Medicare reimbursement and regression to the mean

by James C. Beebe

There is evidence that Medicare's payment formula for health maintenance organizations (HMO's) overpays or underpays HMO's in cases of biased selection. There is also evidence that costs of biased groups regress toward the population mean cost, so the incorrect payment is temporary. We found that reimbursement regressed toward the mean for cohorts biased on medical use but not for groups biased on demographic factors. In a simulation of HMO-favorable selection, Medicare lost money in the first 3 years, but, because of regression toward the mean, early losses were recouped by the seventh year.

Introduction

The Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA) provides new incentives for health maintenance organizations (HMO's) and competitive medical plans to participate in the Medicare program on an at-risk basis. (Henceforth, all of these organizations are referred to as HMO's.) Payment to HMO's is determined prospectively at 95 percent of the adjusted average per capita cost (AAPCC). The AAPCC is defined as the estimated average per capita amount that would be payable by Medicare if services for HMO members were furnished in the local fee-for-service (FFS) market. In the AAPCC formula, underwriting factors are used to adjust payments for age, sex, welfare status, and institutional status.

There has been concern for some time that the current factors in the AAPCC may not be adequate to adjust for biased selection of healthier than average or less healthy than average persons into HMO's. Eggers and Prihoda (1982) studied the preenrollment experience of Medicare beneficiaries who enrolled in three demonstration HMO's. They found that in the 4 years prior to their enrollment, two of the three HMO enrollee groups had reimbursements, adjusted for the AAPCC factors, that were 20 percent below average. Eggers (1983) also found that, in four additional HMO demonstrations in which health screening was allowed, AAPCC-adjusted use for enrollees in the 3 years prior to enrollment was 10-47 percent lower than use for a comparison group. If these use patterns persisted after enrollment, then 95 percent of the AAPCC would constitute an overpayment to the HMO's of 5-42 percent relative to what the payment would have been had the enrollees remained in the fee-for-service sector.

An important question deriving from these preenrollment studies concerns the extent to which use patterns persist over time. Several researchers have presented evidence that cohorts of high (or low) users tend to remain high (or low) users over time. McFarland et al. (1983) found that 13 percent of 1,401 HMO enrollees of the Kaiser Permanente Health Plan in Portland, Oregon, remained consistently high users over a 7-year period, and 8 percent were consistently low users over the same period. Anderson and Knickman (1984) found that high fee-for-service Medicare users in one year tend to remain high users in subsequent years. They also cited several studies showing similar results for specialized populations. Eggers (1981) and McCall and Wai (1983) showed that groups in the upper and lower percentiles of Medicare reimbursement in one year tended to remain in the upper and lower percentiles in the following year. Further evidence of persistence of use over time is the fact that health insurers establish group premiums on the basis of previous costs (Trapnell, McKusick, and Genuardi, 1982) using a process called experience rating. This fact and the studies cited all lend support to the possibility that HMO's enrolling persons who were low users before they joined are overpaid for some years thereafter.

Although the studies cited previously have emphasized consistency of use, there is also evidence that high and low users regress toward the mean use over time. Welch (1985a) pointed out that, in the Anderson and Knickman study (1984), persons with expenditures of more than $5,000 in 1974 had an average expenditure that was 17 times greater than the overall average in that year. However, in 1975, 1976, and 1977, this same group had average expenditures that were 4.0, 3.3, and 2.8 times greater than the average, respectively. Welch went on to estimate that the correlation of medical expenditures for any two years is about .20. From this, he used an error components model to estimate that the 20 percent lower use found by Eggers and Prihoda (1982) in the preenrollment period for beneficiaries who joined the two HMO's would regress to about 10 percent below average in the first year of enrollment and could be expected to further approach the mean in subsequent years. Blumberg (1984) also emphasized regression toward the mean. Generalizing from data on both enrollees in the Federal Employees Health Benefit Plan and Medicare enrollees, he estimated that a group of 5,873 HMO enrollees in Minnesota with preenrollment year use that was 34 percent below the mean could be expected to have use of only 10 percent below the mean in the first year of enrollment.

Although research on adjusters reflecting prior use and health status is underway (Beebe, Lubitz, and Eggers, 1985), none has been developed to the point where it could be implemented nationally. The lack of

an adjuster for persistently low or high use (if, indeed, practical adjusters can ever be developed) could present serious obstacles to the Administration's policy of promoting capitation for Medicare enrollees. It is generally recognized that HMO's offer savings through more efficient health service utilization, but the possibility that the Government may be overpaying some and underpaying others is a serious concern as the participation in capitated systems grows. From the HMO's viewpoint, the possibility of enrolling a sicker than average group without a compensating payment mechanism may discourage program participation. On the other hand, if any bias that may exist at the time of enrollment quickly dissipates after enrollment, then Medicare's HMO payment formula may be adequate and, thus, not a serious concern to the Government or the HMO's.[1]

In this study, a 7-year longitudinal sample of aged Medicare beneficiaries is used to look at the nature and extent of regression to the mean and to examine whether the relationship between prior use and regression to the mean is consistent enough to be useful in predicting future use. It is important to observe that the behavior of Medicare beneficiaries in the fee-for-service market is examined. In actuality, persons who enroll in HMO's use services in a managed-care environment. Nonetheless, these data should be useful in gaining a better understanding of the patterns of use in the fee-for-service market.

Data and methods

The data used in this study are derived from a subsample of the continuous Medicare history sample (CMHS), a 5-percent longitudinal sample of Medicare beneficiaries. It is part of the Medicare Statistical System, which is maintained by the Health Care Financing Administration (HCFA) and contains demographic and utilization data derived from administrative files. The analytical file used for this study is a 2-percent subsample of the CMHS and is further limited to the 19,293 sample persons who meet the following criteria:

- Age 65 years or over.
- Medicare beneficiary at the beginning of 1974.
- Alive at the beginning of 1975.
- Entitled to both Parts A and B in 1974.
- Not a member of a group health plan at any time from 1974 through 1980.
- Not an end stage renal disease beneficiary.

For each individual, the file contains demographic data, some utilization data, and amounts reimbursed for each year from 1974 through 1980. In all of the previous studies cited, persons who were alive for the entire period of the study were observed. In this study, a cohort of persons alive as of January 1, 1975, some of whom die thereafter, is followed. Average annual reimbursement amounts are calculated

by dividing the total reimbursement for the year by the number of persons alive at the beginning of the year. Thus, reimbursements for persons who die are included in the average. For analytical purposes, the data can be viewed as a hypothetical cohort of 19,293 persons who were enrolled in an HMO as of January 1, 1975, with an annual capitation payment made on January 1 of each year for persons alive at that time. (However, the cohort was formed by a random sample of all Medicare beneficiaries and, thus, may not be at all characteristic of a cohort of persons who actually choose to join an HMO.)

