve depends on the relative weights the physician

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1 A hospital bears supply-side cost sharing when with supply of an extra unit of care (for example when length of stay is extended by one day), the hospital pays some of the cost. In cost-based reimbursement (analogous to full insurance on the demand side), there is no supply-side cost sharing. At the other extreme, in a pure prospective payment system, the hospital can be regarded as paying all of the marginal cost of care. Supply-side cost sharing can range between zero and one, just as demand-side coinsurance can range between 0 and 100%. Medicare hospital discharges paid under TEFRA, for example, have supply-side cost sharing in the intermediate ranges.
decision-maker places on hospital profits and patient benefits, and the point on the supply curve chosen depends on the supply-side cost sharing in the payment system.

The post-PPS revival of the profit-maximizing assumption appears in other papers [e.g. Pope (1989), Custer et al. (1990)]. Although utility models are still widely used, profits or net revenues are generally one of two arguments in the utility function.\(^2\) Output is generally decomposed into number of discharges and services per discharge in the post-PPS models, but occasionally authors are able to proceed [e.g., Custer et al. (1990)] without making this distinction.

In this paper we interpret the empirical literature on hospital response to payment systems against the background of a general model of hospital behavior, integrating Dranove-type volume effects and Ellis and McGuire-type moral hazard. Following the recent literature, we make profits an objective. In addition, we include intensity of care in the hospital’s objective function, in the spirit of Ellis and McGuire (1986), Frank and Lave (1989) and others who have argued that hospitals are concerned with patient benefits or quality. ProPAC’s working definition of ‘intensity’ is the number and complexity of patient care resources, or intermediate outputs, used in producing a patient care service. Hospitals may value intensity because it confers benefits on patients, or because it adds to the institution’s technological sophistication and prestige. Finally, we recognize that hospital volume may be a function of the intensity offered, following Dranove (1987), Pope (1989) and Cutler (1990).

3. Volume and intensity response to payment change: a simple model

This section addresses the question of how hospitals’ volume and intensity should in theory respond to a change in payment system. The following are the basic equations of the model:

\[
U = U(\pi, I) \tag{1}
\]

\[
\pi = R - TC + Y \tag{2}
\]

\[
R = pX \tag{3}
\]

\[
p = \alpha + \beta c \tag{4}
\]

\(^7\) Cromwell and Burge (1991) depict hospitals in the short run as risk averse, and posit that they maximize the expected utility of profit. Hospitals in Friedman and Farley (1992) use net revenues to fund various stakeholder objectives, potentially including technology and management salaries. Frank and Salkever (1991) study hospital supply of charity care by hospitals that have a utility function with profit and ‘unmet need’ (which plays the role of a ‘public bad’) as arguments.
\[ TC = cX \quad (5) \]
\[ c = c(I) \quad c' > 0 \quad (6) \]
\[ X = X(I) \quad X' > 0. \quad (7) \]

The variable \( I \) denotes intensity, which is the hospital's other objective besides profit. Profit is the sum of patient revenues (\( R \)) and outside income (\( Y \)) less total costs (\( TC \)). Revenues are determined by the volume of admissions (\( X \)) and the price per admission (\( p \)), which is set as the sum of a fixed per-case payment (\( \alpha \)) plus a share of actual cost (\( \beta \)). The family of payment systems given by (\( p = \alpha + \beta c \)) includes prospective payment (\( \alpha > 0, \beta = 0 \)) and cost-based reimbursement (\( \alpha = 0, \beta = 1 \)), and can be used to represent mixed systems such as TEFRA (\( \alpha > 0, \beta > 0 \)). Cost per discharge (\( c \)) is an increasing function of intensity. As indicated in Eq. (7), intensity may also affect the volume of discharges. An increase in intensity attracts more patients.³

The model described in Eqs. (1) through (7) is very simple in a number of respects. There is one payer, one hospital and one type of discharge. The hospital can be regarded as being in a market with other hospitals, Eq. (7) describing the relation between number of admissions and own intensity, with the behavior of other hospitals taken as given. Consideration of the role of outside income (\( Y \)) allows for a revenue-side cross-payer effect, but cost-related cross-effects (such as economies of scale) are ignored. Physicians have no direct role in the model, although one interpretation of the model is that the utility function belongs to the physician, who balances the hospital's interest in profit with the patient's interest in services. The only decision the hospital makes is about 'intensity', and there is no distinction between types of intensity (such as capital and operating costs). There is no technological inefficiency in the model. We assume the hospital is always paid enough to remain in operation. While these restrictions are notable, we purposely start with the most simple model capable of showing that average and marginal payment levels have different effects on hospital behavior. Comparing predictions from this simple model with the data will tell us where adding complications has value.

Intensity plays a central role in the model. Intensity could include services per admission, technical sophistication or length of stay. Note that average cost per discharge is assumed to be constant with respect to changes in admission volume, varying only with intensity.

Substituting Eqs. (3) through (7) into (2), we can write profit as:

³The model here is analogous in most respects to a monopolist choosing the level of quality provision: see Tirole (1988, p. 100). A difference is that our firm (the hospital) may value quality (intensity) per se, as well as for its effect on demand.
\[ \pi = [a + \beta c(I)]X(I) - X(I)c(I) + Y, \]  
and the derivative of profit with respect to intensity as:

\[ \pi_t = X'(p - c) + Xc'(1 - \beta - 1). \]

The hospital chooses intensity to maximize utility (1), a function of both profit and intensity. Using the expression for (9), the first-order condition for utility maximization can be written as:

\[ X'(p - c) + Xc'(1 - \beta) + U'/U_\pi = 0. \]

Eq. (10) is a modified marginal revenue/marginal cost condition, with the terms grouped to distinguish two effects of a payment system on the hospital’s choice of intensity.

Volume effect: \( X'(p - c). \) The volume effect of a payment system is the incentive to increase/decrease intensity in order to attract/discourage admissions. The volume effect could be positive or negative. Since \( X' > 0, \) the volume effect will be positive if price \( p \) exceeds cost, and negative if price is less than cost. Note that the volume effect does not depend on the division of payments between prospective and cost-based, but only on the overall price/cost margin.

