

# Alternative geographic configurations for Medicare payments to health maintenance organizations

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*Under prevailing legislation, Medicare payments to health maintenance organizations (HMOs) are based upon projected fee-for-service reimbursement levels for enrollees' county of residence. These rates have been criticized in light of substantial variations in rates among neighboring counties and large fluctuations in rates over time. In this study, the use of nine alternative*

*configurations and the county itself were evaluated on the basis of payment-area homogeneity, payment rate stability, and policy criteria, including the fiscal impacts of reconfiguration on HMOs. The results revealed rather modest differences among most alternative configurations and do not lend strong support for payment area reconfiguration at this time.*

## Introduction

Provisions of the Tax Equity and Fiscal Responsibility Act of 1982 (TEFRA) authorized that full prospective payments to health maintenance organizations (HMOs) for covered services provided to Medicare enrollees be set at a rate of 95 percent of the adjusted average per capita cost (AAPCC). The AAPCC is intended to be the average amount that Medicare would have paid for services had they been furnished in the local fee-for-service (FFS) market. In the implementation of the law, counties were chosen as the geographic unit for computation of AAPCC rates. The purpose of the study presented here was to investigate whether use of the county or some alternative geographic configuration would best comply with legislative requirements and best promote Medicare's policy goals for the HMO payment system.

In the current AAPCC formula, a projected level of national Medicare reimbursements per capita is multiplied by a county geographic index to obtain an estimate of projected per capita costs at the county level. This geographic index is a simple average of the ratios of county to national per capita reimbursements for the 5 most recent years of available data. The result is then multiplied by a third ratio factor accounting for differences in the composition of HMO enrollees versus FFS beneficiaries among the AAPCC risk classes (age, sex, welfare status, and institutional status) to yield the AAPCC. Questions have been raised about the appropriateness of using enrollees' county of residence as the geographic basis for setting capitation rates. County-based payment rates have been criticized for differing inexplicably and dramatically between seemingly similar adjacent counties (Greenlick, 1985). An often-cited example of the county "boundary problem" is the AAPCC rate for Part A for Prince Georges County, Maryland, which is about 50 percent higher than the rate for adjacent Montgomery County, Maryland.

Other than examples of the more extreme boundary differences, no empirical research has shown how much

AAPCC rates typically vary between contiguous counties. To briefly explore this, we selected 33 counties comprising the service areas of HMOs in the Medicare Competition Demonstrations and all counties that were contiguous to any of these 33 counties. The simple average absolute percentage difference in the 1987 Part A or Part B rate between pairs of neighboring counties was found to be about 14 percent. This is considerably less than the roughly 25-percent difference between the AAPCC rate for noninstitutionalized, non-Medicaid males 65-69 years of age and the rate for similar males 70-74 years of age.

The year-to-year instability of AAPCC rates has also been an issue of concern (Milliman and Robertson, 1987). It has been suggested that this instability may be the result of a county having a relatively small number of Medicare beneficiaries or high HMO penetration rates. Only about one-third of the more than 3,000 counties in the Nation have Medicare FFS beneficiary populations of more than 5,000. The severity and importance of these potential problems are not entirely clear. However, one might suspect that the appropriateness of the county to represent local markets could vary among areas, because there are substantial variations in the sizes of counties among States and in the population concentration within many counties. Whereas there are 159 counties in the State of Georgia, the much larger State of California contains only 59 counties. The Los Angeles metropolitan statistical area (MSA) is a single county, but the Atlanta MSA is comprised of 18 counties.

## Criteria for evaluating alternative configurations

Geographic location is an important element of a capitation payment system simply because location has some effect on the cost of care. Input factor prices to providers, such as wages and rents, vary geographically. Health care use rates may also vary among different markets across the country or within market areas (e.g., inner cities versus suburbs) because of population health status, access, or medical practice patterns. Under an administered price system, geographic units serve a purpose similar to other enrollee risk factor classifications. Capitation rates can be adjusted to reflect systematic cost variations among geographic units, just as rates can be adjusted for the age class of enrollees. Under

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competitive bidding or negotiated ratesetting processes, geographic cost variations would be implicitly incorporated through providers' bids and their service area definitions. Without such geographic adjustments, providers serving markets in which costs are higher as a result of factors beyond their control would be penalized, and even the most efficient providers may not be able to serve these markets in the long run. In the case of Medicare HMOs, capitation rates are currently adjusted to fully reflect Medicare FFS reimbursement experience, regardless of why FFS rates might be higher or lower. Analysis of the broader policy issue of what geographic variations should be adjusted for when setting HMO capitation rates (e.g., input price differences only) is beyond the scope of this article.

Under prevailing legislation, Medicare HMO payment rates are set at 95 percent of Medicare's expected FFS costs for enrollees. Because one cannot observe FFS costs once individuals enroll in an HMO, projected reimbursement rates for similar nonenrollees must serve as the basis of measurement. Geographic units serve an important conceptual purpose here, because their empirical definitions in effect delineate groups of FFS nonenrollees to determine these expected FFS costs. We have proposed elsewhere that alternative geographic configurations be evaluated on three criteria: actuarial (i.e., cross-sectional) homogeneity, temporal stability, and policy aspects (Porell, Tompkins, and Pomeranz, 1987).

### **Actuarial homogeneity**

Alternative geographic configurations should be evaluated in terms of their ability to capture systematic differences in expected costs resulting from FFS market forces. It is desirable to define geographic areas in such a way that the mean FFS cost for an entire unit reasonably reflects the mean costs of any subarea from which an HMO might draw enrollees. For example, if a geographic configuration grouped an urban area with a rural area, and urban FFS costs were higher than rural costs, the mean FFS cost for the unit might not accurately reflect either urban or rural FFS market conditions. HMO payment levels for this urban-rural unit would only be technically correct if an HMO's enrollees were drawn from the area in proportion to the beneficiary populations in the two subareas. Such heterogeneity can create a financial incentive for an HMO to enroll disproportionately from the lower cost subarea. Actuarial homogeneity is best achieved by using relatively small geographic units so that small area patterns can be captured.

### **Temporal stability**

It is desirable to have geographic units defined in such a way that year-to-year fluctuations in HMO revenues are small. Mean FFS reimbursement levels are more stable over time in more heavily populated geographic areas, because the extreme temporal variation of medical care use by individuals is dampened for larger populations. Because larger geographic areas tend to be more heterogeneous than smaller areas, the performance of alternative configurations is likely to vary inversely on stability and homogeneity criteria.

## **Policy aspects**

Although the homogeneity and stability criteria just discussed have implicit policy elements, broader policy issues need to be considered. Policy aspects include concerns about the objectivity of unit definition and the administrative feasibility of implementing an alternative to the current method. It is important that a configuration not be viewed as subject to potential gerrymandering. Given concerns about county boundary problems, the perceived fairness and understandability of the resulting configurations should be considered. Payment differentials among geographic units should make sense.

The potential financial impact of reconfiguration on both the HMO industry and on the Medicare program is of obvious policy importance as well. Because the market-entry decisions of existing TEFRA HMOs were made prior to any reconfiguration, significant adverse financial impacts upon existing TEFRA HMOs are possible and would be undesirable. A final concern pertains to likely future directions for Medicare capitation policy. If certain geographic configurations are more suitable for areas with high HMO market penetration, or if possible future changes in ratesetting are not strictly based on local FFS Medicare experience, certain options might be favored over others, particularly if future policy directions are known.

## **Bases for alternative geographic configurations**

Ten alternative geographic configurations were constructed for testing in this study and are summarized in Table 1. Because Health Care Financing Administration (HCFA) administrative files contain the five-digit ZIP Codes and county residence of all beneficiaries, all configurations were based on these geographic units. In some cases, counties and/or ZIP Codes were aggregated to reproduce existing territorial definitions, such as the MSA definitions of the U.S. Bureau of the Census. Other aggregations made use of additional data, such as population density levels or hospital use patterns, to formulate geographic units specifically for this study. Explicit decision rules for grouping were developed in these cases so that resulting spatial units were reproducible (assuming that the required data and resources are available) and therefore less vulnerable to potential charges of arbitrariness in construction.