Comparing average annual reimbursements for successive years requires an adjustment for inflation. In the adjustment method chosen, each individual's annual total reimbursement is divided by the average annual reimbursement for all persons alive at the beginning of each year. The resulting number, referred to as a reimbursement ratio, is the primary study variable throughout the article.[2] Keep in mind that this method of adjustment also removes the effects of aging and other demographic changes in the cohort. Thus, the average reimbursement ratio for the cohort is 1 in both 1974 and 1980, in spite of the fact that the cohort is 7 years older in 1980 and probably uses more services.

In this study, we examine a variety of different subgroups selected from the full sample of 19,293 persons on the basis of their 1974 characteristics. It may be useful to consider how different characteristics of groups influence their longitudinal reimbursement patterns. One such characteristic is health status. In any given year, health expenditures are generated by some persons with chronic conditions and others with acute episodes (Welch, 1985a and 1985b). The chronic group can be expected to have continuing high expenditures. The nonchronic group is characterized by a distribution of randomly occurring acute episodes. If we select a group of persons with primarily nonchronic conditions but with high use in one year, we would expect to see a strong regression to the mean in the next year. On the other hand, if we select a group with mostly chronic conditions, we would expect to see little or no regression in the next year.

Other characteristics that might influence expenditures over time are the proclivity to use or not use health care services, the extent of insurance coverage, and impending death. None of these characteristics is directly observable in our data set. However, we will see groups that exhibit some of the behavior expected of these groups.

Findings

Groups formed on 1974 reimbursement

The basic data for the cohort of 19,293 persons alive on January 1, 1975 are shown in Table 1. These

[1]Bias in the enrolled population could also be achieved by selective disenrollment. The potential for this is not addressed in this article.

[2]The reimbursement ratio and some of the analytical techniques used in this study were suggested by Trapnell, McKusick, and Genuardi (1982).

Table 1

Reimbursement interval and sample size for 1974 and mean reimbursement and reimbursement ratios for 1974-80 for aged Medicare enrollees alive as of January 1, 1975, by stratum: United States

Stratum[1]	1974 Reimbursement interval (1)	Sample size (2)	Mean reimbursement[2] (3)	1974 (4)	1975 (5)	1976 (6)	1977 (7)	1978 (8)	1979 (9)	1980 (10)
				Mean reimbursement[2]						
Total	—	19,293	$412	$412	$593	$685	$863	$926	$1,071	$1,211
				Reimbursement ratio						
1	0	9,858	0	0	.54	.65	.73	.74	.75	.76
2	$1–$100	3,731	42	.10	.98	.97	.99	1.01	1.03	1.04
3	$101–$400	2,203	199	.48	1.44	1.36	1.23	1.37	1.32	1.34
4	$401–$700	734	545	1.32	1.64	1.46	1.31	1.53	1.47	1.52
5	$701–$1,000	518	846	2.05	1.48	1.34	1.33	1.43	1.24	1.37
6	$1,001–$2,000	1,029	1,431	3.47	1.70	1.68	1.67	1.38	1.45	1.56
7	$2,001–$4,000	779	2,796	6.79	2.53	2.39	2.09	1.99	1.84	1.63
8	$4,001 or more	441	6,506	15.79	3.30	2.83	2.75	1.89	2.40	2.10

[1] Based on 1974 reimbursement interval.
[2] Unadjusted for inflation.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

persons have been classified into eight strata on the basis of their 1974 reimbursement. The reimbursement range for persons in each stratum is shown in column 1. The number of persons in the stratum in 1974 is shown in column 2, and the mean reimbursement in 1974 is shown in column 3. The average reimbursement for all strata, unadjusted for inflation is shown in the first row of columns 4 through 10. Reimbursement ratios for each stratum for the years 1974-80 are shown in the other rows.[3] These values can be used to find the average reimbursement for any stratum-year simply by multiplying the reimbursement ratio by the average reimbursement for that year.

The strata were formed on the 1974 data, and the ratios for this year show the greatest variation, ranging from 0 to 15.79. More than one-half of the sample received no reimbursement in 1974. The ratios for 1975 range from .54 to 3.30, and there is a general decrease in range as we move away from the base year.

Figure 1 is a graph of the least-squares lines[4] fitted through the data in Table 1 for the years 1975-80. Straight lines drawn from the 1974 reimbursement ratios to the intercepts of the least-squares lines complete the graph. A rather sharp movement toward the mean occurred in the first year after the base year.

Thereafter, the lowest and highest groups continued to move toward the mean but did not reach it in 6 years. Strata 3-6 had roughly the same trend from 1975 onward and, if the linear fit is appropriate, would require from 15 to 50 years to intersect the mean. Strata 7 and 8 would require about 10 years at the rate shown. However, one would expect that a nonlinear trend with a decreasing rate would be a better fit if enough data were available. If so, the higher groups would take even longer to reach the mean.

Stratum 3 has a rather unexpected pattern. It had a reimbursement ratio of .48 in 1974, which increased to well above the mean in 1975 and remained high for the subsequent years. This probably is not just a chance occurrence. A similar stratum formed from 1975 reimbursements (instead of 1974) has a similar pattern. The persons in this stratum had a mean reimbursement of $199 and a maximum of $400, which suggests high Part B use in 1974 and little or no Part A use. Thus, one plausible explanation for the unusual pattern may be that the high Part B use indicates a group with a higher than average prevalence of chronic conditions, resulting in a high probability of being hospitalized and incurring higher costs in subsequent years.

The patterns shown in Table 1 and Figure 1 are a result of forming strata of beneficiaries according to their total Medicare reimbursement in 1974. It would also be of interest to see what reimbursement pattern existed for these various strata prior to the year of stratification. One might expect that persons with low reimbursement in one year would have had low reimbursement in the immediately preceding years. Similarly, persons with high reimbursement in one year might be expected to have had high

