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Fee-for-Service Versus HMO Outpatient Expenditure Patterns

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ABSTRACT

This study compares the higher moments of fee-for-service (FFS) and health maintenance organization (HMO) expenditure distributions in connection with outpatient episodes for randomly assigned patients over 39 diagnoses. The results indicate that the variance and skewness of the unexplained variation in expenditure is much greater for FFS health care than for HMO health care. The results may be attributable to the construction of the dependent variable or to physician financial incentives.

Introduction

By removing much or all of the marginal cost of medical care to the consumer, health insurance tends to induce moral hazard that may result in a substantial welfare loss associated with overutilization.[1] The health maintenance organization (HMO) has been frequently touted as a means of controlling this moral hazard effect. Integrating the insurance and care provision functions, the HMO makes overutilization costly to the physician and creates strong supply-side incentives to control costs.

HMOs have been shown to provide health care at a lower cost than traditional fee-for-service (FFS) providers. Some studies suggest that the cost savings associated with HMOs are achieved primarily because healthier consumers are more likely to choose HMOs (Eggers and Prihoda, 1982; Jackson-Beeck and Kleinman, 1983; and Buchanan and Cretin, 1986). However, Manning et al. (1984) found evidence that HMOs have lower

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[1] See Pauly (1968), Feldstein (1973), and Pauly (1986).

expenses even for patients that are randomly assigned to this type of health plan. The lower costs of HMOs appear to result because of substantially lower hospitalization rates for HMO patients than for FFS patients (Luft, 1981).

The financial incentives associated with HMOs might affect how physicians conduct outpatient care as well. Ligon (1993) has shown that mean outpatient expenditures under HMO care do not significantly differ from FFS care for randomly assigned patients for 39 diagnoses. However, an absence of significant difference in mean expenditure does not imply that the expenditure distributions are similar.[2]

This article examines the higher moments of the expenditure distribution for outpatient care for particular diagnoses for randomly assigned patients. The concentration upon higher moments of the expenditure distributions extends previous research that has concentrated on average expenditure.

Physician Utility

This section develops a utility maximization model for physician behavior. It is assumed that the physician chooses medical inputs, N, to maximize expected utility with respect to the following specification:

$$EU = \int U(dH, Y, R)\, dN, \tag{1}$$

where dH = the expected improvement in patient health for any given initial health status, diagnosis, and choice of medical inputs, N,[3]

Y = the physician's net monetary income, and

R = the reputation effect of the choice of any particular combination of medical inputs given the diagnosis.[4]

For present purposes, the important aspect of Y is that fee-for-service physicians have non-negative net marginal revenue for each N used, while HMO physicians have non-positive net marginal revenue for each N used. That is,

$$\frac{\partial Y_{FFS}}{\partial N} \geq 0, \tag{2}$$

and

$$\frac{\partial Y_{HMO}}{\partial N} \leq 0. \tag{3}$$

R, the reputation effect, is defined as

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[2] The HMO "expenditures" referred to here and those used in this analysis were constructed in connection with the Rand Health Insurance Experiment. See the discussion of the data, below.

[3] For any particular health status and diagnosis there may be any number of possible combinations of medical inputs that yield equivalent results. N, as used here, is intended to reflect this substitutability of inputs. Rather than reflect a particular quantity of any particular input, it is intended as a numeraire to measure overall utilization of medical resources.

[4] R represents the impact of current input choices upon future patient demand. Consumer demand enters the model through reputation. The physician must be concerned that current choices affect future income.

$$R = f(E[\Lambda], E[M]), \tag{4}$$

where $E[\Lambda]$ = a measure of patient satisfaction with the physician's choice of N, and

$E[M]$ = the expected malpractice cost of choosing a particular level of N.

This latter is the cost to reputation (e.g., loss of patients or professional censure). The monetary cost would be an element of Y. A substantial source of malpractice risk is assumed to be the failure to provide a minimum standard of care. That is, provision of inputs above a critical level, N', is equivalent to meeting a type of minimum quality malpractice standard. Meeting this quality standard substantially reduces E [M]. Thus, the physician is expected to tailor treatments to incorporate the preferences of individual patients (maximize E [Λ]) within limits (i.e., subject to E [M] being below some acceptable threshold).

The Data

The data set used in this analysis is from the Rand Health Insurance Experiment (RHIE) and is the same as that used in Ligon (1993). The RHIE was conducted by the Rand Corporation from 1974 to 1982. The experiment was a controlled trial in health care financing funded by the U.S. Department of Health and Human Services. Its purpose was to assess the interrelationship of many factors—including different types of insurance—upon the consumption of health care services and the resulting effects, if any, upon consumer health.