Note that in the presence of different types of discharges and payers, the volume effect would encourage the hospital to increase intensity for profitable discharges, and decrease it for unprofitable ones. For example, if the same prospective payment amount applies to more and less costly cases within the same DRG, the hospital has an incentive to increase intensity in a dimension relevant to the low-cost patients, and decrease intensity in a dimension valued by the high-cost patients. In models with multiple types of discharges, this volume effect is the driving force for any adverse or favorable selection effects of payment systems.

Moral Hazard Effect: \( Xc'(1 - \beta). \) The moral hazard effect of a payment system is the incentive to reduce care per episode to avoid supply-side cost sharing. The moral hazard effect is always negative, and is more powerful the greater the share of costs at the margin paid by the hospital \( (1 - \beta) \). Note that the moral hazard effect does not depend on the overall profitability or unprofitability of the payment system. Whatever the level of payment in relation to cost, supply-side cost sharing creates some incentive to reduce care per episode. The moral hazard effect here is analogous to the moral hazard in demand caused by reduction in demand-side cost sharing.

To be complete in dissection of (10), we could also identify a Utility Effect associated with the term \( U'/U_\pi, \) although this effect is not caused by the payment system but is simply a feature of the utility function itself. Assuming intensity confers some marginal utility, the utility effect is positive independent of the payment system, tending to increase the hospital’s choice of
intensity. The $U_1/U_\pi$ term is absent in a model of simple profit maximization.

'Outside income' $Y$ affects the choice of intensity through the utility effect. Assuming declining marginal utility of profits in the utility function, an increase in $Y$ increases the relative subjective benefit of intensity, $U_1/U_\pi$. Thus, an increase in outside income should increase intensity in a utility-maximizing model, whereas in a profit-maximizing model, an increase in $Y$ has no effect on intensity. This suggests one way to test an assumption that hospitals simply maximize profits.4

Cross-price effects are another way to test for profit maximization. For example, if Medicare lowers its price to a hospital, profit maximization predicts that intensity for other payers' discharges should be unaffected, in the absence of cross-payer demand, economies of scale, cost interactions and uncertainty. This prediction is a testable statement that is not true in a utility maximization model (in which the marginal utility of profit is not constant). Even within one payer's caseload, cross-price effects between services may be studied. As we will discuss below, the 'PPS-bite' measure of reimbursement impact has a cross-price effect interpretation which bears on the hypothesis of profit-maximization.5

In terms of the parameters of payment systems, $\alpha$ and $\beta$, an increase in $\alpha$ affects only $p$, the price per admission. An increase in $\alpha$ makes discharges more attractive and leads to an increase in intensity. An increase in $\beta$ means the hospital is reimbursed for a higher share of costs. With parameter $\alpha$ constant, an increase in $\beta$ makes discharges more attractive by increasing $p$, and makes intensity less costly to the hospital. With respect to both effects, an increase in $\beta$ increases intensity. Comparative statics support for the statements in this section is contained in the Appendix.

Table 1 summarizes the predictions from the models. The direction of

4Philanthropy is one form of outside income. Testing the effect of philanthropy on intensity is complicated by the possibility that donations respond to perceived quality of the hospital. Other researchers have proposed tests of the profit maximizing assumption. Hoerger (1991) contains a clever test for hospital pursuit of objectives other than profits, based on the observation that if the hospital has multiple objectives, the impact of an exogenous change affecting any one objective will be less than if the hospital has only one objective. Empirical tests confirm that profits in nonprofit hospitals are less sensitive to exogenous shocks than profits in for-profit hospitals. Dranove (1988) also proposes a test of the profit maximization assumption based on hospitals' cost-shifting behavior.

5A special case of the utility function is one where the hospital has a 'target' profit. Friedman and Farley (1992) model profit-targeting behavior, and indeed the non-profit status of the hospital can be represented as a constraint or target profit at zero. Cross-payer effects will be particularly strong under the assumption of a target profit because the marginal utility of profit will be declining extremely fast in the region of the target. Hospital supply in pursuit of 'target profit' possibly at zero is closely analogous to the utility model containing a 'target income' studied in the case of physician supply by McGuire and Pauly (1991).
Table 1
Hospital intensity response to reimbursement changes

<table>
<thead>
<tr>
<th>Hospital intensity response to:</th>
<th>Hospital objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Profit only</td>
</tr>
<tr>
<td>Increase in $\alpha$</td>
<td>+</td>
</tr>
<tr>
<td>(per-case payment)</td>
<td></td>
</tr>
<tr>
<td>Increase in $\beta$</td>
<td>+</td>
</tr>
<tr>
<td>(payer costshare)</td>
<td></td>
</tr>
<tr>
<td>Increase in $Y$</td>
<td>0</td>
</tr>
<tr>
<td>(outside income)</td>
<td></td>
</tr>
</tbody>
</table>

hospital responses to payment system parameters does not differ with hospital objectives. Whether or not the hospital is a pure profit-maximizer, it responds to increases in the marginal or average reimbursement by increasing the intensity of care. Only the hospital's treatment of outside income distinguishes the pure profit-maximizer from other hospitals.

4. Medicare experience with PPS

The major US experience with alternative hospital reimbursement systems has been Medicare's PPS. Has Medicare's experience with PPS been consistent with the model just set out?

4.1. Payment trends

Medicare policy over the 1980s can be summarized as follows. Prior to FY1982 when the TEFRA payment system was put into place, the Medicare payment system was roughly a cost-based system in which $\alpha = 0$, and $\beta = 1$. Medicare switched in FY1983 to a system in which $\alpha > 0$ and $\beta = 0$ (essentially). The parameter $\alpha$ was determined by case-mix and by adjustments for hospital type; the overall level of payment was initially intended to ensure that Medicare's payments would be the same as under a trending forward of the cost-based system.\(^6\)

With the exception of pass-through costs for non-operating expenditures

\(^6\)In fact, due to an error in rate calculation, the DRG rates were not budget-neutral as intended (ProPAC, 1988). The error resulted in excessively generous Federal rates, which would have overpaid hospitals by about 4% in aggregate if payments had been based solely on the Federal rate. As it turned out, the impact of the error was lessened by the fact that use of national rates was phased in, and initially, rates were based partly on a hospital's own historic cost base.
and very small outlier payments, the new payment system was entirely prospective. Since FY1983, the major changes Medicare has made in PPS are the movement to national rates, changes in the update factor, and the adjustments for particular hospital types, all of which may be interpreted as changes in the parameter $\alpha$.