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[3] The reimbursement ratios were also calculated with adjustment for age, sex, and welfare status. The direct adjustment method was used, with the 1974 age, sex, and welfare distribution as the standard population. The difference between the adjusted and unadjusted ratios was small. Therefore, only unadjusted figures are used throughout the article.
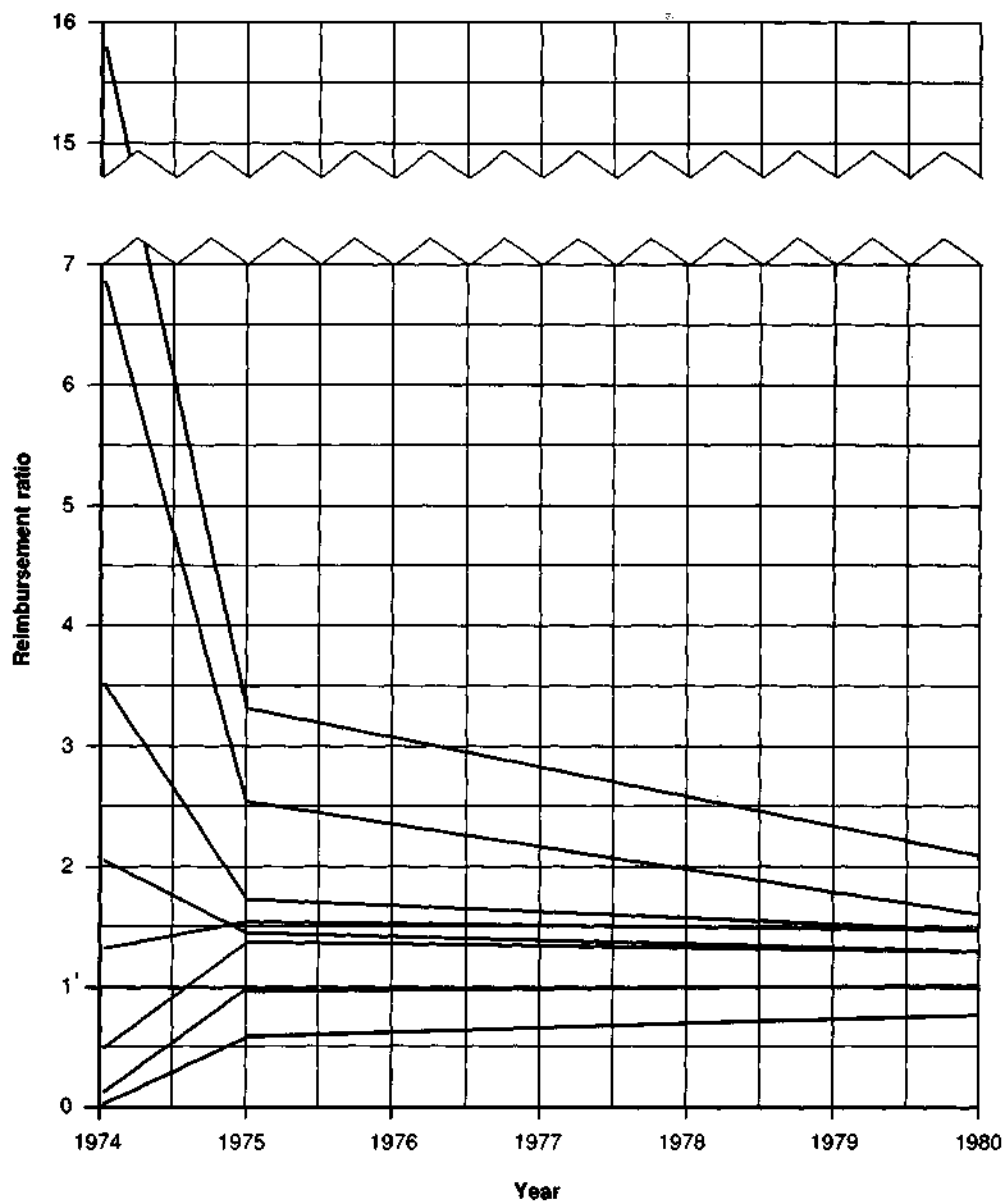
[4] One might expect that an exponential trend, rather than a linear trend, is more appropriate. However, the author did not feel that there were an adequate number of points to fit an exponential curve.
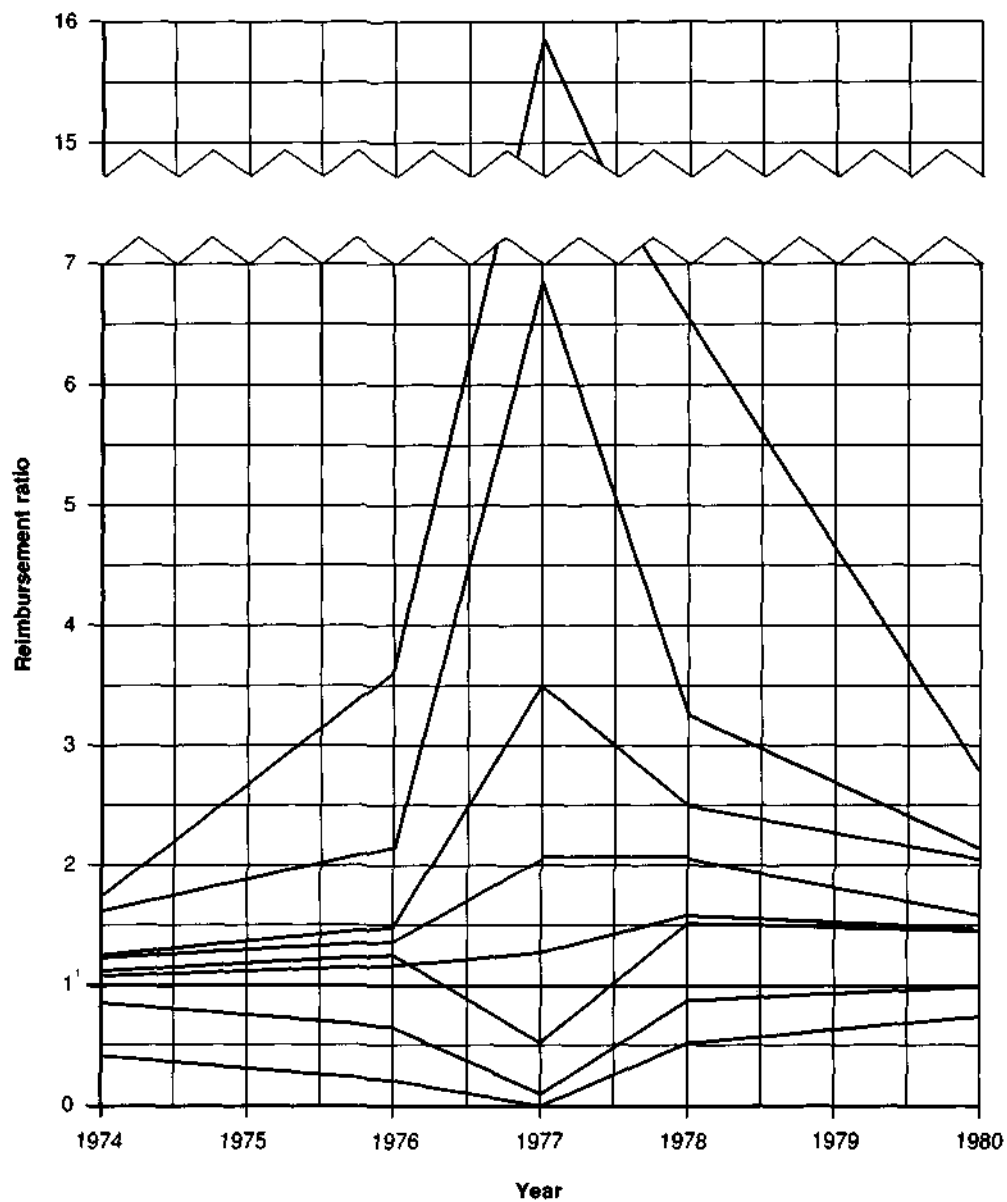
Figure 1
Smoothed reimbursement ratios for strata formed on 1974 reimbursement:
United States, 1975–80

¹ Mean.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

Figure 2
Smoothed reimbursement ratios for strata formed on 1977 reimbursement:
United States, 1974–76 and 1978–80

¹ Mean.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

reimbursement in the preceding years. In Figure 2 are shown the smoothed results of forming the strata on 1977 data and examining reimbursement behavior both before and after the stratifying year. Keep in mind that the reimbursement ratios for 1974-77 are for live persons only, whereas the ratios for 1978-80 are for both persons alive throughout each year and those who died during the year. For the two lowest strata, we see from Figure 2 that there was a gradual decline in reimbursement in the 3 years before the sharp drop in 1977. Stratum 3 started above the mean in 1974 and increased slightly until the drop to one-half of the mean in 1977. The other groups all had moderate to high rates of increase in the 3 years before 1977. Thus, for the most part, the low use and high use observed in the stratifying year are the culminations of trends in previous years.

