

Do hospitals behave like consumers? An analysis of expenditures and revenues

by Edgar A. Peden

Hospitals adjust expenditures to be a constant proportion of their revenues. An unexpected 10-percent change in hospital revenue generates a 3.5 - 4.8 percent expenditure change (in the same direction) the year it occurs, with declining changes thereafter (10 percent in total). Non-profit and government hospitals adjust expenditures about 80 percent of the way toward their

longrun change near the end of the third year of the revenue change; for-profit hospitals do this at the end of the fourth year. Hospitals with revenue increases make an 80-percent adjustment toward the end of the third year; those with revenue declines do so near the end of the fourth year.

Introduction

Historical hospital data show a strikingly close relationship between hospital revenues and expenditures, both in aggregate and for individual hospitals. American Hospital Association (AHA) data for 1966-90 indicate that total expenditures for community hospitals by 5-year segments (1966-70, 1971-75, etc.) were 97.2, 98.8, 97.2, 95.4, and 96.0 percent of total net revenues, respectively, at a time when both revenues and expenditures increased about twentyfold¹ (1966-69 data from American Hospital Association [1991]; 1970-90 data from American Hospital Association [1970-90]).

This stable longrun relationship between expenditures and revenues is similar to that relating consumption and income found by Kuznets (1946) who, using data from the period 1869-1928, showed that, during this long period of dramatically rising income, the consumption-income ratio varied only between 0.83 and 0.90. Both consumers and hospitals have receipts that they spend to further some measure of well-being. And because both seem to behave in such a way that their expenses (consumption for consumers and expenditures for hospitals) are a longrun stable proportion of receipts (income for consumers and revenue for hospitals), it is plausible that they exhibit similar behaviors in moving toward the long run.

With this background, I examine whether the model of consumer behavior seen in Milton Friedman's (1957) permanent-income hypothesis, a model that has proved quite fruitful in looking at consumption behavior (Evans, 1969), might also be a useful analog for explaining hospital expenditure behavior. Just as Friedman has shown a systematic way in which consumption adapts to changes in income over time (the

consumption-income ratio moving toward longrun equilibrium), so might there be a similar systematic relationship in which expenditures adapt to changes in hospital revenues over time, their ratio also moving toward a longrun equilibrium.

Friedman posits that consumers base their consumption (except for a random component) only on permanent (or expected longrun) income and shows how expectations are formed that determine permanent income as a function of current and past levels of income. Unexpected shifts in the income stream result in changes in permanent income only to the extent that they persist over time, and when they do, consumption changes as well. In addition, Friedman's model contains a parameter for determining how quickly consumers adjust their consumption to an unexpected shift in income. Following Friedman's propositions, I develop a model in which hospitals base their expenditures on permanent revenues, resulting, in effect, in a permanent-revenue hypothesis. I also posit an analog to the consumer-adjustment mechanism in which hospitals determine their permanent (or expected longrun) revenues based on current and past revenues. Finally, the model contains a parameter (similar to Friedman's) for determining how quickly hospitals adjust their expenditures to unexpected changes in revenues.

My analysis begins by looking at the rationale for viewing hospital expenditure behavior as an analog to consumer consumption behavior, then I present Friedman's model. Using Friedman's framework as a basis, a model of hospital economic behavior is developed relating expenditures to revenues. The model is estimated using the Health Care Financing Administration (HCFA) hospital cost report data for the second through fifth years (PPS2-PPS5) of the prospective payment system (PPS) (approximately 1985-88) (Health Care Financing Administration, 1991). The purpose here is twofold: to test whether the data from HCFA's cost reports support the permanent-revenue hypothesis, in particular the constant longrun expenditure-revenue ratio, and within the context of the estimated model, to estimate how quickly hospitals adjust expenditures to unexpected shifts in revenue. The results as a whole might then be used to look at the response of hospitals to changes in revenues resulting from government policy changes.

¹The relationship, although fairly stable, contains two slightly anomalous periods: The 1971-75 period encompassed the economic stabilization program, when the percentage rose to an average of 98.8 percent, and the 1981-85 period, when the prospective payment system was introduced and the percentage averaged only 95.4 percent.

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I then expand on the similarities between the permanent-income hypothesis and the expenditure behavior found for hospitals. For this purpose, the findings of a number of other researchers are brought to bear, and an economic picture of hospitals' responses to changes in revenue is drawn with respect to both the speed and magnitude of expenditure changes and the changing nature of these expenditures. Hospital expenditure behavior is put in terms of a consumer-hospital analogy. In this context, the implications for how revenue cuts will affect hospital expenditures are examined. In particular, given the results of the study, I look at whether it is possible to control expenditures (and the cost of hospital care) by controlling revenues and how such reductions in revenues would affect the way hospitals do business.

Rationale for the permanent-revenue hypothesis

One can analogize the expenditure behavior of consumers and firms (in this case hospitals) by equating consumption to expenditures and income to revenues. But in addition to consumption and expenditures constituting an outflow of funds and income and revenues an inflow of funds, one must look more closely at the sense in which the consumption-income relationship is analogous to the expenditure-revenue relationship.

Consumers and hospitals have similar problems. Both face situations in which if they borrow money now, it must be paid back in the future, or if they lend money now, they will have more to spend in the future. Investment opportunities are experienced by each as they orient their activities to realize longrun gains. Both face windfall gains and losses, hard times, and changes in financial markets that might affect their decisionmaking.