Some years have passed since the experiment was conducted, and the delivery of medical care has undergone some significant changes (in particular, greater reliance upon managed care and prepaid HMO-like arrangements and greater variety in types of HMOs). Nevertheless, the data still provide a unique insight into consumer behavior in traditional FFS and group practice HMO contexts.[5] The experimental design removes the frequently encountered problem of the endogenous nature of the insurance choice.

The experiment was conducted at six different sites: Dayton, Ohio; Seattle, Washington; Franklin County and Fitchburg, Massachusetts; and Georgetown County and Charleston, South Carolina. Over 8,200 people were enrolled in the experiment. Families were randomly assigned to one of several insurance plans that varied by coinsurance rate, delivery mode, and maximum out-of-pocket expenditure.[6] Because of the interest in the effects of insurance coverage on health status and attitudes toward health care, data regarding use of health care,

[5] The HMO data are from one group practice HMO, Group Health Cooperative of Puget Sound, Seattle, Washington.

[6] Although assignment to plans was random, participation in the experiment was voluntary. Rand conducted extensive tests of those accepting participation to ensure that the random assignment procedure was not contaminated by acceptance bias (see Ware, et al., 1986, for example).

health status and attitudes, and underlying demographic information were collected at various points throughout the experiment.[7] This study uses data from all years and sites.

Individual demand for medical care is, essentially, a demand for an episode of care, and, hence, the episode of care serves as the unit of analysis. An episode of medical care is any treatment (expenditure) related to and/or arising out of an initial contact with the medical care system for a particular person for the same diagnostic condition in the same calendar year (see Keeler and Rolph, 1988, for example). Expenditures per episode of outpatient care were computed for individuals with the same diagnosed condition. Episodes with any inpatient expenditures were omitted for the reasons discussed in Appendix C of Ligon (1991). The analysis uses preexisting FFS episodes created by Rand. The HMO episodes were created for this analysis using Rand's episode creation guidelines. Examination of HMO episodes revealed that they were of similar duration to FFS episodes for the same diagnosis.

However, one difference between Rand's calculation of FFS and HMO expenditures is critical for interpretation of the analysis. The FFS episodes summed all services related to a particular diagnosis within a limited period of time at the price actually charged for that service. That is,

$$\Psi = \sum_i X_i P_i, \tag{5}$$

where X_i = the quantity of service i performed, and
P_i = the price charged for service i.

Since HMO services involve no charge for service performed, there is no individual price for each service. Rand calculated the average price charged for each service at that time by FFS physicians in the same community and used this average price to calculate HMO expenditures. The HMO episodes were then created by summing all services related to a particular diagnosis within a limited period of time at this average price. That is,

$$\Psi = \sum_i X_i \bar{P}_i, \qquad where \quad \bar{P}_i = \frac{\sum_{i=1}^{n} P_i}{n}, \tag{6}$$

where n = the number of service i performed in the community by FFS physicians.

The fact that the dependent variable for HMO is constructed by multiplying the average price for a service times the quantity of services while the dependent variable for FFS is constructed by multiplying the actual price times the quantity of services could produce significant effects on this analysis (and,

[7] For an introduction to the RHIE, see Manning et al. (1987). For greater detail, see d'Arc Taylor et al. (1987).

perhaps, previous analyses of the Rand HMO data as well). The FFS dependent variable measures variation in both quantity and price. The HMO dependent variable measures variation in quantity only. The impact of this type of data construction depends upon the distributions of the price and quantity variables and their correlation, ρ. Given what is known about the characteristics of the distributions analyzed here, certain constraints on their relationships hold.

Even if the distributions of quantity are identical between FFS and HMO, the variance of the FFS expenditure distribution will be larger than that of the HMO expenditure distribution, if the correlation of price and quantity is positive. If the correlation of price and quantity is negative, the variance of the FFS distribution might be smaller than the HMO distribution even if the distributions of quantity are identical. No direct information regarding this correlation is readily available.[8]

If both the price and the quantity distributions are positively skewed and positively correlated, then the expenditure distribution will appear more positively skewed for FFS expenditures than for HMO expenditures, even if the distributions of quantity are identical. However, if neither distribution is skewed, or if either is negatively skewed, or if the price and quantity distributions are negatively correlated, this need not be the case. The appearance of a positive skewness for the HMO distributions suggests that quantity may be positively skewed, but nothing is known about the skewness of the price distribution.[9]