The survival rates of persons in the original cohort are shown in Table 2. At the end of the 7-year period, stratum 1 had a 5-year survival rate 5 percent above the average of 73 percent. Stratum 2 was 1 percent above average, and all other strata had survival rates below average. The last stratum had a 5-year survival rate of only 44 percent. These survival rates show the positive relation between health care use (and, thus, morbidity) and mortality.

Pearson correlation coefficients of reimbursement ratios for persons surviving 1975, paired with persons alive at the beginning of each of the subsequent years, were calculated. The overall correlation for 1975 and 1976 was .22, which confirms the values used by Welch (1985b). Correlations between 1975 and 1977-80 were small but positive and fairly consistent. These correlations suggest that there is at least a weak relationship between one year's reimbursement and reimbursement in several subsequent years.

Thus far, we have looked at subgroups formed by stratifying the entire sample on the basis of total reimbursement in a particular year. We will now look at groups formed on the basis of their type of use and on various demographic characteristics. Later, we will examine the behavior of groups randomly biased on their reimbursement in a particular year.

Groups formed on other 1974 characteristics

Reimbursement ratios for selected groups that are unrelated to the groups forming the strata discussed earlier are shown in Table 3. (When examining this table, keep in mind that the effects of aging and other changes in demographics in the cohorts are removed when calculating the reimbursement ratio.) The first group is comprised of persons with no acute care

Table 2

Number of sample persons in 1974 and percent of persons alive at the beginning of each year 1975-80, by stratum: United States

Stratum[1]	1974 sample size	Persons alive at beginning of year					
		1975	1976	1977	1978	1979	1980
		Percent					
Total	19,293	100	94	89	83	78	73
1	9,858	100	96	92	87	82	78
2	3,731	100	95	90	85	80	74
3	2,203	100	94	88	83	77	72
4	734	100	92	84	78	71	65
5	518	100	93	86	80	74	67
6	1,029	100	90	82	75	67	61
7	779	100	83	74	67	61	55
8	441	100	80	67	57	50	44

[1]Based on 1974 reimbursement interval.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

Table 3

Sample size for 1974 and reimbursement ratios for 1974-80 for groups formed on prior use or demographic characteristics: United States

Type of group, number, and description	1974 sample size	1974	1975	1976	1977	1978	1979	1980
Groups formed on prior use		Reimbursement ratio						
1: No acute care admission in 1974	15,499	.10	.80	.84	.87	.89	.90	.91
2: 1 acute care admission or more in 1974	3,794	4.69	1.80	1.71	1.60	1.50	1.51	1.45
3: Did not meet Part B deductible in 1974	9,999	.02	.54	.66	.73	.75	.76	.76
4: Met Part B deductible in 1974	9,294	2.06	1.49	1.38	1.31	1.30	1.28	1.29
Group formed on demographic characteristics								
5: Not on welfare in 1974	17,072	.96	.97	.96	.98	.96	.97	.97
6: On welfare in 1974	2,221	1.31	1.21	1.33	1.18	1.31	1.31	1.24
7: Under 75 years of age in 1974	12,010	.88	.87	.91	.92	.90	.90	.91
8: 75 years of age or over in 1974	7,283	1.20	1.22	1.16	1.15	1.20	1.21	1.21
9: Under 75 years of age and not on welfare in 1974	10,984	.85	.85	.86	.89	.86	.86	.89
10: 75 years of age or over and not on welfare in 1974	6,088	1.17	1.21	1.14	1.15	1.18	1.20	1.18

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

admissions in 1974. This group's reimbursement ratio was .10 in 1974, increased to .80 in 1975, and then increased (at a decreasing rate) to .91 in 1980. At this rate, it would reach the mean by about 1984.[5]

Both group 1 (persons with no acute care stay in 1974) and group 2 (persons with one acute care stay or more in 1974), show a steady regression toward the mean from 1975 through 1980. Groups 3 and 4, stratified on whether or not the Part B deductible was met, also show a strong regression over the first 4 years but tend to level off thereafter.

Groups 1-4 appear to be a mixture, to varying degrees, of persons with and without chronic illnesses. Group 1, persons who did not have an acute care hospital stay, probably contains a large, although below average, number of chronically ill persons because this group's average 1974 Part B use was fairly substantial ($41) and it regressed close to the mean within 3 or 4 years. Group 3, persons with no Part B reimbursement in 1974, had much less tendency to regress toward the mean and may consist almost entirely of nonchronically ill persons in 1974. Of the high users, persons with one acute care hospital admission or more (group 2) appear to include a larger proportion of chronically ill persons than persons meeting the Part B deductible (group 4).

The remaining six groups shown in Table 3 were formed on demographic characteristics and had reimbursement ratios in the expected direction. Persons on welfare (as measured by whether the enrollee was covered by Medicaid as well as Medicare) were above the mean; those not on welfare were below the mean. A similar pattern held for the older versus the younger groups and for the older group without welfare versus the younger group without welfare.

The most interesting characteristic about groups 5-10, however, is their consistency over time. None of the groups showed any appreciable tendency to regress toward the mean, in contrast to the strong regression for the four groups stratified on prior use. One explanation for this difference is as follows. Groups selected on the basis of high use in one year (groups 1-4) will contain, simply by chance, a large component of persons who happened to have an acute episode in that year as well as a higher than average component with chronic conditions. In subsequent years, the number of acute episodes will regress to the mean number of acute episodes, but the reimbursement ratio will remain high because the group also contains a greater than average proportion of persons with chronic conditions. Similarly, groups selected on the basis of low use in one year will contain both a lower than average proportion of persons without chronic conditions and a lower than average proportion of persons who, by chance, did not have an acute episode in that year. On the other

hand, groups selected on the basis of demographic characteristics (groups 5-10) will tend to have an average number of acute episodes for that group but a high or low proportion of persons with chronic conditions. The consistency of reimbursement over time suggests that demographic characteristics can be used to identify groups that are healthier than average or have a higher than average proportion of persons with chronic conditions.