One substantive difference between consumers and hospitals may be that consumers have a finite life, whereas hospitals presumably have infinite lives. But this should affect primarily how each views and discounts its income stream. And if anything, this difference should make consumer behavior less generalizable and less stable than hospital behavior. But the permanent-income hypothesis posits a highly general and stable model across consumers. Thus, one might suspect that hospital behavior would be highly predictable as well.

One might also consider the expenditure objectives of consumers and hospitals to see whether these objectives are analogous in the sense that they lead to analogous behavior. For consumers, the normal objective assumed is maximizing utility given their past, current, and expected income stream. But hospitals too can have objectives that would imply such a relationship between expenditures and revenues. What follows is a look at some of these objectives.

Given that the majority of hospitals are not-for-profit hospitals, and these set the industry norm, it could be that hospitals act to maximize their institutional prestige subject to their revenue

constraints, as in Vladeck (1976). He conjectures that this might take the form of hospitals (and other similar non-profit institutions) attracting "superstars" who "are lured from one institution to another by the presence of others of their ilk—an extremely circular process and by the promise of physical facilities and surroundings appropriate to such great men." If this is the case, one would expect the sort of highly stable relationship between expenditures and revenue predicted by the permanent-revenue hypothesis, because the proportion of revenues spent to enhance institutional prestige would be targeted at some optimum level (close to 1), at which expenditures are this proportion times the amount of revenues regarded as permanent.

Others present a similar scenario. Lee (1971) argues that hospitals maximize prestige. Newhouse (1970) and Feldstein (1971a, b), to quote Budde and Meeker (1978), "both assume that hospitals maximize a combination of quality and quantity subject to the constraint that they break even, or in the case of those with an endowment, that their total revenue from patient revenues plus their income from the endowment must equal total costs."

What these findings tell us in general is that when hospitals compete with the objective of something other than profit, they will end up spending the revenues they take in to maximize quality, prestige, quantity, etc. The constraint these hospitals face would be that revenues cover expenditures over time or, stated another way, that there is some profit target such that revenues exceed expenditures by a given percentage. Expenditures are adjusted to maximize the hospital's objective and thus become a given proportion of permanent revenues.

But even if hospitals are profit maximizers, it is possible that expenditures could follow revenues in the manner predicted by the permanent-revenue hypothesis. To the extent that hospitals compete on the basis of quality (so-called "non-price competition"), their costs will be greater to pay for increased quality. Thus, if the pursuit of profits is part or all of their objective, and they compete with other hospitals on the basis of quality, one could find that expenditures closely follow revenues. Quoting Pope (1989), from a study of non-price competition among hospitals, "The more competitive the market is—measured by either the number of competitors or the mobility of patients/physicians among hospitals—the higher equilibrium quality expenditures will be. The higher quality raises costs and lowers profits [revenues-expenditures]."

In a classic article, Donald Dewey (1962) showed that firms will invariably operate in situations in which their revenues just cover expenditures (except for a normal, opportunity-cost, rate of return). This occurs because when profits rise, for example from an increase in demand, they are capitalized into costs and taken as rent (a fixed cost). One way this occurs is that when a profitable firm is sold, the old owners capture the firm's discounted profits in the sale price. The new owners however, will regard the latter as a fixed cost. Spreading

these fixed costs over greater levels of output will mean that average cost will fall as output levels rise. Indeed, Dewey concludes, “. . . virtually all studies of average cost in the business world have reached the same conclusion, i.e., that most firms most of the time operate at an output where average cost is falling.”

Moreover, Dewey generalizes this phenomenon to argue that when the factor markets are imperfect, profits will be captured by factors of production. Again, suppose there is an increase in demand for a firm's product. This will in turn raise the demand for factors of production, such as workers. And unless their supply is perfectly elastic, this demand will raise their wages. Profits are thus captured as rent in the form of higher wages. Indeed, Dewey tells us that “factor markets do an excellent job of rapidly capitalizing rents and monopoly profits into factor costs—which we ought to have suspected.” In sum, Dewey tells us that “in all firms at all times average cost ‘tends’ toward average revenue irrespective of the degree of competition prevailing in the factor or product markets. When factors are free to move, and none can command a rent, the equality is produced by factor movements and the concomitant changes on output. When these conditions are not present, the equality is produced by the capitalization of the surplus (rent or monopoly profit) into factor costs.”

Friedman's permanent-income hypothesis

Milton Friedman's permanent-income hypothesis postulates that a consuming unit's permanent consumption (expressed as *Comp*) will be a proportion of its permanent income:

$$Comp = K(i, w, v) Yp \quad (1)$$

where *Yp* is permanent (or expected average long-term) income, and *K* is the proportion consumed ($0 < K < 1$) (Friedman, 1957). Permanent income *Yp* is “the income on which consumers actually base their behavior . . . the amount a consumer could consume (or believes it could) while maintaining its wealth intact” (Evans, 1969). The factor of proportionality, *K*, will, according to Friedman, vary with the interest rate, *i*, the ratio of non-human wealth to total wealth (non-human plus human wealth), *w*, and the consumer's propensity to consume (e.g., age and taste), *v*. However, *K* does not vary with permanent income, *Yp* (Aschheim and Hsieh, 1980).