Fig. 1 addresses the issue of overall payment generosity by comparing the movement of PPS payments per admission to the PPS update factor, and to an index of 'exogenous costs' which we have constructed (see below).

The PPS update factor is the annual increase in the base payment rate, which is set by policymakers. Fig. 1 shows that in the early years of PPS the updates were over 4 percent, but later they fell below 2 percent only to recover again more recently. The updates are intended to reflect 'changes in the prices of goods and services purchased by hospitals, as well as changes in hospital productivity, technological advances, quality of care and long-term cost-effectiveness of services' (ProPAC, 1992).

However, it may be seen from Fig. 1 that payments per admission increased at a substantially faster rate than the updates, particularly in the early years of PPS. ProPAC (1992) attributes most of the increases to a sharp increase in reported case-mix, reflecting both real resource use (rising severity as less sick patients were treated in non-PPS settings such as outpatient departments) and accounting changes (hospitals choosing diagnoses to maximize reimbursement).

Payments are only one aspect of reimbursement generosity, since we must also consider how costs changed. We compare update factors and changes in payments per admission to an estimate of cost changes exogenous to hospital behavior. We computed the change in 'exogenous cost' in each year, as follows:
Table 2
Sources of exogenous growth in hospital costs

<table>
<thead>
<tr>
<th>Year</th>
<th>Market basket</th>
<th>Intermediate productivity</th>
<th>True case-mix</th>
<th>Exogenous cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984</td>
<td>4.9</td>
<td>-1.6</td>
<td>1.1</td>
<td>7.6</td>
</tr>
<tr>
<td>1985</td>
<td>3.9</td>
<td>-3.8</td>
<td>1.3</td>
<td>9.0</td>
</tr>
<tr>
<td>1986</td>
<td>3.1</td>
<td>-1.2</td>
<td>1.3</td>
<td>5.6</td>
</tr>
<tr>
<td>1987</td>
<td>3.6</td>
<td>-1.4</td>
<td>1.6</td>
<td>6.6</td>
</tr>
<tr>
<td>1988</td>
<td>4.8</td>
<td>-0.3</td>
<td>1.5</td>
<td>6.6</td>
</tr>
<tr>
<td>1989</td>
<td>5.4</td>
<td>0.0</td>
<td>1.5</td>
<td>6.9</td>
</tr>
<tr>
<td>1990</td>
<td>4.5</td>
<td>-0.7</td>
<td>1.5</td>
<td>6.7</td>
</tr>
<tr>
<td>1991</td>
<td>4.3</td>
<td>-1.2</td>
<td>1.5</td>
<td>7.0</td>
</tr>
</tbody>
</table>

Note: Percent change in exogenous cost is computed as the percent change in the market basket, less the percent change in intermediate productivity, plus the true annual change in case-mix. Sources: ProPAC (1992, 1993) for productivity and market basket. Carter et al. (1991) for casemix change 1981-84 and 1986-88; other years were extrapolated by the authors.

\[
\% \Delta \text{cost} = \% \Delta \text{real case-mix} + \% \Delta \text{market basket} - \% \Delta \text{intermediate productivity}.
\]

ProPAC data (1992, 1993) were used for the market basket (an index of the cost of hospitals' purchased inputs) and for intermediate operating productivity.\(^7\) Real case-mix change is taken from the summary of existing research by Carter et al. (1991), with extrapolation for those years where they reported no estimate (see Table 2).

Fig. 1 shows that in every year exogenous costs have increased by at least 5 percent, and the increase has always exceeded the PPS update by at least 2 percent. Since 1986, exogenous cost has also been increasing more rapidly than payments per admission, suggesting that even the hospitals' upcoding activities could not keep revenues in line with costs. The result was a gradual

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\(^7\) ProPAC (1993, p. 67) defines aggregate intermediate productivity as 'service output per unit of labor (FTE employees) and supply and service inputs'. The index of service outputs is derived by finding the volume for each service, weighting that volume by inflation-adjusted posted charges for the service, and then aggregating across services. The supply and service input quantities are computed from overall cost figures, adjusted for price inflation. ProPAC uses AHA data to derive most of these series. Our exogenous cost measure incorporates intermediate productivity rather than productivity per discharge, because the latter is affected by intensity, which is endogenous in our model. (See Cromwell and Puskin, 1989, for greater detail about intensity and intermediate productivity change.)
but persistent erosion of payment generosity over time, with the payment–cost differential deteriorating by about 5% from 1986 to 1991.

What predictions does the model make based on these payment system changes?

**Prediction 1:** In the initial years of PPS, the switch to a prospective payment system was approximately payment-neutral (in other words, $c$ was set to be approximately equal to the forecast of average cost). Therefore, the reduction in parameter $p$ should have reduced intensity, decreased admissions, and increased profits (compared to trends under a hypothetical continuation of cost-based reimbursement).

**Prediction 2:** In subsequent years, the gradual decline in parameter $\alpha$ should have reduced intensity, decreased admissions, and decreased profits.

Fig. 2 illustrates these predictions by plotting costs and revenues as a function of intensity. Total cost is depicted as a convex, increasing function of intensity. An increase in intensity increases both cost per discharge and the number of discharges. Under cost-based reimbursement, total revenue equals total cost and hospital profits are zero for all choices of intensity. Hospital utility maximization takes place where the marginal utility of intensity (to the hospital) falls to zero. Suppose $I_c$ is that level.