## **Counties**

All States are divided into counties, primarily for governmental and administrative purposes. As the geographic base of the existing payment system, the county configuration is the standard against which all alternative configurations must be compared. Although the county configuration has been criticized for a number of reasons already discussed, one advantage of using counties that is not often cited is that a significant amount of secondary data regarding population demographics, economic activity, and health care delivery systems are collected and reported on a county basis.

**Table 1**  
**Ten alternative geographic configurations**

Geographic configuration	Description
County	Areas are defined by counties.
5-digit ZIP Code	Areas are defined by 5-digit ZIP Codes.
3-digit ZIP Code	Areas are defined by 3-digit ZIP Codes.
5-digit MSA with 3-digit rural	Metropolitan statistical areas, or MSAs (which conform to county boundaries), are partitioned by 5-digit ZIP Codes; rural areas are partitioned by 3-digit ZIP Codes.
Urban areas with 3-digit rural	Urban areas are based on population density; rural areas are partitioned by 3-digit ZIP Codes.
Core-ring with 3-digit rural	Urban areas are categorized by population density levels (urban core-suburban ring); rural areas are partitioned by 3-digit ZIP Codes.
Core-ring with MSC units	Same as above, except rural areas are partitioned by groups of 3-digit ZIP Code areas called management sectional centers (MSCs).
PPS model	MSAs are defined by counties as in the prospective payment system (PPS); all other counties for each State are combined into a single rural unit.
Modified county	Counties are divided into their urban and rural components based on population density.
Hospital choice areas	Residents' 5-digit ZIP Codes are aggregated according to similarities in hospital choice patterns among Medicare beneficiaries.

SOURCE: Bigel Institute for Health Policy, Brandeis University: Data from the Redefining Geographic Areas for HMO Payments Study.

### Five-digit ZIP Code

The five-digit ZIP Code is the smallest geographic unit by which Medicare can routinely identify the residence of beneficiaries and, hence, the smallest administratively feasible unit for paying HMOs. Accordingly, a virtue of the use of ZIP Codes is the minimal risk of implicitly mixing heterogeneous market conditions in rate development. A practical result is that HMO payments would be most closely associated with the actual service area. A potential drawback of five-digit ZIP Codes stems from the fact that there are more than 40,000 of them nationally. Given the high incidence of sparsely populated units, county problems of payment-rate instability and inexplicable boundary differentials are likely to be exacerbated.

### Three-digit ZIP Code

Three-digit ZIP Code areas have geographic boundaries defined by the U.S. Postal Service that reflect the shape and size of an area's transportation pattern, which in turn reflects local economic patterns (Rand McNally, 1985). It is plausible that health care markets could follow similar patterns. Nationally, there are 770 3-digit ZIP Code areas, compared with more than 3,000 counties.

Consequently, payment stability may be enhanced relatively easily through the use of an alternative set of existing boundary definitions with an economic basis. For this reason, Milliman and Robertson (1983, 1987) suggested that Medicare base its payments to HMOs on three-digit ZIP Codes.

### Hybrid ZIP Code configurations

Some of the relative advantages of using more than one type of geographic area definition can be seen by considering hybrid systems. One such system would define payment areas within MSAs using five-digit ZIP Codes as boundary lines and within rural areas using three-digit ZIP Codes. This approach would reserve the precision of individual five-digit ZIP Codes for more populated MSAs, where most HMOs operate, and where market conditions may be most heterogeneous. In rural areas, three-digit ZIP Code areas should be much less vulnerable to payment-rate instability than would sparsely populated five-digit ZIP Code areas.

The configuration tested here pooled together all ZIP Codes in an MSA with fewer than 500 Medicare beneficiaries into a separate single MSA unit. This pooling was done to avoid the specification of separate payment units for numerous ZIP Codes with very small populations. Under this population threshold, the least populated ZIP Code areas were comparable in size to the least populated rural counties, and the pooled MSA units did not account for a large fraction of the MSA population. The choice of 500 persons was arbitrary, however. Larger or smaller thresholds could have been employed without significant changes in the results.

Another variant of the use of three-digit ZIP Codes is to use them to configure rural areas, while urban areas are defined in accordance with population-density criteria. The U.S. Bureau of the Census definition of "urbanized areas" (a set of contiguous areas with a population of at least 50,000 and density exceeding 1,000 persons per square mile) was approximated by our own computation of five-digit ZIP Code total population densities. Urban areas were delineated for all MSAs defined by the U.S. Bureau of the Census. In essence, this configuration represents a rather simple and objective approach for capturing broad urban-rural and regional differences in market conditions through urban population density and through rural transportation patterns reflected in three-digit ZIP Code definitions.

### Core-ring areas

Welch (1987) advanced a core-ring-rural approach to HMO payment area configuration that uses population density to classify areas. HMOs would receive different payment levels for enrollees residing in core urban areas, suburban ring areas, and rural areas. The concepts of urban land and wage-rent gradients of spatial economic theory were invoked as a theoretical basis for configuration. Land prices and wage levels tend to be highest in densely populated core areas of metropolitan areas and lowest in outer fringe areas. In the course of this study, we also found both Medicare reimbursements and hospital days per 1,000 to be higher in more densely populated core areas. Under the premise that beneficiaries

tend to use providers close to their homes, beneficiary residence is used to approximate provider location.

Under this density-based approach, urban areas were first delineated as the urban-area portions of MSAs with Medicare and total populations exceeding 10,000 and 100,000 persons, respectively. For MSAs with populations exceeding 1 million, core subareas were distinguished from suburban rings when population densities exceeded 5,000 persons per square mile. In certain of the largest metropolitan areas, their core areas were still further subdivided by distinguishing subcores where population density exceeded, for example, 15,000 persons per square mile.

Small MSAs and rural areas were configured two different ways and treated as separate alternative configurations in this study. Three-digit ZIP Codes were used in one alternative. The other core-ring alternative employed management sectional centers (MSCs), which are defined by the U.S. Postal Service as groupings of two or more three-digit ZIP Code areas. Details concerning the construction of the core-ring models can be found in Porell et al. (1988).

The core-ring approach to configuration has a number of potential strengths. First, there should be greater payment-rate stability, because configuring rural areas and small MSAs through MSCs would only yield about 500 payment areas in the Nation. Second, this approach has a theoretical basis concerning expected central city-suburban-rural differences that is intuitively understandable. Core reimbursement rates should be higher than those in the ring, and ring reimbursement rates should be higher than those in surrounding rural areas. A weakness of this model is that there is no theory on which to base the density level used to distinguish core subareas from the urbanized area. The higher the threshold density level, the fewer metropolitan areas will have cores distinguished from rings and the smaller core areas will be.

### **Prospective payment system model**

Medicare prospective payment system (PPS) payment rates to hospitals are currently adjusted by a wage index set for each MSA defined by the U.S. Bureau of the Census and a single rural area for each State. PPS area wage adjustments have been used to take into account price differences faced by hospitals in different parts of the country. Because the PPS configuration involves aggregations of counties, payment-rate stability may be enhanced while retaining important regional price differences recognized by Medicare in hospital prospective payments. Modeling HMO payment areas after PPS may lend an air of simplicity to Medicare that could be intuitively appealing to providers. A disadvantage of the PPS configuration may be greater heterogeneity in payment units, because most counties would be aggregated together into larger units.

### **Modified counties**

Rather than developing complex and potentially arbitrary configurations that could adversely affect the HMO industry by making significant changes in HMO payment areas, it may be preferable to improve upon the

current county configuration through less drastic modifications that address specific shortcomings of the existing configuration. One approach would be to aggregate counties with the explicit intention of improving payment rate stability through the use of more highly populated units. The PPS option already discussed might be viewed this way.