Because permanent consumption is based on permanent rather than actual income, Friedman distinguishes the two, calling actual income “*Y*,” and the difference *Y* - *Yp* transitory income *Yt*. Similarly, Friedman distinguishes permanent from actual consumption *con*, the difference being transitory consumption *cont*. Thus, one can write

$$Y = Yp + Yt, \text{ and} \quad (2a)$$

$$Con = Comp + Cont. \quad (2b)$$

Yt may be either positive or negative, depending on whether actual income exceeds or falls short of

permanent income. Similarly, *Cont* can be either positive or negative. Friedman also posits that the transitory components of consumption and income are not correlated with one another or with their corresponding permanent components, i.e.,

$$r_{YpYt} = r_{CompCont} = r_{YtCont} = 0,$$

where *r* is the correlation coefficient (Friedman, 1957). Furthermore, Friedman tells us that “it is plausible to suppose that the absolute size of the transitory component varies with the size of the permanent component: that a given random event produces the same percentage rather than the same absolute increase or decrease (or stated another way) . . . that the transitory component is equally likely to be plus or minus 10 percent of the permanent component.” This will be important in determining the functional form used in this analysis because it implies that $\ln Yt$ and $\ln Cont$ (not *Yt* and *Cont*) can be regarded as random.

Permanent income is regarded by Friedman as the individual consumers' long-term expected income, where expectations are formed as a weighted moving average of actual current and past incomes, plus a secular trend. Friedman expresses this in the following formula:

$$Yp_t = B \int_0^1 e^{(B-tr)(T-t)} Y(T) dT \quad (3)$$

where

B = an adjustment coefficient between measured and permanent income,

tr = the trend rate of growth, *t* = the present time period, and

T = an index of time periods;

T = *t* back to - infinity.

It was seen in equation 1 that permanent consumption is based on permanent income. Thus placing equation 3 in equation 1 one gets:

$$Comp_t = KB \int_0^1 e^{(B-tr)(T-t)} Y(T) dT. \quad (4)$$

Equation 4 implies that permanent consumption is determined by current and past levels of actual income plus an assumed trend rate of growth in permanent income. It will also be a function of *B*, the adjustment coefficient, which is discussed subsequently.

Equation 3 also implies that the change in permanent income per unit of time can be expressed as a partial adjustment function:

$$d \ln(Yp) / dt = B [\ln(Y_t) - \ln(Yp_t)], \quad (5)$$

where *B* is the adjustment parameter taking values in the interval 0 to 1. This equation implies that the consumer's expected or permanent income in the current period will change only by a proportion, *B*, of the deviation of current income from the permanent level because previous income levels are also considered in its determination. The equation is expressed in natural logs so that *B* represents the proportion of the deviation percentage [$\ln(Y_t) - \ln(Yp_t)$] by which permanent income changes. The closer *B* is to 1, the

more weight is given to current income and the quicker Yp adapts to Y when the two are not equal. At all times, the consumer will adjust permanent consumption to be a constant proportion K of permanent income, i.e., $Conp = K Yp$. This implies that permanent consumption will adapt at the same rate that permanent income adapts to changes in income, i.e., $d Conp = K (d Yp)$, where $d Conp$ is the change in $Conp$, and $d Yp$ is the change in permanent income. Friedman's formulation is thus deemed an adaptive-expectations process. Because the deviations in Yp from Y are eliminated over time and because $Conp$ is uncorrelated with $Cont$ (the latter, or more accurately $\ln Cont$, being regarded as random), actual consumption will tend to be the constant proportion K of actual income over time (i.e., in the long run $Con/Y = K$).

Hospital permanent-revenue analog

A methodology similar to that just explained can be hypothesized for the expenditure behavior of hospitals, with their expenditures being the analog of consumption and revenues the analog of income. Following Friedman's methodology, hospitals will adapt their expenditures to be a given proportion of their expected (or permanent) revenues, where the factor of proportionality is highly stable. One might think of permanent revenues as the amount the hospital thinks it could spend while leaving its net worth (analogous to consumer wealth) intact. Permanent revenues will be a weighted moving average of actual current and past revenues, analogous to permanent income as a weighted average of current and past income. This formulation implies (as it did in Friedman's consumption-income model) that the hospital's permanent revenue will change only by a proportion of any unexpected change in current revenues because past revenues are considered as well. Only when an unexpected revenue change persists will the hospital fully adapt, so that the change becomes expected or permanent. In addition, as under Friedman's permanent-income hypothesis, there will be a transitory component of expenditures reflecting unexpected contingencies.

Although the model of expenditures presented herein is analogous to the model of consumption under the permanent-income hypothesis, it is not isomorphic to it. First, although the permanent-income hypothesis assumes that the elasticity of permanent income on consumption is 1, I introduce an additional parameter in the model to test for this. Second, because the observations available are for discrete periods, I fashion the model based on these discrete periods (an adjustment Friedman makes in doing his estimates as well). Third, the factor of proportionality is treated somewhat differently. In Friedman's model, it was seen that the factor of proportionality was a function of the interest rate, the ratio of non-human to total wealth, and the consumer's propensity to consume (age, taste, etc.). Because I use primarily cross-sectional data, the interest rate should not vary to any great extent; the ratio of non-human to total wealth is not a factor for

hospitals; and the variable propensity to spend (which reflects consumers' tastes and preferences based on such things as age and family composition) should not be a factor for hospitals. It might be expected that the factor of proportionality would vary with the type of hospital (such things as size, urban or rural status, and profit or non-profit status). Here K_o is treated initially as a constant and then separate regressions are run for these different categories to allow K_o to vary. Fourth, although my formulation of the adaptation function is essentially the same as Friedman's (equation 5), I let the speed of adjustment parameter (analogous to B in equation 5) vary in the regressions.