The introduction of prospective rates creates a new total revenue function ($TR_1$). Total revenue is still an increasing function of intensity, since intensity...
Table 3
Predicted effects of prospective payment in terms of model parameters

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Early PPS</th>
<th>Later PPS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( (x \text{ constant, } \beta \text{ decreases}) )</td>
<td>( (x \text{ falling, } \beta \text{ constant}) )</td>
</tr>
<tr>
<td>Intensity</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Admissions</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hospital profits</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

... attracts more admissions – but the marginal effect of intensity diminishes, so \( TR \) is concave under prospective payment. If, as intended by Medicare, parameter \( x \) was payment-neutral then the new \( TR \) function would intersect \( TC \) at intensity level \( I_c \). The hospital which chose to continue supplying \( I_c \) would make zero profit as before. However, hospitals now have the opportunity to make profits. The profit-maximizing hospital will reduce intensity until it reaches \( I_1 \). Profits rise and discharges fall (because intensity falls).

The post-implementation decline in real \( DRG \) prices (that is, in \( x \)) is illustrated by the shift downward in the total revenue function, from \( TR_1 \) to \( TR_2 \). As a result, a further decrease in intensity occurs, from \( I_1 \) to \( I_2 \). At the same time, profits shrink, and discharges fall further.

Table 3 summarizes these predictions, for ease of comparison with the stylized empirical results to be discussed. Note that the model is developed in the case of a single hospital, whereas the data we review first are industry-wide.

4.2. Utilization trends

Fig. 3a presents Medicare utilization trends at short-stay hospitals before and after PPS, and highlights the sharp changes which coincided with PPS implementation. The volume of admissions, which had been increasing before PPS, dropped by 11 percent over the first eight years (most of this in the first two years). Length of stay per admission, which had been falling gradually, began a much faster decrease during early PPS. However, in later years LOS crept up again, so that by 1988 the overall change over the PPS period totalled 9.2%. Average LOS in 1989 was 8.8 days, close to its 1984 level of 8.9 days per admission.

Were these trends unique to Medicare, or merely reflective of the health...
Fig. 3a. Medicare utilization trends. Source: Health Care Financing Administration. Note: Short-stay hospitals only, for aged enrollees.

Fig. 3b. Utilization trends for population under age 65. Source: National Hospital Discharge Survey.

care system in general? To answer this question, Fig. 3b presents utilization data for the population under 65 (National Center for Health Statistics, 1992). It may be seen that admissions and LOS were both already declining in the under-65 population before Medicare trends began to decline in 1984–85. In this sense, the changes of 1984–85 brought Medicare into line with trends already found for other payers. However, the changes in Medicare are nonetheless striking for other reasons. First, in Medicare's case, the changes were a reversal of previous trends (which had been increasing),

8 The population under 65 includes a small number of people who are enrolled in Medicare due to disability or renal failure. However, the number is small enough to have little effect on the aggregate data.
rather than an acceleration of declines, as in the under-65 case. Second, the magnitude of the utilization changes from year to year is substantially greater in the case of Medicare.

However, length of stay is only one component of the intensity of care, which also includes such aspects as the number of procedures performed, time in special care units, etc. Data on pre-PPS intensity were presented in a study by Cromwell and Puskin (1989), but since their series runs only as far as 1987 we also present the ProPAC series, which runs from 1984 to 1991.9 It may be seen from Fig. 4 that the two series are in substantial agreement. Note that in both cases the change in intensity includes the LOS changes already presented in Fig. 3a.

The results show that intensity was increasing before PPS, and fell rapidly in the first two years of PPS. Intensity increased again in 1986–87. Thereafter, according to ProPAC, intensity growth slowed, reaching zero growth in 1990.

How well do these trends match the predictions? As the model would predict, during the first two years of PPS both admissions and intensity were lower than one would have expected, extrapolating from pre-PPS trends, or comparing to trends in the under age 65 population. In contrast, many

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9 Intensity has many components, so construction of a single-number intensity measure raises aggregation issues. ProPAC measures the relative value of hospitals' intermediate service units by their posted charges, with adjustments for price change. Cromwell and Puskin use one measure for each of the 34 cost centers within the hospital: for bed accommodations the measure is patient days per discharge (average LOS), but other units are evaluated by the number of visits, procedures and so forth.
observers expected hospitals to increase volume, since PPS made admissions more profitable. [See for example Lave (1984, p. 261), Guterman and Dobson (1986, p. 98)]. This view neglects the fact that the way admissions were made profitable by hospitals was by decreasing intensity. Our model emphasizes that the demand-side effect of lowering intensity is to lower admissions. Indeed, intensity change appears to have led admissions change in the trend data.

Intensity growth rebounded during 1986–87, with intensity growing at roughly the same rate as prior to PPS, over a period when the updates were falling short of cost increases. This contradicts the model's prediction that reductions in parameter $\alpha$ should reduce intensity. Several explanations can be considered for the rebound effect.

Some analysts suggest that hospitals which accumulated windfall profits during early PPS appear to have spent them on innovations which enhance demand but also raise intensity and cost [Sheingold (1989)]. Such hospitals then found themselves locked into higher average costs, possibly because they failed to anticipate the eventual slowdown of update factors. A second consideration might be inability of hospitals to discriminate by payer in their intensity provision, which would reduce their responsiveness to cuts in Medicare's reimbursement level. Finally, some of the early decreases in intensity at PPS hospitals could have been one-time savings, such as would be achieved by a shift of long-stay patients from acute care hospitals to PPS-exempt settings [Newhouse and Byrne (1988)]. Since this process could not continue indefinitely, neither could the decline in intensity.

Trends after 1987 are more in keeping with the model's predictions, as intensity growth slowed somewhat, to below pre-PPS levels. One could argue that this represents hospitals' rational long-run response to the continued decline in the real value of $\alpha$, whatever the reason for the intensity growth in 1986–87. We therefore conclude that the model's predictions about utilization are broadly supported by the aggregate data on the early and late years of PPS, but that questions remain about the middle years.