The Empirical Model

The theoretical model develops a utility maximization process for the physician. The basic premise is that, if reputation effects are potentially

[8] Products of random variables are generally less well understood than the sums of random variables. Kendall and Stuart (1977) give one of the better treatments of the properties of products of random variables. Here, since $x,y > 0$, $\sigma^2(\ln xy) = \sigma^2(\ln x + \ln y)$ is a monotonic transformation of $\sigma^2(xy)$, and the variance of sums is a positive monotonic function of ρ, the statements regarding variance above are easily verified. Assume identical quantity distributions between FFS and HMO. The FFS distribution is quantity times price (xy). The HMO distribution is quantity times mean of price ($x\mu(y)$). Mean of price is like a random variable with zero variance and zero correlation with quantity. Hence, $\sigma^2(xy) > \sigma^2(x\mu(y))$ if $\rho > 0$ (because of the positive variance of price and covariance terms in the case of the former). If $\rho < 0$ the result is ambiguous. If the negative covariance terms are greater than the terms related to variance of price, $\sigma^2(xy) < \sigma^2(x\mu(y))$; if the negative covariance terms are less than the terms related to variance of price, $\sigma^2(xy) > \sigma^2(x\mu(y))$.

[9] The statements regarding skewness can be proved by an argument similar to that used for variance, at least for certain commonly used distributions. Craig (1936) proves that skewness is maximized at $\rho = 1$ and minimized at $\rho = -1$ for products of correlated normal random variables. (The positive relationship between correlation and skewness appears to hold even for distributions with non-positive support, although, as Craig notes, observations = 0 are problematic). The logarithmic transformation can again be used. Thus, the results hold for any distribution that can be modeled using the lognormal. As long as the positive relationship between correlation and skewness holds, the statements regarding the skewness of products above will hold for any positive support distribution.

significant, the physician will have an incentive to be a good agent for the consumer and will choose a level of medical inputs for each patient that reflects the patient's circumstances and preferences. However, if the physician is not a good agent, she will choose inputs which may be influenced by her own interests (e.g., her income). This implies an econometric model of the form

$$\Psi = \beta_0 + \beta_1 X + \beta_2 Z + \varepsilon, \tag{7}$$

where Ψ = the expenditure on medical care,
X = a vector of consumer related variables,
Z = a vector of physician related variables, and
ε = an error term.

Data limitations do not permit one to simultaneously specify the X and Z vectors, identify diagnoses, and use episode of care analysis. The data set chosen does allow comprehensive specification of the X vector, and the analysis of episodes of care by diagnosis. The influence of Z is inferred by running separate sets of regressions on the FFS and HMO data and analyzing the residuals of these regressions for evidence of physician influence.

Separate regressions were performed for each diagnosis with the dependent variable being expenditures per episode adjusted for inflation (the expenditure regressions). Regressions were also performed using the natural logarithm of inflation-adjusted expenditures per episode (the ln(expenditure) regressions). Functional form for the explanatory variables was determined for each diagnosis by conducting preliminary regressions. The criterion for variable retention in the analysis was Theil's adjusted R-squared.[10] For each diagnosis, identical models were applied in the separate FFS and HMO regressions, although models differed between diagnoses. Thirty-nine diagnoses had sufficient sample sizes to allow analysis.[11] Summary statistics for these regressions appear as Tables 6-5 and 6-6 in Ligon (1991).

The adjusted R-squares and variances and skewnesses of the residuals of these regressions were then treated as paired observations. For example, the variance of the residuals of the FFS regression for colitis and the HMO regression for colitis were treated as a pair of observations. The differences between the FFS and the HMO observations were then calculated and signed for the adjusted R-square and the variance and skewness of the residuals. The

[10] The construction of the consumer variables and the model selection criteria used in these regressions is discussed in detail in Chapter 5 and Appendices B, C, and D of Ligon (1991) and is summarized in Ligon (1993).

[11] Some of the HMO sample sizes were quite small. In some cases, the model applied in these regressions was reduced so that the number of degrees of freedom in the regression was always twice that of the number of parameters included. The variables retained were those that had the highest explanatory power in the combined FFS-HMO regressions used for model selection. The diagnoses for which the procedure was applied were anemia, chronic heart disease, ingrowing nail, psoriasis, cervicitis, prostate, and uterine tumor. The results from these smaller sample sizes may have been considered suspect; however, deleting these diagnoses from the sign test analysis does not change the results (see Tables 1 and 2).

signs of these differences then constitute a binomial distribution with p = 0.5. (The null hypothesis is that the distributions are the same, and, hence, it would be equally likely that the FFS would exceed the HMO observation and vice versa.) Confidence intervals for acceptance or rejection of the null hypothesis were then constructed.