Theoretical model

An equation that allows permanent hospital expenditures during t , Ep_t , to have a relationship to permanent revenues that is analogous to the relationship of permanent consumption to permanent income under the permanent-income hypothesis can be written:

$$Ep_t = K_o (R_t^e) k_1, \text{ for a given year } t, \quad (6)$$

where Ep_t is the expenditure level during t , K_o is a parameter, R_t^e is expected revenue during t (the superscript e represents expectation), and k_1 is a parameter representing the elasticity of expected revenues on the level of expenditures. If the permanent-income hypothesis analogy holds exactly, k_1 will be 1 (as it was assumed to be in equation 1) and K_o the factor of proportionality. In addition, following Friedman and assuming the transitory deviation in consumption to be approximately proportional to its size, I express the model using Friedman's double-log specification (Friedman, 1957). In this way, $\ln E_t$ (the log of actual expenditures) can be expressed $\ln Ep_t + e_t$, where the e_t 's (reflecting the transitory component $e_t = \ln E_t - \ln Ep_t$) are assumed to be random and normally distributed. Taking the natural log of equation 6, putting in $\ln E_t - e_t$ for $\ln Ep_t$, and adding e_t to both sides results in:

$$\ln E_t = k_o + k_1 \ln R_t^e + e_t, \quad (7)$$

where

$k_o = \ln K_o$ (the log of the factor of proportionality).

The period-to-period adaptive-expectations algorithm for changes in permanent revenue can be expressed in the following equation:

$$\ln R_t^e - \ln R_{t-1}^e = g_t^e + j [\ln R_t - (\ln R_{t-1}^e + g_t^e)]. \quad (8)$$

In this equation, the change in the log of expected revenues R^e from $t-1$ to t , i.e., $\ln R_t^e - \ln R_{t-1}^e$, is equal to the expected growth rate of revenues, g_t^e , plus the proportion j of the amount by which $\ln R_t$ exceeds $\ln R_{t-1}^e$ plus g_t^e .² Equation 8 is analogous to equation 5 as can be seen by subtracting g_t^e from both sides of the equation and noting that $\ln R_t^e - (\ln R_{t-1}^e + g_t^e)$ is the discrete analog to the growth rate in permanent income $d \ln(Yp_t) / dt$; $\ln R_t$ is analogous to $\ln(Y_t)$; $\ln R_{t-1}^e + g_t^e$ is analogous to $\ln(Yp_t)$; and j (the adjustment factor

²Including expected growth g_t^e in the model is equivalent to Friedman's secular growth term μ .

for permanent revenue) is analogous to B (the adjustment factor for permanent income).

Using equation 7 for period $t-1$ to solve for $\ln R_{t-1}^e$, putting the result in equation 8, solving for $\ln R_t^e$, and putting the latter result in equation 7 for period t yields:

$$\ln E_t = j k_o + k_1 (1 - j) g_t^e + k_1 j \ln R_t + (1 - j) \ln E_{t-1} + e_t - (1 - j) e_{t-1}. \quad (9)$$

If $k_1 = 1$, then this can be written as:

$$\ln E_t = j k_o + (1 - j) g_t^e + j \ln R_t + (1 - j) \ln E_{t-1} + e_t - (1 - j) e_{t-1}.^3 \quad (10)$$

At this point, it would be helpful to put in a reasonable proxy for the hospital's expected growth in revenues, g_t^e . The growth in revenues lagged 1 year seemed to be the logical choice. However, in ordinary least squares regressions on equation 9, this variable added no explanatory power to the estimated equation, *ceteris paribus*. It was thus discarded in favor of a constant intercept term for all hospitals in a given year. This implies treating the first two additive terms of equations 9 and 10 as constant terms. The unfortunate part of this result was that it was not possible to look at k_o (the log of the factor of proportionality) and g_t^e (expected revenue growth) separately.⁴ Making the implied change results in:

$$\ln E_t = a + k_1 j \ln R_t + (1 - j) \ln E_{t-1} + e_t - (1 - j) e_{t-1}. \quad (11)$$

where a , k_1 and j are the parameters of estimation. If $k_1 = 1$, then equation 10 can be transformed and run as:

$$\ln E_t = a + j \ln R_t + (1 - j) \ln E_{t-1} + e_t - (1 - j) e_{t-1}. \quad (12)$$

A problem with the specifications in equations 11 and 12 is that one of the regressors, $\ln E_{t-1}$, is correlated with the error term, $e_t - (1 - j) e_{t-1}$ (because of its correlation with e_{t-1}). One solution to this problem would be to solve for $\ln E_{t-1}$, run the result, and then use the predicted values of $\ln E_{t-1}$ in equations 11 and 12 to estimate their parameters. The lagged expression for $\ln E_{t-1}$, however, has an error structure analogous to that of the unlagged equations (11 and 12) and will thus result in bias and inconsistent predictions of $\ln E_{t-1}$. But what can be done in this special case is to solve the lagged equations for their theoretical predicted values, put these in the unlagged equations, and then run the resultant regressions. The lagged predicted relationships (i.e., lagging equations 11 and 12 by 1 year) are as follows:

³Running regressions with this error structure in a time-series analysis would result in autocorrelation problems and would adversely affect the efficiency of the estimated coefficients. Here, the results are based on cross-section data, which obviates the problem. If the observations from 3 consecutive years were included for each hospital in a single regression, the estimated coefficients would be consistent and unbiased, albeit not strictly efficient.