4.3. Profitability trends

When combined with slower growth in payment rates, the steady annual cost inflation has resulted in worsening PPS margins for hospitals. Fig. 5 shows the evolution of average PPS margins from 14.5 percent in year 1 to a projected -10.2 percent in year 9. The averages conceal considerable dispersion which has increased over time, despite policymakers' modifications of PPS designed to mitigate its distributional effects. Over the same period hospitals' total margins (including non-Medicare) have also fallen slightly while remaining positive on average.
The profitability trends are thus in accordance with the model's predictions. The introduction of PPS reduced parameter $\beta$, allowing hospitals to keep their profits, and hospital profits therefore started out high compared to pre-PPS levels. The subsequent real decreases in a reduced profits, as hospitals earned lower profits on each admission.\footnote{Of course, deterioration of accounting profit does not have a straightforward interpretation in an industry where firms are widely believed to have other objectives in addition to profit. Hospitals which earned windfall profits during early PPS may have turned some of the surplus into managerial rents, or intensity in excess of the profit-maximizing level. Any of these items would appear in the accounts as cost, and therefore understake true potential profit. For example, Fisher (1992) discusses evidence that some hospitals overstated their Medicare inpatient costs, resulting in lower reported profits. This could have been an attempt to influence subsequent PPS updates.}

5. Empirical evidence: controlled studies

This section evaluates several studies which attempt to separate out the effect of reimbursement changes from other effects on hospital behavior. Of particular interest are studies which identify a separate effect of the level of prospective payment (parameter $\alpha$ in the model), independent of the effects of changes in the payer's share of costs (parameter $\beta$). Studies of this type will be discussed in greater detail, followed by a review of some other reimbursement studies. Table 4 presents a schematic overview of studies discussed, in terms of whether they address variation in $\alpha$, $\beta$ or both.
Table 4
Hospital response to reimbursement change: some recent studies

<table>
<thead>
<tr>
<th>Paper</th>
<th>Source of variation in payment</th>
<th>Model parameters affected</th>
<th>Does the study observe variance in $\alpha$, $\beta$ at the hospital level?</th>
<th>Effect of $\alpha$ on</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Intensity</td>
</tr>
<tr>
<td>A. Studies which isolate the effect of $\alpha$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hadley et al. (1989)</td>
<td>1. Cross-section: hospital's length of time on PPS, in 1985</td>
<td>$\alpha$</td>
<td>$Y$</td>
<td>+ -</td>
</tr>
<tr>
<td></td>
<td>2. Cross-section: variations in fiscal pressure among PPS hospitals</td>
<td>$\alpha$</td>
<td>$Y$</td>
<td>+ -</td>
</tr>
<tr>
<td></td>
<td>3. Over time: variations in fiscal pressure among PPS hospitals</td>
<td>$\alpha$</td>
<td>$Y$</td>
<td>+ -</td>
</tr>
<tr>
<td>Newhouse (1989)</td>
<td>Variations in nationwide average profit, by DRG</td>
<td>$\alpha$</td>
<td>$N$</td>
<td>n/a +</td>
</tr>
<tr>
<td>Staiger &amp; Gaumer (1989)</td>
<td>Variations in hospital payment rates, under PPS 1984-87</td>
<td>$\alpha$</td>
<td>$Y$</td>
<td>+* n/a</td>
</tr>
<tr>
<td>B. Other relevant studies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frank and Lave (1989)</td>
<td>Interstate differences in Medicaid reimbursement systems</td>
<td>$\alpha, \beta$</td>
<td>$Y$</td>
<td></td>
</tr>
<tr>
<td>Dranove (1988)</td>
<td>Change in Medicaid per diem</td>
<td>$\beta$</td>
<td>$N$</td>
<td></td>
</tr>
</tbody>
</table>

*Assuming that mortality is a negative function of intensity.
5.1. Studies of variation in average payment levels

A recurring feature of these studies is the appearance of a 'PPS bite' variable, involving the interaction of each hospital's PPS payment rate with a measure of its dependence on Medicare. The aim is to measure the degree of 'fiscal pressure' to which PPS subjects each hospital.

Hadley et al.

Hadley, Zuckerman and Feder (1989) used hospital-level data to investigate the role of fiscal pressure in determining hospitals' response to PPS incentives. Their key variable was the 'fiscal pressure' index, an estimate of each hospital's likely margin on Medicare inpatients if it did not alter costs or volume from the previous year.

Fiscal pressure by this definition varied among hospitals at any given date (with their costs and dependence on Medicare), and also at the same hospital over time (with the update factor and the phase-in to national rates). Hadley et al. asked how these variations were related to the pace of change in hospital utilization and financial performance. Regressions included controls for the number of years a given hospital had been on PPS, since utilization changes in the early years were likely to reflect the change in marginal incentives as well as any change in fiscal pressure. Pressure was recoded as low, middle or high (the first, middle two or fourth quartiles of the index, respectively). Other control variables included bedsize, region, teaching status and ownership.

Hadley et al. found that among hospitals entering PPS in FY1985, the (controlled) LOS reduction was 9.4% for highly pressured hospitals, compared to 6.8% at ones facing low pressure (see Table 5). If the controls were adequate, then pressure differences account for a major difference in response, since these hospitals all faced the same change in marginal incentives. At the same time, the decline in discharges (see Table 6) was greatest at the least pressured hospitals (14.1 percent, compare to 10.8 percent at the most
Table 6
Percent change in Medicare discharges 1984–85 by time on PPS, fiscal pressure

<table>
<thead>
<tr>
<th>Hospital's time on PPS</th>
<th>Degree of fiscal pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>First year</td>
<td>-14.1%</td>
</tr>
<tr>
<td>Second year</td>
<td>+10.9%</td>
</tr>
</tbody>
</table>

Note: Time on PPS is computed as of hospital's FY 1985. Changes are coefficients from multivariate regression.
Source: Hadley, Zuckerman and Feder (1989), Table 2.

pressed hospitals). Hadley et al. suggest that this implies Medicare discharges were profitable in the sense of making a contribution to overhead, whatever the nominal ‘Medicare margin’. Highly pressured hospitals needed such contributions the most, and were therefore less willing to transfer Medicare patients to their outpatient clinics, as the low-pressure hospitals were doing.¹¹

In conclusion, the results in Hadley et al. strongly suggest that the average payment level affects LOS independently of marginal incentives, but do not directly estimate the magnitude of the effect. In terms of our model, they support the idea that payment generosity has an independent positive effect on intensity, but the effect on discharges has the wrong sign (with payment hikes resulting in reduced admissions).