However, this modified county configuration represents a different approach. It would seek to address the noted problem of heterogeneity in urban-rural border counties. HMOs enrolling beneficiaries primarily from urban subareas of these counties may receive inadequate payment rates, because lower rural reimbursements are factored into payment rates.

With this configuration, counties are generally retained as the basic unit for Medicare payment. Counties are subdivided into subareas only when there are significant Medicare populations in both urban and rural parts of the county. Urban subareas are defined by urban-area population density requirements of 1,000 persons per square mile. Urban-rural county subareas were formed only with populations of more than 500 Medicare beneficiaries to avoid possible creation of numerous small payment units.

### **Hospital choice areas**

This alternative entails delineation of market areas in which beneficiaries share similar choices with respect to providers of medical care. Market areas defined in such a manner would pay HMOs differently when input prices vary among markets but not within markets where groups of individuals face similar choices among HMOs. Differences in medical practice style among distinct markets are also retained by the nature of market area definitions. Given the apparent intent of the existing TEFRA regulations that an HMO be paid on the basis of the experience of FFS beneficiaries who could have enrolled in that HMO, this approach has the strongest theoretical basis for defining HMO payment areas.

Market areas of similar provider choice were constructed using patient origin data to aggregate Medicare beneficiaries' residence ZIP Codes according to their tendency to use the same hospitals. Similar choice tendencies were measured by the overlap in the fractions of beneficiaries in different ZIP Codes admitted to the same hospitals. A hierarchical computer algorithm was developed that grouped five-digit ZIP Codes (and/or previously grouped ZIP Codes) together in a series of sequential steps on the basis of maximum overlap in hospital admission patterns. Starting with individual five-digit ZIP Codes as payment areas, the number of payment areas was reduced in each step of the algorithm through aggregation of areas with the most similar hospital admission patterns. The resulting configurations tested in the study generally had fewer payment units than did the county configuration.

Although the algorithm generally yielded cohesive areas, a set of explicit rules was applied when noncontiguous groupings were formed by the algorithm, so that all payment areas were made up of contiguous ZIP Codes. A detailed discussion about the algorithm used for configuration and an illustrative example are contained in Porell et al. (1988).

The hospital choice approach to configuration is attractive in that it is the only alternative that seeks to explicitly define market areas through Medicare utilization patterns. In contrast to other approaches, it does not use indirect measures such as population density or jurisdictional lines to delineate market area boundaries. However, the rather complex operational aspects of constructing these hospital choice markets make this approach less appealing for actual implementation.

## Data, methodology, and empirical findings

### Data

The primary data for the study were Medicare FFS reimbursement data from the Health Insurance Skeleton Bill file and Medicare beneficiary population data from the Health Insurance Skeleton Eligibility Write-off (HISKEW) file. Data were obtained for seven States for calendar years 1984-86. Empirical tests were applied only to aged Medicare beneficiaries. Reimbursements from individual Part A and Part B bills from the Health Insurance Skeleton Bill file were aggregated to the five-digit ZIP Code level using the beneficiary residence ZIP Code contained on bills and payment records.

(Preliminary findings showed that standardizing expenditure rates by age and sex composition had no material effect. Unstandardized rates were used for the analyses presented here.) Counts of beneficiaries for these same areas were aggregated from the July writeoff of the HISKEW file for each of the calendar years. Because five-digit ZIP Code boundaries may not coincide with county boundaries, ZIP Codes lying in more than one county were split into separate ZIP Code-county units so that all configurations based on counties or ZIP Codes could be consistently defined with the same set of data.

The seven study States (California, Connecticut, Florida, Georgia, Illinois, Massachusetts, and Minnesota) were chosen to be representative of States with high TEFRA risk HMO enrollment and/or diverse county sizes. Georgia was included, for example, because of the large number of counties it has relative to its land area. California was chosen as a State with few counties relative to land area and with a large number of TEFRA risk HMO enrollees. For five of the study States, 1984 and 1985 calendar year data were employed in the analyses. Because of difficulties in constructing 1984 reimbursement files for Massachusetts and Minnesota, 1985 and 1986 data were employed for these States.

A second major source of data was a writeoff from the Group Health Plan Operations Master HMO file for October 1987. For each of the 54 TEFRA risk HMOs in the 7 study States operating during that month, counts of enrollees were obtained by ZIP Code and county and were matched to the reimbursement data files. Finally, a mapping program and several five-digit ZIP Code data files were obtained from a private vendor. These data files contained the population and square mileage data used to calculate ZIP Code population densities.

### Statistical methods and empirical findings

In this section, we discuss both the operational methods employed to test the alternative configurations

based on the three evaluation criteria outlined earlier and our empirical findings. Before discussing the specific methods, it should be noted that all statistical tests were applied separately for each of the seven study States. It could be reasonably argued that States represent arbitrary spatial aggregations and that data observations should be simply pooled together over all seven States. However, given the diversity in the numbers and sizes of counties in different States, we believed it was important to assess whether the relative performance of the alternative configurations differed much among the study States. For example, in a State like Georgia, where counties are smaller, they might be expected to exhibit greater actuarial homogeneity than in California, where they are much larger. Pooling over States would obscure any State differences that could be potentially important for generalizing our empirical findings to the Nation as a whole.

Although all empirical results were reported in Porell et al. (1988), only summary results representing population-weighted averages of State-specific findings are reported here. In general, patterns in the findings were quite consistent across the States. Any notable exceptions to the general patterns for certain States are discussed along with our general findings.

### Actuarial homogeneity

For any particular geographic unit, its homogeneity may be measured by the variance of subarea reimbursement levels around the mean reimbursement level for the unit as a whole. The less the variation, the greater is the internal homogeneity. Three empirical tests of homogeneity were used. Statistical formulas for these tests are contained in the "Technical note." The first two are measures of explained variance and are called "R<sup>2</sup>" because of their similarity to R<sup>2</sup> values commonly used in regression analysis. R<sup>2</sup> values range from zero to one, with higher values reflecting greater homogeneity. Because five-digit ZIP Codes are the smallest geographic unit available from Medicare data systems, a five-digit ZIP Code configuration would have no within-unit variance in reimbursements and would have an R<sup>2</sup> equal to one. All other configurations will have R<sup>2</sup> values of less than one. Two R<sup>2</sup> values were computed for each configuration by applying two different sets of population weights to ZIP Code observations: Medicare FFS beneficiaries and TEFRA risk HMO enrollees. FFS population weights attach greater importance in the computation of R<sup>2</sup> values to those ZIP Codes in which more Medicare beneficiaries actually reside. Use of HMO enrollment weights attaches importance only to how well configurations perform in areas in which actual TEFRA risk HMO enrollment exists.

We have labeled the third test a measure of the effective homogeneity of different configurations. If an HMO systematically enrolls beneficiaries from subareas with FFS reimbursement levels that are higher or lower than the mean FFS reimbursement level for the larger payment area, a form of spatial enrollment bias may be said to exist. Although such bias could not exist if subarea reimbursement rates were completely uniform, a heterogeneous configuration could still be effectively homogeneous if an HMO drew enrollments

proportionately from high- and low-cost subareas of a larger payment unit. Measuring the effective homogeneity involved two calculations. First, we computed enrollment-weighted averages of FFS reimbursement rates for each TEFRA risk HMO, based upon each configuration under study. Then we calculated a more precise average based upon the five-digit residence ZIP Codes of the HMO's Medicare enrollees. The smaller the mean absolute percentage difference between these two rates, the lesser is the effective impact of payment unit heterogeneity on TEFRA risk HMO payments.