Randomly biased groups

If biased selection results from HMO's enrolling disproportionate numbers of persons selected randomly from groups with either high or low levels of prior use, then we can simulate that process and observe the degree of regression to the mean. Reimbursement ratios for 10 groups that were biased on the 1974 reimbursement ratio are shown in Table 4. Group 1 was biased by selecting a disproportionately low share of high users and a disproportionately high share of low users. Group 2 had slightly more high users and slightly fewer low users, and so on up to group 10, which had a relatively large share of high users and a small share of low users. The groups were formed by retaining what seemed to be a reasonable number of persons in each stratum. Thus, even the group biased most toward high use had 39 percent nonusers.

The groups are arranged from the lowest 1974 reimbursement ratio (.51) to the highest (1.68). The regression to the mean of these groups is best seen in Figure 3, in which smoothed plots of the data in Table 4 are shown. There was a sharp regression in 1975 and a slow regression thereafter. None of the groups shown here actually reached the mean by 1980, although all were within a few percentage points. The low-bias groups moved closer to the mean than did the high-bias groups.

If these simulations were an accurate reflection of the actual enrollment process, we might conclude that selection of moderately biased groups is not a major problem because of relatively rapid regression to the mean. Selection of a more extreme group, particularly one with a high bias, could result in a loss continuing over several years. However, as is cautioned throughout this article, we do not know the extent to which such simulations reflect reality.

Assessing risks under biased selection

This section contains a description of a simulation in which we endeavor to evaluate the risks associated with HMO enrollment of biased groups of Medicare beneficiaries, taking into account regression to the mean. In the simulation, it is assumed that the methods for forming randomly biased groups described in the previous section result in a distribution of enrollees with characteristics that approximate those of a group of actual enrollees with lower than average use in the year prior to enrollment

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[5]This statement is based on a straight-line projection. The data suggest strongly that a straight line might not be appropriate. If not, this group would not be projected to reach the mean until after 1984.

Table 4

Sample size for 1974 and reimbursement ratios for 1974-80, by randomly biased group: United States

Group	1974 sample size	1974	1975	1976	1977	1978	1979	1980
					Reimbursement ratio			
1	17,033	.51	.89	.91	.93	.95	.95	.96
2	17,328	.57	.92	.93	.94	.97	.96	.96
3	17,632	.64	.91	.95	.96	.97	.96	.98
4	17,946	.71	.94	.96	.97	.97	.98	.98
5	18,271	.79	.94	.95	.97	.98	.98	.98
6	18,601	.86	.98	.97	.97	.98	.98	.98
7	13,910	1.16	1.05	1.05	1.04	1.03	1.03	1.03
8	12,262	1.25	1.06	1.07	1.08	1.06	1.05	1.04
9	9,876	1.43	1.13	1.09	1.08	1.06	1.06	1.08
10	7,645	1.68	1.21	1.13	1.08	1.11	1.07	1.08

NOTES: Groups biased on reimbursement were formed by altering the relative distribution of persons across the 8 strata defined in Table 1. For example, the full sample had the following percentages of persons in strata 1-8, respectively: 51.1, 19.3, 11.4, 3.8, 2.7, 5.3, 4.0, 2.3. To form group 1 (low bias), the percentage of persons was increased in the low dollar strata and decreased in the high dollar strata as follows: 54.8, 21.9, 12.5, 3.3, 1.9, 3.1, 1.8, .7. Total sample size was then limited to assure that all strata would contain enough cases to fill the proportions of the sample required by the altered distribution. The actual persons comprising the biased groups were selected at random within strata.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

in the HMO. As emphasized throughout this article, there is no way to test the validity of this assumption. Although the simulation is for a group with low prior use, the methods for assessing risk can be applied to any group. (Detailed formulas and examples of the calculations can be obtained from the author.)

Two risks are assessed. The Medicare program is at risk of paying more for the HMO enrollees than it would have paid if they had remained in the FFS sector. The HMO is at risk of having the costs of its enrollees exceed the payment. Both risks depend on the size of the group enrolled, random variation in health care use, the degree of bias in the enrollee group, and, because of the regression phenomenon, the time elapsed since enrollment. To illustrate this dependency in a general way, plots of reimbursement ratios for 26 randomly biased samples of 500 enrollees are shown in Figure 4. Each sample had a reimbursement ratio of approximately .57 in 1974. The vertical sets of points in Figure 4 represent 26 reimbursement ratios for each of the years 1974-80. The groups were biased on the 1974 reimbursement ratio, resulting in a tight cluster of points near .57 for that year. In subsequent years, two things happened. First, the spread became greater, reflecting the role of random variation in separating groups that were relatively homogeneous in 1974. (The spread for larger cohorts would, of course, be less pronounced.) Second, the midpoint of the 26 groups generally tended to move toward the mean reimbursement ratio of 1.0, illustrating the regression phenomenon.

A graphical illustration of the risks that are quantified in a specific model later in this section is provided in Figure 4. Suppose the group of points for 1974 represents the use of 26 potential enrollee groups in the year prior to enrollment. Assume that the line drawn at a reimbursement ratio of 1 represents Medicare's level of payment, which is equal to the

amount the enrollees would have cost in the FFS sector. Referring to Figure 4, we see that, in 1975, all but 1 of the 26 groups had costs at or below the payment level. Thus, we might infer that the chance of the Government losing money or breaking even in the first year of enrollment is 25 out of 26, and the chance of a loss to the HMO is only 1 out of 26. As regression to the mean occurs over time, the distribution of points on either side of a reimbursement ratio of 1 becomes more equal, and the risks appear to approach 50-50 for both the Government and the HMO. These risks can be quantified in the context of a specific simulation, as described next.

The basic characteristics of the simulation model are as follows:

- It is assumed that the HMO is new and has enrolled 5,000 persons effective January 1, 1986. (This is about the average Medicare enrollment in HMO's with TEFRA risk contracts.) The enrollees will remain enrolled for the next 6 years or until they die.
- The average monthly AAPCC for TEFRA HMO's in mid-1986 was about $220. In the model, $220 is used as the basis for calculating the FFS county per capita cost (CPCC). The payment to the HMO will be 95 percent of the CPCC after it is adjusted for county-HMO demographic differences. Thus, all results are in constant dollars.
- It is assumed that the 5,000 enrollees have, on average, the same characteristics as a randomly biased group with an average reimbursement ratio of .57 when the biasing is done in the manner described earlier and shown in Table 4. Thus, the average reimbursement ratio of enrollees in the model was .57 in 1985, the year prior to enrollment.