Newhouse

Newhouse (1989) tested various hypotheses about hospital behavior, using the fact that DRGs differed in their profitability. Medicare had intended to choose DRG weights to equalize average accounting profitability, based on 1981 cost data, but Newhouse showed that coding and technology changes between 1981 and 1984 (the implementation year) resulted in substantial variation in accounting profitability between DRGs.

Newhouse computed the national mean profit for each DRG, and ranked the 470 DRGs by their accounting profitability. He found that 31 had negative accounting profits. (Newhouse notes that accounting profit is defined somewhat differently than economic profit, but suggests the rankings may still be similar.) He then defined city and county hospitals as ‘hospitals

¹¹ In addition to the analysis of PPS newcomers, Hadley et al. also looked at 1985 utilization in hospitals which had already been on PPS one year, with the idea that much of the response to increased cost-sharing should have already occurred in 1984. Most results were of the same sign but smaller, with highly pressured hospitals again revealing larger LOS declines and smaller decreases in discharges than other hospitals.
of last resort', and asked whether patients in unprofitable DRGs were more likely to be transferred to such hospitals, or whether such DRGs were overrepresented in the last-resort hospitals' caseload. Where found, such differences were to be interpreted as 'selection' by private hospitals steering unprofitable patients elsewhere, either via transfers or other means.

Newhouse found that 'transfer behavior provides no evidence for the existence of selection', since the percent of cases transferred out of the hospital was actually higher at last-resort hospitals than at other hospitals. Also, patients in unprofitable DRGs were less likely than other patients to be transferred. On the other hand, for unprofitable DRGs there was a strongly significant difference between last-resort and other hospitals in the cumulative distribution of cases by profitability. In PPS year 1, 2.2 percent of cases at the last-resort hospitals studied were for unprofitable DRGs. By comparison, 1.9 percent of cases at other hospitals were in unprofitable DRGs. Furthermore, Newhouse showed that the pattern was not a reflection of pre-PPS trends, and that there had been a swing of about one-quarter of all unprofitable cases towards last-resort hospitals.

The implication for the selection hypothesis which Newhouse was testing is that selection does indeed appear to be occurring, but not by extensive use of transfers [the usual mechanism assumed in economic models of selection, such as Dranove (1987)]. In terms of the current paper, Newhouse's work implies a strong effect of average payment levels on admission patterns, since the interhospital differences in caseload cannot be attributed to differing marginal incentives.

Staiger and Gaumer

Staiger and Gaumer (1992) evaluated the impact of reimbursement on Medicare hospital mortality rates. Strictly, mortality reflects more than just hospital behavior, since it may be affected by demographic and other changes in the hospital catchment area. However, their study is still of interest because their chief reimbursement variable is the hospital-specific payment rate for each DRG, observed over several years of PPS. In other words, their data do not include variation in the marginal incentive, only in the average payment level within PPS.

Staiger and Gaumer used AHA data on Medicare patients in short-stay general hospitals for urgent care in general and for two specific diagnoses, over the period 1984–87. During this period PPS payment rates changed substantially, both because of one-time changes in the adjustment formulas (in 1986) and because of a phased transition from hospital-specific to national payment rates. Staiger and Gaumer used Medicare formulas to compute each hospital's payment rate, excluding potentially endogenous components such as case-mix adjustment. In addition, they computed a PPS
The 'bite' variable, defined as the payment rate times Medicare's share of total hospital costs in 1984.

Their dependent variables were mortality rates over various periods of between 15 days and one year after discharge. Regressors included the PPS payment rate, the PPS bite, admission volume, predicted mortality and a hospital-specific fixed effect (since each hospital contributed multiple observations).

Staiger and Gaumer's main finding is that reductions in reimbursement under PPS are associated with increased mortality rates. However, much of this impact involved shifting the timing of death within the first year after discharge, not decreasing long-term survival. In addition, the results suggest differential response by ownership. A 10% decrease in the PPS payment rate to government hospitals is associated with an additional 11 to 12 deaths per 1000 urgent care admissions, whereas the same rate decrease at non-government hospitals adds only 2 to 3 deaths per 1000.

Several aspects of the results are particularly relevant to the current paper. First, Staiger and Gaumer found that the PPS bite variable had considerably more explanatory power than the PPS payment level alone; in other words, payment rates mattered much more if Medicare had a large share of volume at the hospital. Possible reasons for this will be considered in the discussion section below. Second, the stronger reimbursement response by government hospitals could imply that they have different objectives or constraints, for example a more stringent profitability constraint. Staiger and Gaumer note this possibility, along with an alternative one — that government hospitals have fewer resources, so additional resources have a high marginal benefit (mortality reduction). Finally, if reimbursement affects mortality, it is likely that one important mechanism through which this occurs is hospital intensity choice.

5.2. Studies of reimbursement effects in general

There have been a large number of studies of PPS, reviewed most recently in Coulam and Gaumer (1991). However, only a minority have attempted carefully to separate the impact of PPS from other concurrent changes in the health care system, such as technological change, demographic trends and private sector cost-containment. [For example, see Cutler (1990).]

In the case of Medicaid, Frank and Lave (1989) estimated duration models of length of stay for four different reimbursement systems, using psychiatric discharge data from state Medicaid programs which paid for care in a variety of ways. A semiparametric specification was used to estimate the hazard models, in order to avoid unduly restricting the parameter values. Controls included patient characteristics (age, sex, race, marital status,
diagnosis); statewide hospital beds per capita (general and psychiatric); and
dummies for whether each state Medicaid program used prior authorization
and utilization review.

Fig. 6 illustrates Frank and Lave's results in terms of the probability of
being discharged during various day-intervals, under prospective or cost-
based reimbursement. It may be seen that the probability of a patient staying
between 8 and 20 days is greater if the payment system is prospective per
case. Thereafter, the probability of staying a given number of days is always
less under per case payment, as one would expect. On the other hand,
patients paid under per case were actually less likely to be discharged in the
early days after admission, contrary to usual predictions.