Since there were 39 diagnoses, the normal approximation to the binomial using the standard Z formula was applied:

$$Z = \frac{X - \mu}{\sigma} = \frac{X - pN}{\sqrt{p(1-p)N}}, \tag{8}$$

where p = 0.5, the assumption of equal distributions, and
N = 39, the number of diagnoses.

Results

Expenditure Regressions

Table 1 presents the results of the sign test for the difference between the adjusted R-squares and the variance and skewness of the FFS and HMO residual distributions when expenditures was the dependent variable. The difference in adjusted R-square, $R^2_{FFS} - R^2_{HMO}$, was positive 23 times out of 39, yielding a Z equal to 1.121. A two-tailed test was applied, and the null hypothesis of equality of explanatory power could not be rejected at the 0.10 level of significance.

Table 1
Sign Tests on R-Squares, Residual Variances, and Residual Skewnesses

Dependent Variable = Expenditures

	Full Sample		*Excluding Small HMO Diagnoses*[a]	
	FFS > HMO	*HMO > FFS*	*FFS > HMO*	*HMO > FFS*
Adjusted R-Squared	23 Z = 1.121	16 p = 0.1131	19 Z = 1.257	12 p = 0.1045
Variance	34 Z = 4.644	5 p < 0.001	27 Z = 4.131	4 p < 0.001
Skewness	33 Z = 4.323	6 p < 0.001	26 Z = 3.772	5 p < 0.001

[a] See footnote 11, above.

The difference in variances, $VAR_{FFS} - VAR_{HMO}$, was positive 34 times out of 39, yielding a Z equal to 4.644. Thus, the null hypothesis of equality of variances can be rejected at the 0.0001 level of significance, and the alternative hypothesis that FFS has a higher residual variance can be accepted. Similarly, the difference in skewnesses, $SK_{FFS} - SK_{HMO}$, was positive 33 times out of 39, yielding a Z equal to 4.323. Thus, the null hypothesis of equality of skewnesses can also be rejected at the 0.0001 level of significance, and the alternative hypothesis that FFS has higher residual skewness can be accepted.

Consumer influences have been controlled for through the regression analysis. Because consumers were randomly assigned to FFS and HMO plans, latent consumer heterogeneity would not be expected to have produced these results. Latent heterogeneity would have been expected to be the same between plans. Differences in the residual patterns could, however, be attributable to the construction of the dependent variable or physician influence.

Self-interested physician behavior, such as indicated by equation (1), could have generated the observed pattern. This behavioral model suggests a censored regression model with a stochastic and unobserved threshold (Maddala, 1983, pp. 174-178). The presence of medical malpractice liability (or other minimum quality standards) tends to make physicians averse to levels of inputs below some standard level for a particular condition and health status and would result in a left-hand truncation of the expense distribution. The absence of marginal revenue may make HMO physicians averse to levels of inputs much above some standard level for a particular condition and health status, which implies a right-hand truncation of the HMO expenditure distribution.

Fee-for-service physicians, on the other hand, have no financial disincentive to provide a relatively larger number of inputs for a given condition. The consequence is that the FFS expenditure distribution may appear skewed relative to the HMO distribution. Truncation of the expense distribution has similar implications for the residuals in the regression analysis (Maddala, 1983, pp. 149-151, 365-368). Thus, the FFS residual distribution may be more skewed and have a relatively higher variance than the HMO distribution if physician influence exercises significant control over the level of care offered. However, the results could also be a product of the construction of the dependent variable (see the data section above), if FFS price and quantity are positively correlated.

Ln(expenditure) Regressions

While any physician effects appear to be confounded with possible dependent variable effects, examination of the residual plots of the expenditure regressions contributes to the analysis. In most diagnoses, the differences between the variances and the skewnesses of the FFS and HMO residuals are generated by a few very large FFS residuals. Further, these large residuals are positively correlated with the largest predictive values. Taken together, these facts suggest a positive correlation between FFS price and quantity. Removing these outliers would remove most of the differences between the FFS and HMO distributions. Taking the natural logarithm of the dependent variable effectively reduces the weight assigned to large observations and reduces the impact of a positive price-quantity correlation.