A drawback of this effective homogeneity measure is that the FFS reimbursements in a ZIP Code pertain only to those remaining FFS beneficiaries who have not enrolled in an HMO. A better measure would use FFS reimbursement rates that existed prior to any HMO market penetration. If HMOs tend to selectively enroll Medicare beneficiaries with lower or higher FFS reimbursements than nonenrollees from the same ZIP Codes, effective homogeneity measures derived from post-HMO market penetration data could be biased. We could not readily determine whether the effective homogeneity measures were biased by HMO enrollment patterns.

The three tests of homogeneity were applied to all configurations separately in each of the seven study States for 1985. A summary of the relative performance of each configuration over all of the study States is shown in Table 2. These summary results were obtained by taking FFS population or TEFRA risk HMO weighted averages of State-specific results.

The first column of Table 2 contains the number of distinct payment areas resulting for each configuration for the seven study States. The PPS configuration contained the fewest payment units, and the two configurations employing individual five-digit ZIP Codes had the greatest number of units by far. The next two columns of Table 2 contain our findings for the  $R^2$ . Given that the five-digit ZIP Code is the unit of observation, the  $R^2$  values for other configurations should be interpreted as the fraction of five-digit ZIP Code variance that can be explained through the configuration boundaries.

The five-digit MSA with three-digit rural configuration exhibited the highest  $R^2$  values, and the PPS model configuration exhibited the poorest  $R^2$  values among all configurations. This pattern was maintained over all States. The superior performance of the five-digit MSA with three-digit rural configuration is not surprising as it uses individual five-digit ZIP Codes within MSAs. The rather weak performance of the PPS model configuration also is probably explained by its specification of a single rural payment area for each State. In any event, there was a general, consistent pattern in each State that configurations with larger numbers of geographic units outperformed those with fewer units on  $R^2$  measures.

For example, in Georgia, the county configuration with 159 payment areas had a Medicare FFS-population-weighted  $R^2$  of 0.60. This was only slightly less than the maximum  $R^2$  of 0.61 found for both the 5-digit MSA with 3-digit rural (139 payment areas) and modified county (171 payment areas) configurations in Georgia. The county configuration in Connecticut, with 8 payment areas, had a Medicare FFS-population-weighted  $R^2$  of 0.27. Whereas this was only slightly higher than the 0.26

**Table 2**  
**Results of homogeneity measures for alternative geographic configurations for basing Medicare health maintenance organization (HMO) payments: Selected States, 1984-86**

Geographic configuration	Number of units <sup>1</sup>	R-squared weighted by Medicare population	R-squared weighted by HMO enrollment	Percent effective homogeneity <sup>2</sup>
County	495	0.63	0.51	2.66
5-digit ZIP Code	6,288	1.00	1.00	0.00
3-digit ZIP Code	172	0.62	0.55	2.62
5-digit MSA <sup>3</sup> with 3-digit rural	2,032	0.88	0.84	2.05
Urban areas with 3-digit rural	205	0.58	0.47	3.35
Core-ring with 3-digit rural	204	0.64	0.56	2.45
Core-ring with MSC <sup>4</sup> units	113	0.60	0.54	3.64
PPS <sup>5</sup> model	76	0.49	0.41	5.08
Modified county	607	0.65	0.53	2.40
Hospital choice	426	0.70	0.61	2.03

<sup>1</sup>Total number for the 7 States included in this study.

<sup>2</sup>Effective homogeneity is defined as the mean absolute percentage difference between HMO payment levels based on the geographic configuration and those based on the 5-digit ZIP Code configuration.

<sup>3</sup>Metropolitan statistical area.

<sup>4</sup>Management sectional center.

<sup>5</sup>Prospective payment system.

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

of the PPS model configuration with 6 payment areas, the 5-digit MSA with 3-digit rural model, with 135 payment areas, had the highest Medicare FFS-population-weighted  $R^2$  value in Connecticut with 0.82.

Although the performance of the PPS model, five-digit ZIP Code, and five-digit MSA with three-digit rural configurations generally stood out from the others by defining the range of relative performance among all configurations, there was much less difference in the relative explanatory power of the remaining seven geographic configurations. The remaining average  $R^2$  values for these seven configurations ranged only from 0.58 to 0.70, with FFS population size weights, and 0.47 to 0.61 when HMO enrollment weights were applied. The performance of the county configuration was comparable to the median performance of these remaining 7 configurations on the  $R^2$  measures.

The fourth column of Table 2 contains summary results for the effective homogeneity of the different configurations based on actual TEFRA risk HMO enrollment patterns by HMO. Here again, the PPS model performed most poorly, with an average absolute difference in mean FFS reimbursement rates between PPS and ZIP Code configurations of roughly 5 percent. Whereas the superior performance of the five-digit MSA with three-digit rural configuration is again not surprising because it uses individual ZIP Codes, the hospital choice

configuration actually performed equally well. There was roughly a 2-percent average absolute difference between mean FFS reimbursement rates based on hospital choice areas versus five-digit ZIP Codes. The most striking aspect of these results, however, is the little difference among most of the alternatives. Average absolute percentage differences for the six alternatives with greatest effective homogeneity span a range of only 2 to 2.66 percent.

## Temporal stability

Data limitations precluded testing stability in a way that simulated the actual AAPCC projection methodology. Geographic adjustments in the AAPCC employ 5 years of county per capita reimbursement data to smooth out possible year-to-year fluctuations in reimbursements. There is also a 3-year lag between the last year of data employed in computing the geographic index and the AAPCC projection year. We could not use similar averaging techniques because only two sequential years of data were available for all States.

Temporal stability should not be equated with small yearly absolute dollar changes in the payment rates associated with the geographic units of a configuration. As long as FFS reimbursements are to serve as the basis for payments, payment-rate stability should be measured by how well HMO payment rates follow actual changes in Medicare FFS reimbursement rates. As a measure of temporal stability, we computed the percentage differences between actual and projected Medicare FFS reimbursements per capita for each configuration. Projected reimbursement rates were computed as the product of the previous year's ratio of payment-area reimbursements to the State mean and the current year State reimbursements per capita. The absolute value of these projection error differences was averaged over all areas comprising a geographic configuration and expressed as a percentage to derive mean absolute percentage errors, commonly known as MAPEs. The greater the year-to-year stability in payment area reimbursement rates relative to the State mean, the smaller will be the prediction error. Larger MAPEs indicate unstable payment rates. (Because we were unable to average geographic indexes over several years in making payment area projections, the results probably favor configurations with larger, more populated units. Also, it is unclear what impact on stability measures might have resulted from introducing projection lags.)

Three types of MAPEs were calculated. The first two measure mean area-level prediction error with Medicare FFS or TEFRA risk HMO enrollee population weights. The unit of analysis for these MAPE measures was the county, urban area, MSA, or whatever areas comprised a configuration. The third type used the 54 study TEFRA risk HMOs, rather than payment areas, as the unit of analysis. Temporal instability of smaller individual payment areas may be of little concern if HMOs draw enrollees from enough payment areas so that errors arising from the instability of less populated payment areas will cancel out each other by aggregation of HMO payments. HMO MAPEs were calculated for TEFRA risk HMOs on the basis of their enrollment distributions and the actual and predicted per capita reimbursements for

payment areas comprising each configuration. The actual formulas used are described in the "Technical note."

MAPEs are a meaningful summary measure of stability, because more importance is attached to the stability of payment units where more Medicare beneficiaries (or HMO enrollees) actually reside. However, large projection errors are more likely in less populated payment units, and much less weight is given to these payment units in the computation of MAPE values. It may be argued that an important aspect of payment-rate stability is the minimization of the number of payment areas with large projection errors regardless of population size. Therefore, size distributions of the absolute percentage errors were computed for all three MAPE measures to assess the prevalence of large projection errors.