The study confirmed expectations about the LOS-shortening effect of
prospective reimbursement, on average, compared to cost-based payment. At
the same time it showed that per case payment reduces the number of short
stays too, suggesting that hospitals may selectively increase LOS to attract
patients expected to be profitable. If this explanation is correct, then the
results reflect the effect of payment generosity which differed across high and
low-cost patients, as well as different marginal incentives. Both selection and
moral hazard effects may be operative. However, the study did not control
for differences in payment generosity between state Medicaid programs (or
among DRGs within programs), so it is not possible to separate out the
effects of marginal incentives from average payment levels.

Finally, it is worth noting the literature which has grown up about cost-
shifting responses to PPS, since this has raised questions about both
reimbursement response and hospital objectives. In his 1988 study, Dranove
found that during the early 1980s, hospitals in Illinois responded to cuts in
Medicaid per diem reimbursement by raising their prices to private payers.
Dranove agreed with earlier studies that this type of behavior was not compatible with the separation in pricing decisions implied by pure profit maximization [e.g. Hay (1983), Foster (1985)]. However, Hoerger (1991) has argued that if non-profits value quality as well as quantity, they will not necessarily respond to Medicare price cuts by raising private price, but may instead lower private quality.

Dranove's paper is not useful for isolating the effects of changes in average reimbursement, since the per diem reductions basically amounted to a change in the level of cost-sharing only. (To see this, note that in a per diem system, $\beta = \text{per diem rate/average cost per day}$, and parameter $\alpha$ was zero before and after the cuts.) However, the cost-shifting papers do make the wider point that hospitals are multiproduct firms supplying payers with varying reimbursement systems. This suggests the importance of extending the single-payer model in Section 3 to address cross-payer effects. An additional reason for modeling multiple payers is the independent significance of 'PPS-bite'-type variables in several of the studies reviewed. In other words, even the magnitude of the 'own-price' responses to a price cut appears to be affected by the relative importance of the price-cutting payer in the hospital's case-load.

5.3. Discussion of controlled studies

Several lessons may be drawn from the literature reviewed in this section. First, many studies do not attempt to separate the effects of average and marginal reimbursement levels on hospital utilization, or discuss the issue. There is some awareness in the policy literature that the payment level 'matters', but this awareness is not often reflected in the design of PPS impact studies, as the prevalence of pre-post studies indicates.

Second, in those studies which disentangle the average payment level from other reimbursement effects, it is found to have a substantial effect. Staiger and Gaumer found that a 10% decrease in the PPS payment rate for any hospital is associated with an increase of 10 to 15 deaths per 1000 acute myocardial infarction admissions. These results imply that any study of PPS implementation which ignores the large initial increase in average payment levels is introducing a substantial downward bias in its estimates of marginal-incentive effects.

Finally, the direction of the effects is not always in accordance with predictions from our model. In the Hadley et al. study, average reimbursement level has a positive effect on length of stay, as expected, but a negative effect on admissions which persists in three different tests. On the other hand, positive effects are found by Newhouse (1989) for admissions and by Staiger and Gaumer (1992) for patient survival, which we regard as a function of
intensity. These results are encouraging, and suggest that further study of this issue will be enlightening.

A common theme of the studies is the finding that hospital response to a Medicare price change varies with Medicare’s share of the hospital’s overall volume. Where the two terms are combined as a ‘PPS bite’ this typically explains more behavior change than does the PPS payment rate alone. Staiger and Gaumer suggest that the PPS bite should not be relevant if hospitals maximized profits alone, and could offer differing intensity levels for Medicare versus private-pay patients. By implication, the independent significance of PPS-bite suggests non-profit objectives. However, an alternative explanation would be that even pure profit-maximizers may choose not to use their ability to quality-discriminate, because it is not worthwhile due to joint or transaction costs of intensity provision.\(^\text{12}\)

The question of whether hospitals can be regarded as maximizing ‘only’ profits cannot be answered based on the literature here. This is not surprising, since we noted in Section 3 that a simple single-payer model predicts that the presence or absence of non-profit objectives does not affect the direction of response to reimbursement changes. More theoretical and empirical work on multipayer models is needed, as well as empirical tests which recognize the potentially contradictory effects of changing from one reimbursement system to another.

6. Conclusion

The basic insight suggested by our model is that any change in hospital reimbursement has two potential effects, which it is useful to distinguish. Economists usually focus on the incentive effect of changes in the marginal level of reimbursement, but the average reimbursement level also affects hospital choices. The evidence reviewed above supports the importance of this distinction, in that the average payment level is found to have a significant effect on hospital utilization even when the marginal incentive is held constant. All in all, PPS has had a depressing effect on intensity and volume which can be understood in terms of the incentives to produce intensity embodied in the marginal and average payment levels. Incorporation of demand-side effects helps in making sense of the pattern of changes.

At the same time, the direction of the effect is not always in the predicted direction, perhaps due to the omissions of our model. In particular, our assumption that admissions are a positive function of intensity alone forces

\(^{12}\)This argument is a variant of the ‘norms hypothesis’, whereby hospitals choose intensity for a patient based not only on that patient’s insurance coverage but also (and independently) on the average coverage in the hospital’s caseload or community (Newhouse and Marquis, 1978).
the two to move in lockstep, which is contradicted by some of the data. Although we believe our model has been helpful in structuring this review of PPS impacts, the model is probably too simple to adequately account for all observed behavior. It is worth reemphasizing the features which are missing from our model, which include interhospital competition, attention to non-operating costs, the behavior of other payers, the role of internal hospital organization, and the efficiency of hospital production. All of these are worthy candidates for future extensions, as they are likely to affect response to reimbursement changes.