The method used for biasing the group requires some further discussion. In the AAPCC, the

Figure 3
Smoothed reimbursement ratios for groups biased on 1974 reimbursement ratios:
**United States, 1975–80**
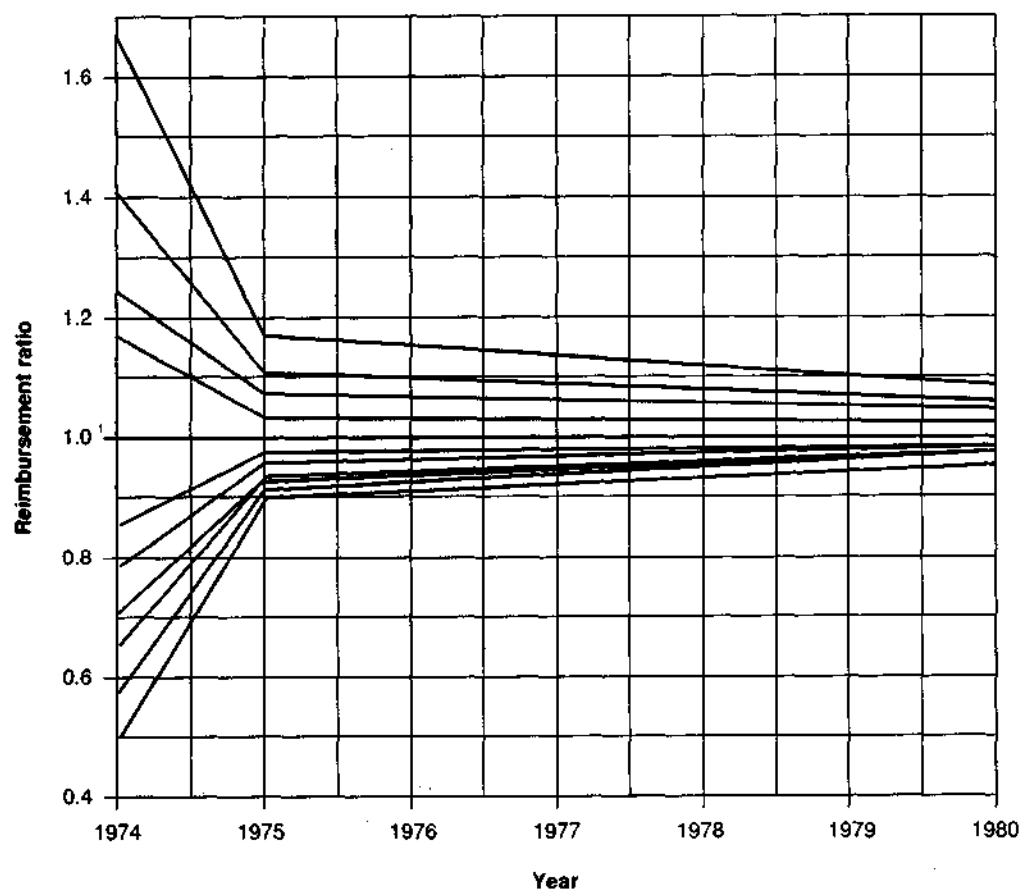
' Mean.

NOTE: Smoothed plots are not corrected for adjusted average per capita cost underwriting factors.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

Figure 4
Reimbursement ratios for groups randomly biased on 1974 reimbursement ratios:
United States, 1974–80
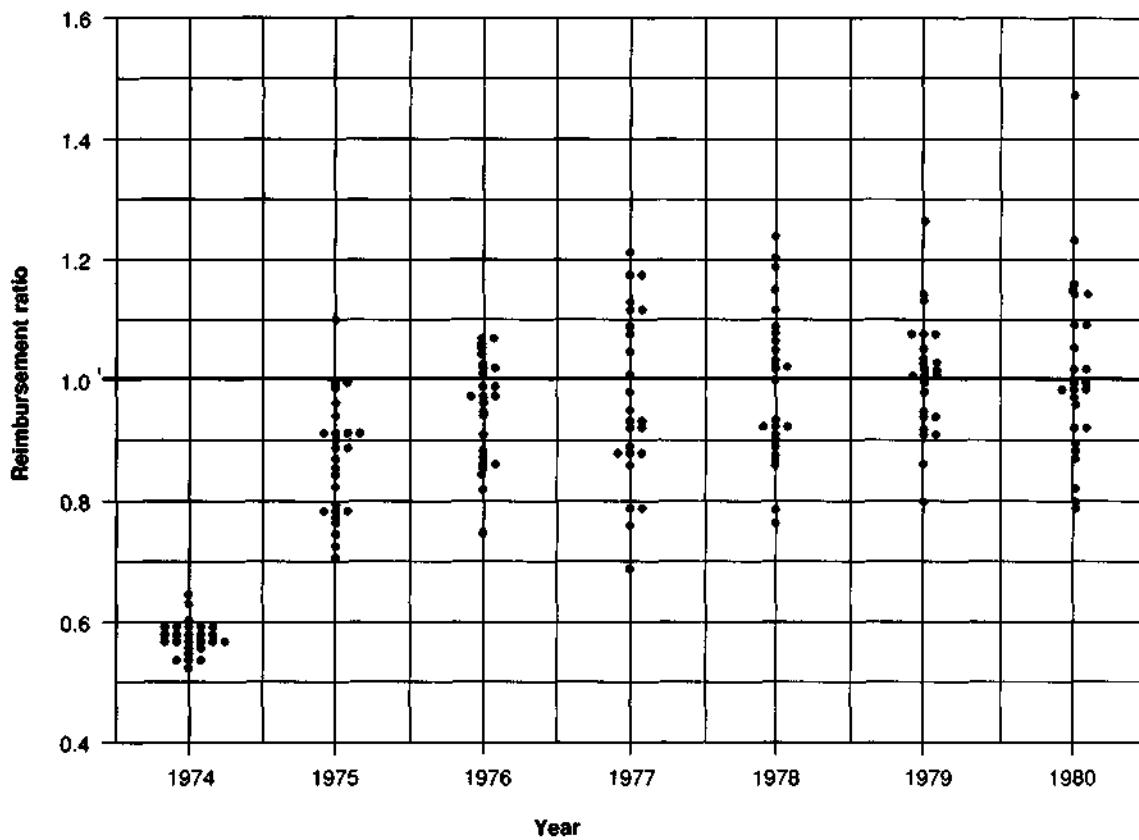
¹ Mean.

NOTE: Reimbursement ratios are shown for 26 groups of 500 enrollees each that were randomly biased to have a 1974 reimbursement ratio of approximately .57.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

underwriting factors discussed in the introduction to this article are used to adjust for any differences in demographic composition between fee-for-service beneficiaries in the HMO service area and the HMO's enrollees. For this simulation, a similar adjustment is necessary. Because the biasing procedure was done without regard to the underwriting factors, adjustment for these factors could remove some or all of the bias. If adjustment removes all or nearly all of the bias, the payments to the HMO will be about what they are supposed to be. However, the evidence suggests that selection favorable to the HMO remains favorable even after adjustment, and the model is intended to simulate this situation. Thus, we need to examine whether the random biasing method results in bias in each of the underwriting cells.

The distribution and reimbursement ratios of the full sample of 19,293 persons and the biased sample of 17,297 persons across 20 underwriting cells representing three of the four underwriting factors—age, sex, and welfare status—is shown in Table 5. (The fourth factor, institutional status, was unknown for this sample.) As shown in the table, the reimbursement ratio for the biased sample is considerably lower than that for the full sample for each of the 20 cells. Thus the biasing method does, indeed, result in a downwardly biased reimbursement ratio in each of the underwriting cells.