⁴Future research using somewhat longer time-series data for hospitals might obviate this problem by including a more complete formulation of expected growth rates, possibly based on a weighted moving average of past values.

$$\ln E_{t-1} \text{ (predicted)} = a + k_1 j \ln R_{t-1} + (1 - j) \ln E_{t-2} \text{ and} \quad (13)$$

$$\ln E_{t-1} \text{ (predicted)} = a + j \ln R_{t-1} + (1 - j) \ln E_{t-2}. \quad (14)$$

Putting these, respectively, in equations 11 and 12 leads to:

$$\ln E_t = a(1 + (1 - j)) + k_1 j (\ln R_t - (1 - j) \ln R_{t-1}) + (1 - j)^2 \ln E_{t-2} + e_t - (1 - j) e_{t-1} \text{ and} \quad (15)$$

$$\ln E_t = a(1 + (1 - j)) + j (\ln R_t - (1 - j) \ln R_{t-1}) + (1 - j)^2 \ln E_{t-2} + e_t - (1 - j) e_{t-1}. \quad (16)$$

In neither of these equations are any of the regressors correlated with the errors. Thus, non-linear least squares will give consistent estimates of the parameters.

Hospital-level regression results

The purpose of this section is fourfold: (1) to look at the expenditure-revenue relationship using the estimated parameters of equations 11 and 15; (2) to see whether it is reasonable to assume that hospital expenditures are proportional to their expected revenues, i.e., whether $k_1 = 1$; (3) if $k_1 = 1$ appears to be reasonable, to present the estimated parameters of equations 12 and 16; and (4) to look at how fast hospital expenditures react to changes in revenues as reflected in the parameter estimates for j . I also report results segregated by type of hospital to allow for variation in the parameters across types.

Data for total revenues and expenditures were taken from HCFA hospital cost reports required under PPS (Health Care Financing Administration, 1993). Revenues include both patient and non-patient revenues, and expenditures include all operating and capital expenditures (where the latter encompass interest and depreciation).

Equations 11 and 15 were estimated using non-linear least squares on data from the third, fourth, and fifth years of PPS (PPS3, PPS4, and PPS5), with appropriate lagged values from previous years (PPS1 thru PPS4). Screening the data for negative and implausibly low values of expenditures and revenues and using the matched set of hospitals that had screened revenue and expenditure data from all 5 years (PPS1 through PPS5) resulted in regressions on 2,929 hospitals for PPS3, PPS4, and PPS5. Results are shown in Table 1. Although both sets of results are discussed, the cited findings are based on the consistent results of equation 15 (similarly, equation 16 will be the basis of findings where k_1 is restricted to be 1).

The results for both equations 11 and 15 are highly satisfactory, as indicated by the standard errors, which are small relative to their coefficients. All parameters shown are significantly different than 0. Both sets of regressions show the key parameter estimates of k_1 to be very near 1 for all 3 years. In the regression on equation 11, estimates of k_1 are not significantly different than 1 in two of the three regressions, PPS4 and PPS5 (approximately 1987 and 1988). For PPS3, however, even though the estimate of k_1 is near 1, it is still significantly less than 1 at the 99-percent level. Of the three regressions on equation 15, only the PPS5

Table 1

Parameter estimates for equations 11 and 15

Year	a	k ₁	j
Non-linear least squares on equation 11			
PPS3	.1341 (.0067)	.9851 (.0008)	.4811 (.0095)
PPS4	.0475 (.0171)	.9974 (.0025)	.4280 (.0096)
PPS5	.0521 (.0232)	.9997 (.0047)	.3039 (.0100)
Non-linear least squares on equation 15			
PPS3	.1048 (.0138)	.9884 (.0016)	.5037 (.0093)
PPS4	.0930 (.0133)	.9910 (.0016)	.4905 (.0089)
PPS5	.0433 (.0155)	.9997 (.0027)	.3536 (.0086)

NOTES: PPS3, PPS4, and PPS5 represent the third, fourth, and fifth years of the prospective payment system (PPS). Asymptotic standard errors in parentheses. All regressions include the same 2,929 hospitals.

SOURCE: Health Care Financing Administration: Hospital cost reports, PPS years 1-5.

estimate of k_1 is not statistically different than 1. The PPS3 and PPS4 regressions estimate it to be a little less than 1 (about 0.99). In any case, because all six regression estimates of k_1 are in fact near 1, the results are highly supportive of the permanent-revenue analogy to the permanent-income hypothesis, indicating that, on average, hospital expenditures are very nearly proportional to expected (or permanent) revenues.⁵ Estimates of j for equations 11 and 15 in Table 1 are virtually identical to what they are for equations 12 and 16 (Table 2) and are discussed in relation to the latter. Estimates of a are discussed there also because the revenue growth rates implied by these latter estimates are more in line with what actually occurred.

Because the evidence suggests that $k_1 = 1$, the regressions were rerun under this assumption, using equations 12 and 16. The results, using the same set of hospitals as in Table 1, are shown in Table 2.

The fact that in both sets of regressions the estimates of j are higher for PPS3 and PPS4 than for PPS5 implies that year-to-year changes in expenditures were somewhat more closely linked with current revenues in the two earlier years than they were in PPS5. This would mean that hospitals adapted their expected revenues, in response to actual revenue changes, more slowly in PPS5 than in PPS3 and PPS4. But differences in the estimates of j between years, although statistically significant, are not striking in effect. The difference here is that, if $j = 0.35$ (the PPS5 estimate from

⁵It might be thought of some concern that estimates of k_1 are slightly less than 1. However, I would note that stochastic measurement errors in the observations of R_t (or even R_{t-1}) may result in the coefficient k_1 (and thus k_1 for a given j) being biased downward as shown colorfully in a recent article by Friedman and Schwartz (1991). Assuming this is true, one might conjecture that the relatively high PPS3 estimates of the parameter a for both equations 11 and 15 and the relatively high PPS4 estimate of a for equation 15 are picking up some of what should be attributed to k_1 . The estimates of a are discussed further later.