As in the case of the expenditure regressions, a separate regression was performed for FFS and HMO episodes for each diagnosis, the only differences being the substitution of the natural logarithm of the inflation-adjusted charge as the dependent variable and changes in the identity of the independent variables significantly related to it. Summary statistics for the 39 diagnoses appear as Tables 6-8 and 6-9 in Ligon (1991). The adjusted R-squares and variances and skewnesses of the residual distributions were treated as paired observations and the sign test applied. See Table 2 for results of the sign tests.

Table 2
Sign Tests on R-Squares, Residual Variances, and Residual Skewnesses

Dependent Variable = ln(expenditures)

	Full Sample		*Excluding Small HMO Diagnoses*[a]	
	FFS > HMO	*HMO > FFS*	*FFS > HMO*	*HMO > FFS*
Adjusted R-Squared	25 Z = 1.761	14 p = 0.0392	20 Z = 1.616	11 p = 0.0532
Variance	37 Z = 5.604	2 p < 0.001	30 Z = 5.209	1 p < 0.001
Skewness	19 Z = -0.160	20 p = 0.5239	13 Z = -0.898	18 p = 0.8133

[a] See footnote 11, above.

The difference in adjusted R-square, R^2_{FFS} - R^2_{HMO}, was positive 25 times out of 39, yielding a Z equal to 1.761, which would allow rejection of the null hypothesis under the two-tailed test at the 10 percent significance level. However, when the small HMO diagnoses are excluded, the Z falls to 1.616, which falls just short of the value needed to reject the null hypothesis at the 10 percent level for a two-tailed test. The difference in variances, VAR_{FFS} - VAR_{HMO}, was positive 37 times out of 39, yielding a Z equal to 5.604, allowing rejection of the null hypothesis under any conventional confidence level. However, the difference in skewnesses, SK_{FFS} - SK_{HMO}, was positive only 19 times out of 39, yielding a Z equal to -0.160, clearly not significant to reject the null hypothesis.

The logarithmic transformation has little effect upon the difference in variance of the residuals of the two sets of distributions. However, changes occur in both the R-squares and the skewnesses of the residuals. The mean R-square for the fee-for-service regressions rises from 0.0832 to 0.0910 under the logarithmic transformation, while the mean R-square for HMO regressions falls from 0.0963 to 0.0831. Skewness of the residuals falls for both practice types under the logarithmic transformation, but the fall is much larger for the FFS regressions. The average skewness of the FFS residuals falls from 3.099 to 0.2391 under the transformation, while the average skewness of the HMO residuals falls from 1.404 to 0.2298. Thus, under the untransformed variable, the skewnesses clearly differ; after transformation they are virtually indistinguishable.

If price and quantity are positively correlated, the logarithmic transformation will reduce the significance of this dependent variable effect for the FFS distribution. The fact that the FFS and HMO variances remain statistically different and the FFS R-squares increase relative to HMO suggests the hardly surprising conclusion that the variance in quantity of care is relatively higher in FFS than in HMO, and this variance is, in part, related to variation in consumer characteristics (i.e., HMOs tend to standardize care).

The dependent variable effects are most severe in the case of positive correlation between price and quantity. Assuming that quantity is positively skewed, as the untransformed HMO distributions suggest, the variance and skewness of the FFS distributions will be greatest in the positive correlation case, and these distributions would exhibit a few very large values not found in the HMO distributions. This appears to be the pattern observed here. However, a positive correlation implies that high-price doctors are also high-quantity doctors. Doctors engaging in demand inducement might be expected to display such a behavior pattern.[12] The infrequency of the large residuals here implies that this behavior may exist but is not widespread. However, elimination of the large residuals would significantly affect the distribution of FFS expenditures.

Conclusions

Even though Ligon (1993) found that mean outpatient expenditures under HMO and FFS delivery systems do not differ, the two systems do generate substantially different patterns of outpatient expenditures. Variances and skewnesses are larger for FFS residual expenditure distributions than for HMO residual expenditure distributions. These effects may be due to differences in the definition of the dependent variable or to physician financial incentives or both. Residual plots suggest that in most diagnoses the effects are generated by a few large positive FFS residuals. Using ln(expenditures) as the dependent variable confirms the importance to the results of large observations, since the differences in skewness disappear. The apparent importance of the few large FFS residuals suggests that a few high-price/high-quantity FFS physicians may be responsible for differences in the expenditure patterns.

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[12] Demand inducement is profitable only for FFS physicians. See Chapter 2 of Ligon (1991) for an extensive review of the demand inducement literature.

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