The findings for both the payment area and aggregate HMO payment MAPE measures are summarized for all seven States in Table 3. The overall patterns of payment area MAPE values again showed a distinct relationship between the number of geographic units in a configuration and its relative MAPE value. The PPS model configuration had the greatest payment rate stability among all configurations as reflected in its small MAPE values. On the other hand, the two configurations using five-digit ZIP Codes as distinct payment areas had the highest MAPE values. With the exception of the two configurations using individual ZIP Codes, it is apparent also that there is no dramatic decrease in stability as the number of units increases. Average MAPE values for these remaining 8 configurations ranged from 2.36 to 3.65 with FFS weights and from 3.78 to 5.63 with HMO enrollee weights.

MAPE values for the county configuration were generally close to the median value for the alternative configurations. As expected, the worst relative MAPE values for the county were found in Georgia, where counties generally have small populations. In other States, such as Connecticut and California, where counties are more populated, MAPE values were only marginally larger than those of the minimum MAPE configuration.

The fourth column of Table 3 contains a summary measure of the HMO MAPEs for the 54 TEFRA risk HMOs in the 7 study States. Individual HMO results were weighted by relative TEFRA risk HMO enrollments to obtain this summary measure. The overall pattern of the relative performance of alternative configurations is generally quite similar to the MAPE values reported earlier. However, the overall spread in the relative performance of alternative configurations was diminished substantially. The two configurations using individual five-digit ZIP Codes exhibited relatively poor stability on the two payment-rate MAPE measures already discussed, but their performance here is quite comparable to that of models with substantially fewer geographic units. This is presumably the result of offsetting errors, when HMOs draw enrollees from multiple payment areas. This is supported by a comparison of the third and fourth columns of Table 3. The only substantive difference between the HMO enrollee-weighted MAPEs in column 3 and the HMO MAPEs in column 4 is that area-level errors are allowed to cancel out before aggregation in the HMO MAPEs.

The size distributions of the absolute percentage errors used to calculate the MAPEs are shown in Table 4. Absolute percentage projection errors were classified into four ranges: 0 to 2.5 percent, 2.5 to 5 percent, 5 to 10 percent, and greater than 10 percent. Error distributions are presented with and without the States of Minnesota and Massachusetts. Errors were generally much larger for all configurations in these two States for which 1986 constituted the projection year. This may be the result of incomplete reimbursement data associated with billing lags. Thus, the error distributions for the other five States may be more reliable indicators of relative performance.

As would be expected, the results indicate that configurations comprised of fewer payment areas exhibit fewer outlier areas with large projection errors. A smaller percentage of their payment areas also exhibit large projection errors. The PPS and core-ring with MSC configurations, with the fewest payment areas, had the fewest number of, and smallest percentage of, payment areas with large errors. The more distinct differences among other configurations evident in Table 4 are largely the result of varied numbers of payment areas with small Medicare populations that are given less weight in the less variable MAPE values.

When the size distributions of the HMO MAPE values are considered in the fifth and sixth columns of Table 4, the results again provide little basis for any discrimination among the alternative configurations. As was seen in Table 3, the reduced stability associated with configurations containing greater numbers of less populated payment areas is not necessarily reflected in instability at the HMO level of aggregation. This is

particularly true when Massachusetts and Minnesota HMOs were excluded in the HMO aggregate error distributions because of the use of the probably incomplete 1986 data.

## Policy aspects

We could not simulate HMO payment rates as they are calculated in the actual AAPCC payment formula because of the data limitations discussed earlier. However, we were able to test for the likely HMO payment impacts of reconfiguration by computing average FFS reimbursement rates at the HMO level, using the actual TEFRA risk HMO enrollee residence distribution among payment areas for each configuration. Similar HMO-level average FFS reimbursement rates were computed using counties. The percentage difference between these two HMO-level mean rates should approximate the percentage change in the average capitation payment rate an HMO would experience under reconfiguration. These tests should be sufficient to assess whether certain HMOs would be significant winners or losers under reconfiguration and how total HCFA payments might be affected by reconfiguration of HMO payment areas.

It is worth noting that these estimates could differ from actual payment-rate impacts because the estimates do not take into account any changes reconfiguration might have on the HMO and FFS population distributions among the AAPCC risk classes (i.e., age, sex, welfare status, and institutional status). It is unlikely that any differences would be of much significance, however. The impact analysis also does not take account of potential HMO responses to new geographic configurations. Recent administrative changes in the Medicare risk-contracting program allow a TEFRA risk HMO to redefine its Medicare service area to be a subset of its commercial service area by dropping counties. To the extent that current enrollment patterns reflect HMO response to county AAPCC payment rates, the long-run impacts of reconfiguration may also differ from those estimated here, as HMOs could react to new AAPCC rates.

Although the likely fiscal impacts of reconfiguration were computed for each of the 54 TEFRA risk HMOs in the study States, 3 summary measures are reported here. The first column in Table 5 contains our findings concerning the likely fiscal impacts that reconfiguration would have for HCFA. These were computed by first aggregating (for each configuration) average FFS reimbursements over all study HMOs to obtain an approximation of aggregate HCFA payments to HMOs. The percent change between this dollar amount and that computed using the county configuration should approximate the fiscal impact of reconfiguration for HCFA. These study State data indicate roughly a 1-percent decrease in aggregate HMO payments relative to those under the county system for all but two of the reconfiguration options. Decreases in aggregate HMO payments of from 2 to 3 percent are suggested under the PPS and core-ring with MSC reconfigurations in the seven States.

The small fiscal impact for HCFA (or for TEFRA risk HMOs as a group) appears to be the result of there being both winning and losing HMOs. Accordingly, an

**Table 3**

**Mean absolute percentage error (MAPE) measures of stability for alternative geographic configurations for basing Medicare health maintenance organization (HMO) payments: Selected States, 1984-86**

Geographic configuration	Number of units <sup>1</sup>	MAPE weighted by Medicare population	MAPE weighted by HMO enrollment	HMO payment MAPE
County	495	3.38	5.05	4.21
5-digit ZIP Code	6,117	8.77	9.78	5.26
3-digit ZIP Code	166	2.91	4.53	3.80
5-digit MSA <sup>2</sup> with 3-digit rural	2,001	5.42	6.95	4.30
Urban areas with 3-digit rural	202	2.91	4.43	3.87
Core-ring with 3-digit rural	204	2.97	4.47	3.81
Core-ring with MSC <sup>3</sup> unit	113	3.32	4.16	3.21
PPS <sup>4</sup> model	76	2.36	3.78	3.58
Modified county	607	3.63	5.12	4.30
Hospital choice	426	3.65	5.63	4.36

<sup>1</sup>Total number for the 7 States included in this study. Numbers may differ from those shown in Table 1 because of missing data in either year of data.

<sup>2</sup>Metropolitan statistical area.

<sup>3</sup>Management sectional center.

<sup>4</sup>Prospective payment system.