Table 2

Parameter estimates for equations 12 and 16

Year	a	j
Restricted least squares on equation 12		
PPS3	.0194 (.0016)	.4619 (.0092)
PPS4	.0295 (.0016)	.4247 (.0090)
PPS5	.0507 (.0022)	.3037 (.0096)
Non-linear least squares on equation 16		
PPS3	.0119 (.0013)	.4800 (.0085)
PPS4	.0227 (.0013)	.4746 (.0083)
PPS5	.0416 (.0015)	.3533 (.0081)

NOTES: PPS3, PPS4, and PPS5 represent the third, fourth, and fifth years of the prospective payment system (PPS). Standard errors for equation 12 and asymptotic standard errors for equation 16 are in parentheses. All regressions include the same 2,929 hospitals.

SOURCE: Health Care Financing Administration: Hospital cost reports, PPS years 1-5.

equation 16), an unexpected change in revenue becomes 80-percent effective (i.e., built into permanent revenue) toward the end of the fourth year; if $j = 0.48$ (the PPS3 and PPS4 estimates), this occurs just after the middle of the third year.⁶

Interestingly, the adjustment estimates for hospitals shown here are quite similar to what Friedman (1957) presents for consumers. He cites work by Raymond Goldsmith (1955) examining consumer behavior for 1905-51, which estimates an adaption coefficient of 0.4 or adaption to 80 percent of the final result toward the beginning of the fourth year.

Another key result from Table 2 is that constraining k_1 to be 1 resulted in more believable estimates of a than seen in Table 1. The increasing year-to-year estimates of a in Table 2 (together with the estimates of j) imply that the expected growth rate of revenues increased over this period, something that indeed occurred. Using the expression for a implied by equations 10 and 12, $a = j k_o + (1 - j) g_t^e$, if one assumes that $k_o = \ln K_o$ and that $K_o = 0.96$, putting in the values of a and j from Table 2 (equation 16) gives $g_3^e = 0.061$, $g_4^e = 0.080$, and $g_5^e = 0.087$. The actual revenue growth rates

⁶The 80-percent adjustment threshold can be calculated by solving equation 8 for $\ln R_t^e$ and getting:

$$\ln R_t^e = j \ln R_t + (1 - j) g_t^e + (1 - j) \ln R_{t-1}^e. \quad (17)$$

Thus,

$$\ln R_{t-1}^e = j \ln R_{t-1} + (1 - j) g_{t-1}^e + (1 - j) \ln R_{t-2}^e. \quad (18)$$

Repeating this gives for the i th iteration:

$$\ln R_{t-i}^e = j \ln R_{t-i} + (1 - j) g_{t-i}^e + (1 - j) \ln R_{t-i-1}^e. \quad (19)$$

Putting 18 in 17 for $\ln R_{t-1}^e$, $\ln R_{t-2}^e$ from equation 19, where $i = 2$, etc. gives:

$$\ln R_t^e = j [\ln R_t + (1 - j) \ln R_{t-1} + (1 - j)^2 \ln R_{t-2} + \dots] + \text{terms in the } g_{t-i}^e\text{'s}. \quad (20)$$

Substituting the relevant values for j shows how long any unexpected change in $\ln R_{t-1}$ must be sustained so that $\ln R_t^e$ changes to 80 percent of its final value, i.e., $j + j(1 - j) + j(1 - j)^2 + \dots$ etc.

for the 2,929 hospitals examined were, respectively, $g_3 = 0.032$, $g_4 = 0.062$, and $g_5 = 0.086$. These figures indicate that hospitals as a whole may have overestimated their revenue growth in PPS3 and to a lesser extent in PPS4. In contrast with the Table 2 results, the estimates of a from Table 1 imply unrealistically large expected revenue growth for PPS3 and PPS4, although it declined to a realistic level for PPS5.⁷

Combining data across years

The 3 years of data were also combined and estimated as a cross-section time-series regression (with different intercepts for each year). But the issue of whether to pool the data for the 3 years or run them separately is technically unambiguous. F tests of regressions that allowed the parameters k_1 and j to vary with the years, against the alternative of common values for all years, are highly significant, rejecting the combination (see Maddala [1977] for the test formulation). The same was true when k_1 was restricted to be 1, but j was allowed to vary across years (against a fixed value for all 3 years). The data should not be pooled and those results are not shown. But the basic story remained the same in the combined case; estimates of k_1 were very near 1, and the estimates of j indicated that an unexpected percent change in revenue would result in a percent change in expenditures between approximately one-third and one-half its size the year it occurs.

Results for different hospital groups

Because data for hospitals from the 3 separate years included only hospitals in each year that were screened for all 5 years, the regressions were also run for unmatched hospitals for the 3 different years both where k_1 was not constrained to be 1 and where it was. More than 4,000 hospitals were used in each regression. These results were virtually indistinguishable from what is shown in Tables 1 and 2. The analysis was also extended to hospitals of different geographic regions (large urban metropolitan statistical areas [MSAs], other urban MSAs, and rural, non-MSA areas), to hospitals of different profit status (i.e., non-profit, for-profit, and government), to hospitals categorized by bed size, and to hospitals categorized as either revenue increasing or decreasing. When equation 11 was estimated, k_1 was very close to 1 in all circumstances, lending credibility to the permanent-revenue hypothesis. Some variation also occurred in the estimates of the intercept a , e.g., it was systematically higher for those whose revenues increased than for those whose revenues decreased in the equations estimated. But it was not possible to conclude much from this because the term $a = j k_1 + (1 - j) g_t^e$, from equations 10 and 12, is affected not only by the

expected growth in revenues, g_t^e , but also by the log of the factor of proportionality, k_1 (where the factor of proportionality may differ by type of hospital), as well as the adjustment coefficient, j . Thus, disentangling the separate effects by type of hospital is highly problematic.