The adjusted[6] average Part A and Part B underwriting factors for each of the cells (based on actual factors used by HCFA for calculation of the AAPCC) are shown in column 5 of Table 5. Using the number of cases in each cell as weights, the weighted average underwriting factor across the 20 cells is 1.00 for both the full sample and the biased sample. Thus, adjustment for age, sex, and welfare status using the HCFA underwriting factors has little or no effect on the base year average reimbursement ratio of .57 for the simulated enrollee group. (Because of deaths and aging of the cohort, the adjustment makes a difference in years following the base year.) This result has rather disturbing implications for the current AAPCC. It shows that three of the four adjusters currently used account for virtually none of the bias in this randomly selected group.

In summary, the model consists of a simulated group of 5,000 HMO enrollees with lower than average Medicare reimbursement in the year prior to enrollment but with an unbiased average underwriting factor in that year. The enrollees are all assumed to have joined the HMO as of January 1, 1986, and they will remain in the HMO for the next 6 years or until they die. We further assume that the enrollees had an average reimbursement ratio of .57 in the year before enrollment. The Medicare program will pay 95 percent of a standard rate of $220, which would be $209 per month per live enrollee (after adjusting for age, sex, and welfare status) for the next 6 years. All results are in constant 1986 dollars.

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[6]The average underwriting factor for the full sample was not equal to 1.00. The adjustment forced the average to 1.00.

Table 5

Sample size and reimbursement ratio for full sample cohort and biased cohort and adjusted average Parts A and B underwriting factor, by sex, welfare status, and age: United States, 1974

Sex, welfare status, and age	Full cohort		Biased cohort		Adjusted average Parts A and B underwriting factor (5)
	Sample size (1)	Reimbursement ratio (2)	Sample size (3)	Reimbursement ratio (4)	
Male					
On welfare:					
65-69 years	196	1.58	165	.95	1.37
70-74 years	197	.98	178	.56	1.70
75-79 years	122	.96	111	.71	2.01
80-84 years	98	.99	88	.46	2.17
85 years or over	91	1.56	78	1.03	2.17
Not on welfare:					
65-69 years	2,796	.83	2,521	.50	.85
70-74 years	1,920	1.00	1,717	.53	1.01
75-79 years	1,303	1.20	1,166	.70	1.21
80-84 years	655	1.09	577	.67	1.26
85 years or over	373	1.40	323	.66	1.26
Female					
On welfare:					
65-69 years	293	1.22	263	.73	1.07
70-74 years	342	1.19	307	.79	1.29
75-79 years	343	1.58	295	.80	1.43
80-84 years	295	1.61	252	.84	1.57
85 years or over	247	1.15	215	.48	1.71
Not on welfare:					
65-69 years	3,460	.75	3,153	.45	.71
70-74 years	2,808	.86	2,535	.49	.85
75-79 years	1,989	1.13	1,782	.65	.99
80-84 years	1,149	1.12	1,025	.68	1.07
85 years or over	616	1.25	546	.70	1.13
Weighted average	—	1.00	—	.57	[1]1.00

[1]Average = 1.00 whether weighted by full cohort or biased cohort.

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

The purpose of the simulation is to assess the probability of a loss to the Government or HMO and the expected amount of such a loss in light of the favorable selection by the HMO and the expected regression to the mean. The assessment is done for the initial cohort of 5,000 enrollees. The effects of new enrollees and voluntary disenrollment are not considered in the simulation. Also, the stated losses do not reflect the time value of money. The assessment of loss is based on the comparison of two numbers:

- CFFS = the aggregate amount the biased cohort would have been reimbursed in 1986, 1987, . . . , 1991 had it remained under the fee-for-service system.
- PAY = the aggregate amount the HMO will be paid under 95 percent of the AAPCC in each of the years 1986-91.

The operational definition of CFFS is as follows:

CFFS = (average predicted reimbursement ratio)
× (CPCC) × (12) ×
(average number of live person-years) ×
(an adjustment for aging of the cohort).

The predicted ratio is calculated from a regression equation fit to the data for 1975-80 on line 2 of Table 4. The average number of live person-years is used to approximate the total annual payment that would result from payments made monthly for only those persons alive as of the beginning of the month. The adjustment for aging is necessary because, in the method of calculating reimbursement ratios, any effects of aging on the reimbursement of the cohort are factored out. This adjustment puts that factor back in. The aging adjuster employed is the ratio of the average reimbursement for the biased sample cohort to the average reimbursement of a national cross-sectional sample of all Medicare enrollees in each year, standardized to 1.00 in 1975. Because of the aging of the cohort and the relatively stable age of the national sample, this ratio gradually increases to more than 1.00 in the years subsequent to 1975. A final step was to fit a least-squares equation to the actual ratios. The ratios predicted from this equation were used as the adjusters.

The operational definition of PAY is:

PAY = (.95) × (CPCC) × (average reimbursement ratio for the parent population in 1974) × (12) × (live person-years) × (the ratio of the average demographic factor for the enrollee cohort in each year to the average demographic factor for the parent population in 1974).

The calculation of PAY is based on the parent population, which, for the model, is the full sample of 19,293 persons. The full sample had a reimbursement ratio of 1.00 in 1974. The average reimbursement ratio for the parent population multiplied by $220 represents the CPCC, i.e., the product of the first and second terms of the AAPCC formula.

The ratio of the average underwriting factors represents the third factor of the AAPCC formula, i.e., the adjustment for differences in demographics between the enrollees and the county FFS population. The denominator of this third factor is equal to the 1974 full-sample average underwriting factor, which is 1.00. Holding the average reimbursement ratio and the average underwriting factor for the parent population constant at 1974 levels implies an assumption that, on balance, the parent population does not change over time. The average underwriting factor for the enrollee cohort changes because of aging and deaths.

To assess losses and gains to the HMO, we assume that the cost to the HMO of providing services to enrollees is equal to 95 percent of the predicted FFS reimbursement, reflecting the greater efficiency of providing care expected of the HMO setting.

The expected losses and gains per enrollee for the 6-year period 1986-91 are shown in Table 6. The average number of persons alive in the cohort for each year is shown in column 1, the predicted FFS reimbursement ratio is shown in column 2, and the amount of the payment in reimbursement ratio form is shown in column 3. Note that the payment reimbursement ratio is greater than the FFS reimbursement ratio in the first 3 years and less than the FFS reimbursement ratio in the last 3 years. This pattern carries over into the relationship between columns 4 and 5; the average annual payment is greater than the average FFS cost in the first 3 years and less in the last 3.

The aggregate losses and gains for the Medicare program and the HMO are shown in Table 7. The predicted annual payments under FFS and simulated payments to the HMO are shown in columns 1 and 2, respectively. The losses to the Medicare program are shown as negative numbers and gains are shown as positive numbers in columns 3 and 4.