It is particularly noteworthy that most models of PPS find the post-PPS drop in admissions to be an anomaly, whereas in our model such a decline is predictable, since cutting intensity reduces the demand for admissions. If we were merely claiming that intensity reductions persuaded some patients to leave the market, that is, to go untreated, then such a demand-side explanation would be implausible. However, demand effects are better understood in terms of the rapid expansion of outpatient treatment which coincided with PPS. The patient and/or physician were faced with a choice between an abbreviated admission, which would no longer include a prolonged stay for recuperation, and outpatient treatment, where many of the same services (other than a bed) were now on offer. Hospitals’ reductions in inpatient intensity made outpatient care a relatively more attractive option, and hastened the reduction in admission rates, even if other factors such as technology and regulation by peer review organizations also played a role.

Resolution of the question of the PPS effect on discharges is an important topic for research. Our model generates testable predictions about how the change in discharges should differ across types of hospital and types of discharge. More ‘profitable’ discharges should respond in different ways than less ‘profitable’ ones. Measures of expected profitability could be developed and tested in empirical work to pursue the question of the types of discharges that were discouraged by PPS. Future research should also investigate the role of Peer Review Organizations in volume changes.

Most of the research into prospective payment has looked at Medicare, focusing on the effect of replacing cost reimbursement with prospective payment. However, the introduction of PPS altered both marginal and average reimbursement simultaneously, and it has proven hard to disentangle the two effects even in the few cases where researchers have tried. Given this difficulty, the effects of Medicare’s PPS implementation are of limited relevance to other payers considering prospective payment, such as state Medicaid programs. For these other payers, the magnitude of volume and intensity response to prospective payment will almost certainly differ from what Medicare experienced, since other payers will not be altering average reimbursement levels in exactly the same amount as Medicare did.
Appendix: Second-order condition and comparative static results

The results presented in Section 3 assume that the hospital's maximization problem has an interior solution. This appendix first identifies conditions under which an interior solution exists, and then notes further conditions under which the comparative statics results hold. For ease of exposition, we first consider the case where the hospital maximizes profits only.

A1. Profit maximization

In the case of pure profit maximization, the first-order condition [Eq. (9)] was derived by differentiating eq. (8) with respect to \( I \). Differentiating (9) again with respect to \( I \), the second-order condition for profit maximization is:

\[
X''(p - c) - 2c'X'(1 - \beta) - Xc''(1 - \beta) < 0. \quad (11)
\]

The second-order condition might fail if intensity has a strongly increasing marginal effect on demand (\( X'' \gg 0 \), and also assuming \( p > c \)) or if average cost per admission were a sufficiently concave function of intensity (\( c'' \ll 0 \)). However, neither situation seems likely, so the SOC should hold. (The problem is similar to the monopolist's choice of quality, discussed in Tirole (1988, p. 100).

Assuming the second-order condition is satisfied, comparative static questions may be addressed by applying the implicit function rule to the first-order condition. Let the left-hand sides of the first- and second-order conditions be denoted as \( F^* \) and \( S^* \), respectively (where \( \pi \) denotes pure profit-maximizing behavior). Then the effect of a change in the per-case fixed reimbursement (\( \alpha \)) on intensity is given by:

\[
\frac{dI}{d\alpha} = \frac{d(F^*)/d\alpha}{-d(F^*)/dI} = \frac{X'}{-S'^*}. \quad (12)
\]

The numerator is positive by earlier assumption, and the denominator must be positive if the problem has an interior solution. So \( dI/d\alpha \) is positive.

The effect of a change in the portion of cost reimbursed (\( \beta \)) is given by:

\[
\frac{dI}{d\beta} = \frac{X'c + Xc'}{-S^*}. \quad (13)
\]

Both terms in the numerator are positive from earlier assumptions, as is the denominator. The whole expression is therefore positive.
A2. Utility-maximizing hospital

Consider now the more general case [Eq. (1)] in which the hospital derives utility from intensity as well as from profit. The first-order condition in (10) generalizes to:

\[
\frac{dU}{d\pi} \{X'(p-c) - Xc'(1-\beta)\} + \frac{dU}{dI} = 0. \tag{14}
\]

The following proposition will prove necessary later.

**Proposition:** The hospital which values intensity will choose a higher level of intensity than the profit-maximizing hospital, even if they face identical costs and demands. Therefore, the left-hand side of the profit-maximizing first-order condition \(F_\pi\) will be negative at the utility-maximizer's optimal intensity level.

This follows from the fact that intensity is a normal good in the utility-maximizing case, but neither a good nor a bad in the profit-maximizing case.

Assuming that crosspartials are zero, the second-order condition for the utility-maximization problem is:

\[
U_{\pi I} + U_\pi \{X''[(\alpha/(1-\beta) - c] - 2c'X' - Xc''\} < 0. \tag{15}
\]

Note that the expression in curly brackets is the second-order condition from the simpler case where only profits are maximized \(S^*\). It has already been shown in that context that the expression should be negative except in the unlikely case where \(X'' > 0\) or \(c'' < 0\). If we further assume that the utility function is strictly concave in both arguments \(U_{\pi I}, U_{\pi \pi} < 0\), then the utility-maximization SOC will certainly be satisfied [since both components of (15) are negative].

We can now evaluate whether the comparative static results differ once the hospital has other objectives in addition to profit.

The effect of a change in the per case fixed payment is:

\[
\frac{dI}{d\alpha} = \frac{U_\pi X'}{-S^U}, \tag{16}
\]

which is unambiguously positive long as the second-order condition is satisfied.

The effect of a change in the payer's cost-share \(\beta\) is:

\[
\frac{dI}{d\beta} = \frac{U_{\pi \pi} cX \{X'(p-c) - Xc'(1-\beta)\} + U_\pi \{X'c + Xc'\}}{-S^U}.
\]

\[
= \frac{U_{\pi \pi} cX \{F^* \} + U_\pi \{[dI/d\beta]' [-S^*] \}}{-S^U}. \tag{17}
\]
If the second-order condition is satisfied, the denominator of this expression must be positive. In addition, the first term of the numerator is positive, from the concavity of \( U(\pi, I) \) and from the fact that \( F'' \) is negative at the intensity level which maximizes utility (see Proposition). Finally, the second term in the numerator will be positive from earlier assumptions. Under these general conditions, \( dI/d\beta \) is positive for the utility-maximizer as for the profit-maximizer.

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