However, the estimates of the adjustment coefficient j using equation 16 proved extremely interesting when considering hospitals by type.

First, non-profit and government hospitals adjusted faster than did for-profit hospitals to changes in revenues. Over the 3 years, the estimates for j using equation 16 averaged 0.47 and 0.46 for non-profit and government hospitals, respectively, but only 0.35 for for-profit hospitals. These estimates imply that the first two groups adjust expenditures to 80 percent of their longrun change near the end of the third year of an unexpected change in revenues, whereas it takes the latter group until the end of the fourth year. This may indicate that, because of their non-profit status, the first two groups turn revenue increases into expenditures more rapidly than hospitals that can earn a profit.

Second, there appears to be a revenue-increasing-revenue-decreasing dichotomy in the speed of adjustment as seen in the estimates for j . For the 3 years, the estimates for j using equation 16 averaged 0.45 for hospitals whose revenues increased (implying adjustment to 80 percent of the longrun expenditure change near the end of the third year) and 0.36 for hospitals whose revenues decreased (implying adjustment to 80 percent of the longrun expenditure change near the end of the fourth year). This difference indicates that the adjustment to increased revenues is somewhat quicker (and undoubtedly easier) than the adjustment to decreased revenues. The basic thrust of the supplementary findings however, is that even when the results are broken into different subsets, they closely reflect those shown in Tables 1 and 2 with respect to k_1 and j .

Summing up the regressions

The results of Table 1 lend a great deal of support to the permanent-revenue hypothesis (this article's analogy to the permanent-income hypothesis) as the way hospitals determine their expenditures. The key result here is that the estimates of k_1 are close to 1. This finding indicates that expenditures (except for a well-behaved disturbance term) are a constant proportion of permanent revenues. In addition, because permanent revenues adjust to actual revenues over time, expenditures will tend to be a constant proportion of actual revenues in the long run. It is not quite so clear how quickly hospitals adjust their permanent to actual revenues. Based on the regression results, there is not a single-point estimate of the adjustment coefficient, j , to which one can point. However, using the results of Table 2, it can be inferred that, j falls in the neighborhood of 0.35 to 0.48, implying a 35- to 48-percent adjustment in the initial year (and adjustment to 80 percent of the longrun level from the middle of the

⁷Using the estimates from Table 1 in the expression for a implied by equations 9 and 11, i.e., $a = j k_1 + (1 - j) g_t^e$, the expected rates of revenue growth for PPS3, PPS4, and PPS5 were $g_3^e = 0.256$, $g_4^e = 0.224$, and $g_5^e = 0.089$.

third to the end of the fourth year). This is, interestingly, very close to what Friedman (1957) found for consumers. The current results also indicate, however, that hospitals with certain characteristics adjust faster than others. Non-profit and government hospitals adjust faster than for-profit hospitals, and those whose revenues increase adjust faster than those whose revenues decline. Of course, once the lagged effects work themselves out over time and any unanticipated change in revenue becomes permanent (and therefore expected), the effect of a 10-percent increase in hospital revenues is to raise expenditures by 10 percent in all cases.

Comparison with other work

Friedman and Farley (1991), analyzing a panel of more than 400 not-for-profit hospitals for the period 1980-87, find support for a model in which hospitals target profit margins and, because profit margins can be defined as 1 minus the expenditure-revenue ratio, this also implies that the latter ratio will be a targeted constant as well.

The present results are also generally consistent with those in an article by Sheingold (1989). He examined Medicare hospital costs as a function of Medicare profits in the first 2 years of PPS and found that the profits generated as a result of the cost cutting that occurred during this period “. . . provided resources to increase expenses for other goals”

Using the permanent-income analogy

Perhaps a good way to think of hospital expenditure behavior for given revenues is again to look at the behavior of consumers. Consumers with relatively low incomes spend what they have mainly on necessities (food, clothing, basic transportation, shelter, etc.). As income rises, however, consumers purchase greater proportions of luxury goods and services (upscale housing, appliances, financial and medical services, new automobiles, vacations, etc.). Thus, although the evidence from numerous sources indicates that the rate of consumption (out of income) does not rise when real income rises (e.g., see Evans, 1969), people do change the kinds of goods and services they buy.

Hospital behavior is analogous. Hospital revenue growth has exceeded the growth in gross domestic product (GDP) by an average of 5.0 percent per year from 1966 to 1990 (American Hospital Association, 1991; Council of Economic Advisors, 1992). Seen another way, although GDP grew a little more than sevenfold during this period, hospital revenues grew more than twentyfold. Moreover, hospital expenditures have grown right along with revenues (something implicit in the permanent-revenue hypothesis). As seen in the Introduction, community hospital expenditures averaged 97.2 percent of net revenues from 1966 through 1970 and 96.0 percent from 1986 through 1990 (respectively, American Hospital Association, 1991 and 1970-90). But the nature of these expenditures has changed. Hospital spending has risen for newer, more technologically advanced equipment, the proliferation

of services, new buildings, more highly qualified personnel, more training for their employees, amenities that induce greater physician allegiance, etc. (Weisbrod, 1991; Feldstein, 1977; Cromwell and Butrica, 1991). In the case of consumers, greater incomes enable them to improve their lifestyles, as reflected in their purchases. In a similar manner, the additional revenues above the economywide growth in GDP have dramatically improved hospitals' business style.