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

Table 4

**Size distributions of absolute percentage errors used to calculate mean absolute percentage errors for health maintenance organization (HMO) payment areas: United States, 1984-86**

Geographic configuration	Number of units <sup>1</sup>	Absolute percentage error ranges	Number and percent of payment areas				Number of HMOs	
			All States		All States except Massachusetts and Minnesota		All HMOs	All HMOs except those in Massachusetts and Minnesota
			Number	Percent	Number	Percent		
County	495	0-2.5	159	32	148	38	25	15
		2.5-5	96	19	85	22	11	7
		5-10	123	25	100	25	15	5
		more than 10	117	24	61	15	3	0
5-digit ZIP Codes	6,117	0-2.5	856	14	732	16	20	12
		2.5-5	763	19	664	13	13	8
		5-10	1,152	19	972	21	12	6
		more than 10	3,346	55	2,336	50	9	1
3-digit ZIP Codes	166	0-2.5	78	47	75	57	28	17
		2.5-5	38	23	34	26	12	6
		5-10	31	19	21	16	11	4
		more than 10	19	11	2	1	3	0
5-digit MSA <sup>2</sup> with 3-digit rural	2,001	0-2.5	512	26	457	29	24	14
		2.5-5	401	20	363	22	15	7
		5-10	502	25	434	27	13	6
		more than 10	586	29	363	22	2	0
Urban areas with 3-digit rural	202	0-2.5	85	42	82	50	26	15
		2.5-5	49	24	42	26	14	8
		5-10	39	20	28	17	12	4
		more than 10	29	14	12	17	2	0
Core-ring with 3-digit rural	204	0-2.5	88	44	85	52	26	15
		2.5-5	48	24	41	25	13	7
		5-10	36	18	25	16	12	4
		more than 10	29	14	12	7	3	1
Core-ring with MSC <sup>3</sup> units	113	0-2.5	56	50	56	58	31	18
		2.5-5	28	25	26	27	12	6
		5-10	8	16	12	13	11	3
		more than 10	11	9	2	2	0	0
PPS <sup>4</sup> model	76	0-2.5	33	44	32	49	30	19
		2.5-5	17	22	16	25	12	7
		5-10	17	22	15	23	8	1
		more than 10	9	12	2	3	4	0
Modified county	607	0-2.5	200	33	188	38	26	17
		2.5-5	118	19	102	21	9	5
		5-10	152	25	126	26	13	5
		more than 10	137	23	75	15	6	0
Hospital choice	426	0-2.5	146	34	138	43	25	17
		2.5-5	99	23	85	27	10	6
		5-10	101	24	71	22	14	4
		more than 10	80	19	27	8	5	0

<sup>1</sup>Total number for the 7 States included in this study. Numbers may differ from those shown in Table 1 because of missing data in either year.

<sup>2</sup>Metropolitan statistical area.

<sup>3</sup>Management sectional center.

<sup>4</sup>Prospective payment system.

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

alternative that imposes minimum disruption on HMOs might be favored. In the second column of Table 5, our findings concerning the average size (positive or negative) of reconfiguration payment impacts on HMOs are shown. The mean absolute percent change in payments for all HMOs (weighted by relative enrollments) reflects the degree to which average HMO payment levels would change (increase or decrease) under alternative configurations.

Examining these findings, it would appear that, on average, HMO payment level shifts would generally amount to no more than 3 percent or so in either

direction. As might be expected, average payment shifts would be least under the modified county configuration (0.65 percent). They would be greatest if counties were replaced by the PPS model configuration (3.5 percent). Given that the average HMO-level MAPEs reported earlier in Table 3 were roughly the same as, or larger than, the percentage payment-rate shifts found here, it is not clear that the suggested HMO payment-rate shifts found here are very significant.

A third summary measure of the likely fiscal impacts of reconfiguration on TEFRA risk HMO payments is reported in Table 6. In this table, one can see the

**Table 5**  
**Impact of reconfiguration on payments**  
**to health maintenance organizations (HMOs):**  
**Selected States<sup>1</sup>**

Type of reconfiguration	Change in aggregate HMO payments	Mean absolute change in payments per HMO
		Percent
5-digit ZIP Code	+0.13	2.63
3-digit ZIP Code	-1.35	2.34
5-digit MSA <sup>2</sup> with 3-digit rural	-0.61	2.28
Urban areas with 3-digit rural	-0.71	1.72
Core-ring 3-digit rural	-1.19	2.28
Core-ring with MSC <sup>3</sup> unit	-2.23	3.26
PPS <sup>4</sup> model	-2.81	3.54
Modified county	0.00	0.65
Hospital choice	-0.24	1.68

<sup>1</sup>The 7 States included in this study.

<sup>2</sup>Metropolitan statistical area.

<sup>3</sup>Management sectional center.

<sup>4</sup>Prospective payment system.

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

distribution of all HMOs in the study by the percent change in HMO enrollment-weighted FFS reimbursements for each of the other nine alternative configurations. In 253 out of the 486 possible HMO payment method combinations (54 HMOs × 9 payment methods = 486), or about one-half of the cases, the change is either 0 or within plus or minus 1.9 percent of the payment under the present county system. In another 179 of the cases (37 percent), the change is within plus or minus 2 to 5.9 percent. In 36 of the cases (7 percent), a loss of more than 6 percent would be produced, and in the remaining

18 cases, a gain of more than 6 percent would be produced.

It is interesting that, with the exception of the urban area with three-digit rural configuration, the data suggest that more TEFRA risk HMOs would probably lose than gain from reconfiguration. Sixty-one percent of the HMO payment method combinations produce a loss, compared with the county method. The PPS-model configuration produces the largest number of extreme losers, with 8 of the 54 HMOs losing more than 6 percent, compared with the county system. The hospital choice configuration produces only one HMO losing more than 6 percent. The five-digit ZIP Code and the hospital choice configuration each produce the largest number of extreme winners, with five HMOs gaining more than 6 percent, compared with the county system.

Although policy considerations other than payment-rate impacts are not easily quantified, it is still useful to discuss some of the more qualitative differences among the alternatives relevant to policy: their administrative burden, their simplicity and perceived objectivity, and the understandability of resulting payment-rate differentials among areas.

In terms of administrative burden, all of the configurations could be implemented with HCFA administrative data. Certain configurations, such as the three-digit ZIP Code and PPS model configurations, were simply borrowed. Others, such as those constructed with population density or hospital patient-origin data, required considerable labor and/or computer resources to develop. Although further development and testing would affect how quickly reconfiguration could be implemented for some alternatives, none of the them appears to have significant longer run administrative burdens.

It should be added that there may be a greater need for periodic updating of configurations and data base maintenance in certain configurations because of boundary changes. The U.S. Postal Service periodically

**Table 6**  
**Distribution of health maintenance organizations (HMOs) by percent change in payment under**  
**alternative geographic configurations: Selected States<sup>1</sup>**

Alternative configuration	Total	Percent change in payment								
		Less than -6.0	-5.9 to -4.0	-3.9 to -2.0	-1.9 to -0.1	0.0	0.1 to 1.9	2.0 to 3.9	4.0 to 5.9	More than 6.0
Total	486	36	26	78	149	27	77	47	28	18
5-digit ZIP Code	54	4	0	16	12	1	5	6	5	5
3-digit ZIP Code	54	4	3	12	13	2	9	7	4	0
5-digit MSA <sup>2</sup> with 3-digit rural	54	5	2	11	19	0	8	6	2	1
Urban areas with 3-digit rural	54	3	0	1	21	7	11	7	2	2
Core-ring with 3-digit rural	54	4	3	8	19	3	7	6	4	0
Core-ring with MSC <sup>3</sup> unit	54	4	6	12	14	1	7	5	3	2
PPS <sup>4</sup> model	54	8	4	8	15	6	3	6	1	3
Modified county	54	3	3	2	19	6	18	1	2	0
Hospital choice	54	1	5	8	17	1	9	3	5	5

<sup>1</sup>The 7 States included in this study.

<sup>2</sup>Metropolitan statistical area.

<sup>3</sup>Management sectional center.

<sup>4</sup>Prospective payment system.

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

changes ZIP Code boundaries. For example, new five-digit ZIP Codes have been added recently to southern Florida as a result of population growth. The U.S. Bureau of the Census has revised MSA definitions, and new MSAs are added as population levels change. These types of changes would not appear to represent significant obstacles for implementation, however.

The perceived objectivity and simplicity of alternative configuration definitions is another policy concern. Being derived from existing jurisdictional boundaries, the current county configuration represents a simple and objective means of delineating HMO payment areas. Alternatives that incorporate three-digit ZIP Code boundaries or urban-area and MSA definitions (as defined by the U.S. Bureau of the Census) share similar appeal with respect to these considerations. The core-ring alternatives have somewhat less appeal, because there is no institutional standard (e.g., U.S. Bureau of the Census definition) for defining density requirements for core areas. Although a statistical algorithm and a set of objective decision rules were employed in aggregating ZIP Codes for the hospital choice configuration, it clearly represents the most complex approach to payment area definition among the alternatives.