The payment in the first year is about 5 percent higher than predicted FFS costs, resulting in a loss to the Medicare program of $604,000, or $124 per enrollee. The losses fall off quickly and become gains in the fourth year. If the trend were continued, the Medicare program would recoup all early losses sometime during the seventh year and make a profit thereafter. Had the Government set the payment at 90 percent of the AAPCC instead of 95 percent, it would have broken even in the first year and profited thereafter. However, the Government's gain is the HMO's loss. A reduced payment might have discouraged the HMO from enrolling Medicare beneficiaries, with the consequence that the Government would not realize even a long-term gain.

The gains to the HMO are shown in columns 6 and 7 of Table 7. Because the model assumes that HMO costs are 95 percent of FFS costs, the HMO profits in all 6 years. However, the amount of profit declines as the cohort regresses toward the mean. If the model had covered more years, it would probably have shown the HMO beginning to experience a loss in the seventh or eighth year.

The probability of experiencing a loss and the expected amount of the loss, given that a loss occurs, are summarized in Table 8. In the simulation discussed earlier, we showed a loss to the Government in the first 3 years of the HMO's operation. However, whether or not a loss occurs is subject to the laws of chance. As shown in Table 8, under the model simulated, there is a 90-percent chance that the Medicare program will experience a loss in the first year. Thus, if many HMO's began operation under the conditions described, the Medicare program would lose money in 90 out of 100 of them during the first year. The average amount of the loss in the 90 percent producing a loss would be $700,000 per year. Both the probability of a loss and the average loss fall off rather quickly, so that in the sixth year, the Medicare program will experience a loss in only 13 percent of the HMO's.

Table 6

Reimbursement ratio and annual cost per enrollee predicted for fee-for-service (FFS) recipients and enrollees in the simulated health maintenance organization, by year: United States, 1986-91

Year	Live person-years in cohort (1)	Age-adjusted FFS predicted reimbursement ratio (2)	Payment reimbursement ratio (3)	Predicted FFS average annual cost per person (4)	Average annual payment per person (5)
1986	4,869	.922	.969	$2,434	$2,558
1987	4,609	.960	.984	2,534	2,598
1988	4,353	.999	1.001	2,637	2,643
1989	4,093	1.038	1.020	2,740	2,693
1990	3,834	1.078	1.059	2,846	2,796
1991	3,593	1.119	1.071	2,954	2,827

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

Table 7

Simulated total Medicare payments, health maintenance organization (HMO) costs, and losses and gains to Medicare and the HMO, by year: United States, 1986-91

Year	Predicted total FFS annual cost (1)	Total payment (2)	Losses and gains to Medicare		Assumed total HMO annual cost (5)	Losses and gains to HMO	
			Total (3)	Mean per enrollee (4)		Total (6)	Mean per enrollee (7)
	Amount in thousands				Amount in thousands		
1986	$11,851	$12,455	$ – 604	$ – 124	$11,258	$ + 1,197	$ + 246
1987	11,679	11,974	– 295	– 64	11,095	+ 879	+ 191
1988	11,479	11,505	– 26	– 6	10,905	+ 600	+ 138
1989	11,215	11,022	+ 193	+ 47	10,654	+ 368	+ 90
1990	10,912	10,720	+ 192	+ 50	10,366	+ 354	+ 92
1991	10,614	10,157	+ 457	+ 127	10,083	+ 74	+ 21

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

Table 8

Probability of loss and expected loss given that a loss occurs for Medicare and the simulated health maintenance organization (HMO), by year: United States, 1986-91

Year	Medicare			HMO		
		Expected loss given that a loss occurs			Expected loss given that a loss occurs	
	Probability of a loss (1)	Total in thousands (2)	Mean per enrollee (3)	Probability of a loss (4)	Total in thousands (5)	Mean per enrollee (6)
1986	.90	$700	$144	.01	$157	$32
1987	.73	496	108	.03	179	43
1988	.52	372	85	.09	210	48
1989	.33	289	71	.20	243	59
1990	.33	279	73	.20	238	62
1991	.13	206	57	.43	302	84

SOURCE: Health Care Financing Administration, Bureau of Data Management and Strategy: Data from the Medicare Statistical System.

The initial favorable selection for HMO's, in addition to their assumed lower cost, gives them hardly any chance of experiencing a loss in the first year. The average amount of a loss, should one occur, would be only $157,000, about 1 percent of the $12.5 million payment (Table 7). Although the Medicare program's situation improves over time, the HMO's situation tends to get worse. By the sixth year, there is a 43-percent chance that the HMO will experience a loss for the cohort, with the expected loss being $302,000. Faced with this, entrepreneurs contemplating going into the HMO business would have to assess their ability to reduce the long-term risks by introducing efficiencies into the delivery of care. It would appear that there is ample opportunity during the low-risk early years to build an operation efficient enough to make the enterprise desirable.

Discussion

This study was motivated by the Eggers (1983) and Eggers and Prihoda (1982) studies, in which it was found that Medicare enrollees in six out of seven

HMO's had lower than average AAPCC-adjusted prior use. These findings sparked a controversy over whether low prior use is a reliable indicator that the enrollees will exhibit subsequent lower than average use of HMO services. If, as some authors contend, groups of low users regress rapidly toward the mean use, then the advantage of enrolling lower than average users will be short lived. On the other hand, if the low use persists over several years, then HMO's may profit considerably at the expense of the Medicare trust fund unless a method is found to correct for the biased selection.

In this study, the question of regression toward the mean was approached by following groups that were biased in a base year in a variety of ways over a period of six subsequent years. For groups biased on prior reimbursement and prior utilization, we found sharp regression toward the mean in the first year following the base year and a slow regression thereafter. The biased groups examined did not regress entirely to the mean even after 6 years. Predictably, the most extreme groups in the base year remained farthest from the mean.

On the other hand, groups that were biased on welfare status and/or age exhibited remarkably stable reimbursement ratios over 7 years. In fact, as shown in Table 3, the future of either an HMO or a third-party payer appears to be much more certain with the groups selected on demographic variables than with the groups selected on prior use. Whether the Medicare expenses of groups actually joining an HMO will be more like that of groups based on prior use or that of groups selected on demographic characteristics reflective of health status is an empirical question.

Finally, this study was an attempt to simulate losses and gains associated with enrollment favorable to the HMO on the basis of prior use in light of regression to the mean. Under the conditions simulated, the Government would pay more for the enrollee cohorts in their first 3 years of enrollment and less thereafter. Early losses would be fully recouped during the seventh year. In addition, if HMO costs are 5 percent less than FFS costs, HMO's should be able to serve their enrollee cohorts profitably for many years after enrollment. Thus, in the long run, the current policy of encouraging Medicare enrollment in HMO's appears justified if we can assume that the phenomenon of regresssion to the mean shown in the statistically simulated groups applies to groups actually joining HMO's.

Unfortunately, it is not possible to conclude with much confidence that groups who join HMO's will behave in a manner similar to the statistically simulated groups in this study. HMO enrollees may well have characteristics not measured by the HCFA statistical system that would cause them to behave much differently from a randomly biased group. An analysis of regression to the mean for groups of actual HMO enrollees would make a most interesting study.

Acknowledgments

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