And just as it is good business to sell goods and services to prosperous consumers who have relatively more money to spend, it is also good business to sell factors of production to hospitals. Increases in hospital expenditures (relative to GDP) have resulted in greater-than-normal increases in the number of jobs, e.g., compare the 124-percent increase in full-time-equivalent jobs for community hospitals from 1965 to 1990 (American Hospital Association, 1991) to the 53-percent increase in hours of all persons employed in the non-farm business sector of the economy (Council of Economic Advisors, 1992). The upward trend in hospital employment was interrupted only when PPS dampened it somewhat in its first 2 or 3 years. Sales of non-labor inputs to the hospital industry have experienced relative increases as well. Cromwell and Butrica (1991) show that deflated non-labor expenses other than capital for short-stay hospitals grew 7.6 percent per year from 1980 to 1989 (overall real GDP growth was 2.8 percent [Council of Economic Advisors, 1992]), and real fixed hospital capital grew 6.9 percent per year from 1976 to 1987 (Cromwell and Butrica, 1991), compared with 3.5 percent per year for the gross stock of fixed private non-residential capital for the U.S. economy (U.S. Bureau of Census, 1985 and 1989).

In addition, there have been relatively greater increases in returns for hospital employees (Pope and Menke, 1990; Fisher, 1992), hospital-affiliated doctors (Woolley and Frech, 1988-89; Pauly and Redisch, 1973), and those selling goods and services to this industry. Returns for this last group can be seen in the HCFA index of prices paid for non-labor related inputs (Health Care Financing Administration, 1992), which rose 1.1 percent per year faster from 1977 to 1989 than did the producer price index (Council of Economic Advisors, 1992). In short, over the past quarter century, increased revenues for hospitals, compared with the economy as a whole, have made them a good business to do business with.

A reversal of the demand stimulus that has existed in the hospital industry would occur if revenue growth were slowed (relative to GDP). The regression results of this study indicate that cutting hospital revenues (below expected levels) would result in slower expenditure growth, but only over time. Indeed, the results show that hospitals whose revenues increase adjust more quickly than those whose revenues decline. This implies that cutbacks in revenues below expected levels would not be easy for hospitals or for those who provide inputs to them any more than cutting income would be easy for consumers (even those who are wealthy) or those who sell them goods and services. Expenditure patterns are well established, and commitments of

funds often stretch well into the future, whether based on expected income, in the case of consumers, or expected revenues, in the case of hospitals. Reducing the consumer's income or the hospital's revenues leads to a more spartan existence and would imply a slow and painful readjustment.

Conclusions

This study finds that hospitals tend to spend a constant proportion of their permanent (or expected) revenues, just as other studies have found that consumers tend to spend a constant proportion of permanent income. In any given year, hospitals reckon permanent revenues as a weighted average of past and current actual revenues and thus adapt them only partially to unexpected revenue changes occurring in the current year. As a consequence, hospitals adjust expenditures in response to unexpected revenue changes only to the extent that permanent revenue changes.

Regression estimates indicate that, within a given year, an unexpected percent change in hospital revenues results in a percent change in expenditures that is 35 to 48 percent as great as the percent revenue change and in the same direction. In subsequent years, expenditures continue to adjust to the revenue change with declining intensity until the percent change in expenditures matches that of the percent change in revenues. This adjustment process applies to hospitals with decreasing as well as increasing revenues, although the adjustment process for the former is estimated to be somewhat slower.

The fact that hospital expenditures and revenues follow the permanent-revenue hypothesis does not imply a particular objective criterion for hospitals. These results are consistent with either quality-maximizing or profit-maximizing behavior or some combination of the two. What can be said is that hospital behavior is analogous to consumer behavior. Consumers whose incomes increase in real terms tend to purchase goods and services that are luxuries. Hospitals whose revenues increase in real terms tend to expand their scope of operation and increase the quality of their services, by employing additional staff with greater skills and by purchasing greater quantities of ever-more technologically advanced supplies, plant, and equipment. Moreover, the subsequent increases in demand for factors of production result in greater quantities being supplied with increasing real rates of return. Finally, doctors using hospital facilities charge more for their services. Thus, real revenue increases have been realized as both improved and expanded services and additional returns to factors of production.

Because there is an exogenous element of revenues controllable through government policy (such as spending through government insurance or the health insurance tax break), the results of this study indicate that hospital expenditures can be restrained over time by restraining revenues. The downside of such revenue

restraints are the lag that occurs between the unexpected revenue reduction and the time when expenditures fully adjust and the fact that hospitals' business styles will deteriorate to the extent that real expenditures decline.

With regard to the first effect, adapting expenditures to lower revenues than expected—even though both adjust by the same percentage in the long run—would mean a period of time when hospital expenditures rise compared with their revenues. Profit margins would decline and could turn negative during this period.

With regard to the second effect, lower real revenues for hospitals would mean that they provide fewer of those goods and services, analogous to consumer luxuries, which make the provision of hospital care an attractive business to be in and to patronize. Cuts would also mean lower real returns to factors of production used by hospitals.

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