By the very nature of delineating geographic boundaries, all of the configurations will produce boundary differences. Unless explicit spatial smoothing techniques are introduced, this problem cannot really be addressed through reconfiguration. The configurations do vary in terms of whether they produce boundary differences that are logical, however. At one extreme, the two configurations that use five-digit ZIP Codes should greatly increase the incidence of large boundary differences with no apparent basis because of the high incidence of sparsely populated units. At the other extreme, the core-ring, urban-area, and PPS-model boundaries largely demarcate urban-rural and/or inner city-suburban differences that should be intuitively understandable by the HMO industry.

## Discussion of findings

Our findings indicated that significant tradeoffs are involved in choosing among alternatives according to performance on certain criteria. In general, we found that configurations with the smallest areas, (e.g., those using five-digit ZIP Codes), tend to do much better than average on cross-sectional homogeneity measures and much worse than average on stability measures. Those with much larger areas (e.g., the PPS option) performed extremely well on stability measures at the expense of quite poor performance on homogeneity measures. This same pattern prevailed in all States. However, when the best and worst performers on these two criteria are removed from consideration, the range of relative performance among those remaining was not that wide. None of the configurations in this middle group could be viewed as standing apart from the others on all measures.

An inverse relationship was expected between performance on stability criteria and homogeneity criteria. What was somewhat surprising was the degree to which stability or homogeneity had to be traded off to materially improve upon the performance of the county

configuration. The county fell in the middle group of configurations noted previously, in which there were relatively modest differences in measured homogeneity and stability. A major improvement in payment-rate stability appears to require that the number of payment areas be substantially reduced from current levels. However, this will greatly increase payment area heterogeneity. The findings also suggest that significant improvements in actuarial homogeneity require that the number of payment areas be substantially increased. However, smaller, less populated payment areas can only increase any problems of payment-rate stability that already exist in the county configuration. If both stability and homogeneity are deemed to be important, significant improvements in either measure may be difficult to achieve through reconfiguration.

Although the empirical results generally provided little grounds for discriminating among all alternative configurations, these findings, along with some qualitative policy aspects of the alternatives, can be used to eliminate some of the alternatives for further consideration in reconfiguration.

It could be argued that reconfiguration could be recommended on a State-by-State basis when the empirical performance of at least one alternative configuration strongly dominates that of the county in a particular State on all evaluation criteria. Although we found no instances of such performance, it is assumed here that the geographic unit should be defined in the same way throughout the country for reasons of perceived objectivity and administrative simplicity.

The greatest weaknesses of the five-digit ZIP Code alternative involve the unnecessary complexities associated with extremely large numbers of sparsely populated units. The hybrid five-digit MSA with three-digit rural configuration maintained much of the explanatory power of the pure five-digit ZIP Code system, while significantly reducing the number of payment areas. Nevertheless, the poor performance of these configurations on most stability tests, along with policy concerns about the increased likelihood of numerous unexplainable boundary differences within MSAs, would tentatively lead us to reject them. We would add, however, that this study did not address the effectiveness of statistical methods for dampening rate instability, nor did it attempt to explain boundary differences.

The PPS-model configuration has some appeal by virtue of its use in the PPS. It would be understandable to providers and perceived to be not arbitrary in construction. The PPS-model configuration exhibited superior performance on all stability tests. This superior performance came at great expense to the homogeneity criterion, however. Comparing the PPS-model performance on homogeneity tests to that of the urban area with three-digit rural configuration that is most similar to it in construction, it would appear that the major factor underlying the former's poor explanatory power is its lack of specificity in configuring rural areas. Unless payment-rate stability were deemed to be a primary motivation for reconfiguration, the need for a finer configuring of rural areas would lead one to reject the PPS option.

The basic premise of configuring areas according to population density, which correlates with many other variables affecting reimbursement levels, is plausible and worthy of further consideration. Comparisons among the core-ring with MSC, core-ring with three-digit rural, and urban area with three-digit rural alternatives largely involve how rural areas are configured and the relative advantages of partitioning urban areas into cores and rings. The core-ring with three-digit rural configuration performed marginally better than the core-ring with MSC and the urban area with three-digit rural options on homogeneity tests, with negligible impact on payment stability. Partitioning urban areas into cores and partitioning rural areas by three-digit ZIP Codes rather than MSCs both appear to be warranted. This leaves only the core-ring with three-digit alternative for further consideration among the three density-based alternatives discussed here.

Using this reasoning, we have eliminated five options from further consideration because of either poor performance on at least one of the evaluation criteria or because a very similar option exhibited equivalent or superior performance on all three criteria. The remaining options are:

- Counties.
- Modified counties.
- Three-digit ZIP Codes.
- Core-ring with three-digit rural.
- Hospital choice areas.

None of these remaining options performed markedly better or worse than did counties on all empirical measures developed in this study. The options do differ markedly as to how reconfiguration is achieved and have both advantages and disadvantages for use as HMO payment areas. Choosing among the remaining list of five options depends more upon judgments about what type of solution is most desirable, given the political environment created by having a system of voluntary contractors, as well as the intended direction of the Medicare HMO payment system in general. This amounts to choice of the relative weight or importance that is given to each of the evaluation criteria, including the more qualitative policy considerations.

## Conclusions and recommendations

We believe that the prior implementation of a system, in this case the county configuration of HMO payment areas, represents a legitimate barrier to change. Reconfiguration would seem to require that there be a significant improvement over the status quo. Given the rather modest differences among alternative configurations on measurable performance indicators and qualitative considerations, we do not believe that reconfiguration of HMO payment areas can be well defended at this time.

This recommendation should not be interpreted as an endorsement of the county as the best geographic configuration for setting HMO payments or to mean that we believe there are not problems with the county configuration. Specific problems raised about the county configuration should still be given further research attention. Although the issue of payment-rate stability

could be addressed administratively through multiyear risk contracts, further study may still be warranted to assess whether a more limited reconfiguration could improve stability. Such a study should be specifically aimed at grouping together sparsely populated counties or using other statistical smoothing methods, such as shrinkage estimators as proposed by Newhouse (1986), to improve stability. Employment of such smoothing techniques would also likely improve the performance of other configurations that use smaller payment areas.

Regarding payment area homogeneity and unexplainable boundary differences, it may be prudent to seek to explain some of the more notable boundary problems through more detailed analysis of Medicare data. National PPS rates and peer review organization activities could eventually diminish many of these large boundary differences as well. It should be noted, however, that these same programmatic developments may render alternatives with larger units, such as the PPS-model option, relatively more homogeneous than was found in this study. Because tradeoffs between homogeneity and stability may be less significant in the future, reconfiguration to larger payment areas could become more desirable, particularly because moving to larger payment areas could possibly avert the eventual effects of high HMO county penetration rates.

Finally, it should be recognized that many of the perceived problems of the AAPCC associated with the county configuration, such as large and possibly inexplicable boundary differences and low rural AAPCC rates, may not be rectifiable at all through reconfiguration. Redrawing boundary lines cannot adequately address the major underlying policy issue of the appropriateness and basic fairness of a pure FFS-based HMO payment system. In light of the uneven experience of Medicare HMO contracting to date and policy goals of expanding Medicare capitation, future research should also be directed toward alternative payment strategies that do not rely exclusively on Medicare FFS experience as a basis for HMO payments.

## Technical note

In this note we provide some detail about the indicators used to quantify the evaluation criteria.

### Indicators of relative homogeneity

#### R-squared

$R^2$  measures of homogeneity were derived through analysis-of-variance techniques. Five-digit ZIP Codes were the units of observation. The within-unit variance in ZIP Code reimbursement levels is variance that is unexplained by the geographic configuration. For any configuration within a State, total within-unit variance is defined as:

$$SS_{\text{within}} = \sum_z c_z (R_z - R_u)^2 \quad (1)$$

where  $c_z$  is the relative population size weight for ZIP Code  $z$  in the State. Both Medicare FFS and TEFRA risk HMO population weights were employed.  $R_z$  is the reimbursements per capita for ZIP Code  $z$ , and  $R_u$  is the

FFS reimbursements per capita for the geographic unit  $u$  in which ZIP Code  $z$  is a member. For example,  $R_u$  is the county mean reimbursement levels for the existing county configuration. The total variance for the State with areas  $R_u$  is the sum of  $SS_{nu}$  across all areas:

$$SS_w = \sum_u SS_{nu} \quad (2)$$

The total variance in reimbursements for all five-digit ZIP Codes in a State is defined as:

$$SS_T = \sum_z c_z (R_z - R_s)^2 \quad (3)$$

where  $R_s$  is defined as the State mean reimbursement level. Homogeneity was defined as the proportion of total variance in State ZIP Code reimbursements that can be reduced (or explained) by delineating reimbursement levels that differ from the State mean reimbursement level. This measurement, commonly known as  $R^2$ , is defined as:  $1 - (SS_w/SS_T)$ .

### Effective homogeneity

Effective homogeneity was measured as follows. Define  $PAY_{ui}$  as the HMO enrollment-weighted mean FFS reimbursement level for the  $i$ th HMO under geographic configuration  $u$ , or:

$$PAY_{ui} = \sum_u c_{ui} (R_u) \quad (4)$$

where  $c_{ui}$  is the proportion of the  $i$ th HMO's enrollment residing in geographic unit  $u$ , and  $R_u$  is defined as for equation (1). Define  $PAY_{zi}$  as the enrollment-weighted mean reimbursement level for the  $i$ th HMO under five-digit ZIP Codes, or:

$$PAY_{zi} = \sum_z c_{zi} (R_z) \quad (5)$$

The effective homogeneity of configuration  $u$  in a State was defined as the mean absolute percentage difference between  $PAY_{ui}$  and  $PAY_{zi}$  over all  $i = 1, \dots, N$  HMOs in the State, or:

$$\text{Effective homogeneity} = \sum_i d_i * \text{abs} ((PAY_{ui} - PAY_{zi})/PAY_{zi}) \quad (6)$$

where  $d_i$  is the proportion of State TEFRA risk enrollment in HMO $_i$ . The less the mean absolute percentage difference in reimbursements, the greater is the effective homogeneity of the configuration.

### Empirical indicators of relative stability

#### Mean absolute percentage error

Stability was measured in terms of relative projection errors. For each geographic unit in a configuration, a geographic index ( $GI_u$ ) for year 1 was defined as the ratio of per capita FFS reimbursements in that unit ( $R_u$ ) to the per capita reimbursements for the State ( $R_s$ ), or:

$$GI_u = (R_u/R_s) \quad (7)$$

A projected FFS reimbursement level for each geographic unit in year 2 ( $PR_{u2}$ ) was obtained by multiplying the actual State per capita reimbursements in year 2 ( $R_{s2}$ ) by the geographic index (7), or:

$$PR_{u2} = GI_u * R_{s2} \quad (8)$$

The mean absolute percentage error in a State for any geographic configuration  $u$  was computed as follows:

$$\text{MAPE} = \sum_u c_u * \text{abs} ((PR_{u2} - R_{u2})/R_{u2}) \quad (9)$$

where  $c_u$  is the proportion of State Medicare or HMO population in geographic unit  $u$ . Greater temporal stability should be reflected in smaller MAPE values.

MAPE values were also computed with HMOs as units of observation. For each TEFRA risk HMO $_i$  in a State, the HMO's projected mean FFS reimbursement in its service area in year 2 (PPAY) was computed as an enrollment-weighted average of projected year 2 reimbursements, or as:

$$PPAY_{ui} = \sum_u c_{ui} (PR_{u2}) \quad (10)$$

where  $PR_{u2}$  is defined as in equation (8), and  $c_{ui}$  is defined as in (4). The enrollment-weighted mean of actual year 2 FFS reimbursements ( $PAY_{ui}$ ) in an HMO's service area was computed as in (4). The HMO MAPE in a State for configuration  $u$  is computed as:

$$\text{HMO MAPE}_u = \sum_i d_i * \text{abs} ((PPAY_{ui} - PAY_{ui})/PAY_{ui}) \quad (11)$$

where  $d_i$  is defined as in equation (6). More stable configurations should exhibit smaller MAPE values.

### Empirical policy impact indicators

#### Payment impacts

HMO payment impacts were measured by the change in the enrollment-weighted mean service area FFS reimbursement under the alternative configurations relative to the service area mean computed with county FFS reimbursement rates and enrollments by county. Define  $PAY_{ui}$  as in equation (4) for all configurations other than the county, and  $PAY_{ci}$  as the enrollment-weighted mean FFS reimbursement level for the  $i$ th HMO under the county configuration, or:

$$PAY_{ci} = \sum_c c_{ci} (R_c) \quad (12)$$

where  $c_{ci}$  is the proportion of HMO $_i$ 's TEFRA enrollment in county  $c$ , and  $R_c$  is the Medicare FFS reimbursement rate for county  $c$ . The mean absolute percent change in FFS reimbursements for all TEFRA risk HMOs in a State was computed as:

$$\text{HMO IMPACT}_u = \sum_i d_i * \text{abs} ((PAY_{ui} - PAY_{ci})/PAY_{ci}) \quad (13)$$

The less the mean absolute percent change in FFS reimbursements, the smaller is the average positive or negative impact of reconfiguration on payments received by HMOs.

The fiscal impact of reconfiguration on aggregate HMO payments by HCFA was measured as follows:

$$\text{HCFA IMPACT}_u = \frac{(\sum_i e_i (\text{PAY}_{ui} - \text{PAY}_{ci}))}{(\sum_i e_i \text{PAY}_{ci})} \quad (14)$$

where  $e_i$  is TEFRA risk enrollment of HMO $_i$ , and the summation is over all 54 study HMOs.

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## References

- Greenlick, M.P.: Comments on Medicare capitation payments to HMOs. In Scheffler, R.M., and Rossiter, L.F., eds. *Advances in Health Economics and Health Services Research*. Greenwich, Conn. JAI Press, 1985.
- Milliman and Robertson, Inc.: *Review of AAPCC Methodology for Implementing Prospective Contracts with HMOs*. Final Report to Health Care Financing Administration. 1983.
- Milliman and Robertson, Inc.: *An Actuarial Review of the AAPCC Methodology*. Final Report to Health Care Financing Administration. 1987.
- Newhouse, J.P.: Rate adjusters for Medicare under capitation. *Health Care Financing Review*. 1986 Annual Supplement. HCFA Pub No. 03225. Office of Research and Demonstrations, Health Care Financing Administration. Washington. U.S. Government Printing Office, Dec. 1986.
- Porell, F., Tompkins, C., and Pomeranz, D.: *Redefining Geographic Areas for HMO Payments: A Concept Paper*. Waltham, Mass. Bigel Institute for Health Policy, Brandeis University, 1987.
- Porell, F., Welch, W.P., Tompkins, C., and Turner, W.: *An Empirical Analysis of Alternative Geographic Configurations for Basing Medicare Payments to HMOs*. Waltham, Mass. Bigel Institute for Health Policy, Brandeis University, 1988.
- Rand McNally: *The Rand McNally Zip Code Atlas*. Chicago, 1985.
- Welch, W.P.: *Medicare Payments to HMOs: Urban Core Versus Suburban Ring*. Working Paper 2171-03-02. Washington, D.C. The Urban Institute, 1987.