ELECTRONIC APPENDIX

Classifying HHA service area changes

Geographic service area delineation

Geographic service areas were first delineated for each active HHA in 1996 and 1999 using an iterative approach commonly employed for the delineation of hospital service areas where zip codes accounting for the most patients are sequentially added one at a time to the service area, each time adding fewer patients, until some threshold percentage of patients served is reached (Garnick., et al. 1987; Slifkin, Ricketts, & Howard 1996). Only five-digit zip codes involving service to two or more beneficiaries by the HHA were used to delineate service areas. Preliminary analyses suggested that many zip codes where only one beneficiary was served reflected idiosyncratic situations, including for example, long-distance moves by beneficiaries during the year that are not reflected in the beneficiary residence zip code on Medicare claims data. There were much higher prevalence rates of: (1) HHA and beneficiary residence locations in different states, (2) a distance of 120 miles or more between HHA and beneficiary residence zip code locations, and (3) beneficiaries who were served by multiple HHAs during the year that were not located in the general vicinity of each other.

Employing a threshold percentage of 90%, each HHA's geographic service area included either: (1) the zip codes with the greatest numbers of beneficiaries served that collectively accounted for 90 % of all beneficiaries served over the year by the HHA, or (2) all zip codes involving visits to two or more beneficiaries if the 90% threshold was not met. The selected zip codes comprising the service areas of HHAs active in 1996 collectively accounted for 89.3% of all Medicare beneficiaries served by these same HHAs in 1996, with duplicated counts of beneficiaries who were served by more than one HHA during the year.

Zip codes added or dropped from HHA service areas

For each HHA, zip codes comprising its service area in 1996 and 1999 were then classified into one of three categories: (1) zip codes served in 1996 but not 1999, (2) zip codes served in 1999 but not 1996, and (3) zip codes served in both 1996 and 1999. Zip codes involving visits to 2 or 3 beneficiaries in one of the years that were not served in the other year were counted as being served in both 1996 and 1999 to reduce the chances of their misclassification due to sampling variation. If it is assumed beneficiaries served in a zip code are events distributed under a Poisson distribution with an expected value equal to beneficiaries served by the HHA in either 1996 or 1996, one can compute the chances that the zip code will not be in the HHA's service area in the other year. The probabilities that zip codes involving service to only 2 and 3 beneficiaries in 1996 will not be contained in the HHA's service area in 1999 due to chance are about 0.41 and 0.20, respectively.

Beneficiaries served in zip codes assigned to these three categories were aggregated to the HHA level to produce four summary totals of beneficiaries served: (1) beneficiaries served in 1996 of zip codes served by the HHA in both 1996 and 1999; (2) beneficiaries served in 1996 of zip codes no longer served by the HHA in 1999; (3) beneficiaries served in 1999 of zip codes served by the HHA in both 1996 and 1999, and (4) beneficiaries served in 1999 of zip codes newly served by the HHA in 1999.

Classification of HHA service area changes

Each of the 7,021 HHAs that actively served beneficiaries in both 1996 and 1999 were then classified into categories of expanded, contracted, changed, or stable geographic service area between 1996 and 1999 based on the relative magnitudes of the four summary variables containing counts of beneficiaries served in dropped, added, and continuously served zip codes. Since most HHAs discontinued service to some zip codes

in 1999 that were served in 1996 and/or added service to zip codes in 1999 that were not served in 1996, the general aim was to distinguish those HHAs with service area changes large enough to be of practical significance from other HHAs whose geographic service areas were relatively stable over time.

We first considered what level of beneficiary service contraction or expansion is necessary to have *practical* significance. Suppose that in 1999 an HHA no longer served a subset of zip codes that accounted for 1% of total beneficiaries in 1996, and the HHA does not serve beneficiaries in any newly added zip codes in 1999. While this may technically be viewed as a service area contraction, it is unlikely to have much practical significance. Recognizing that any minimum threshold will be arbitrary, a minimum threshold percentage of 20% of total beneficiary service volume was chosen as a classification parameter. Under this assumed threshold three important subsets of HHAs were assigned to categories:

- First, an HHA that discontinued service in 1999 to beneficiaries of some zip codes served in 1996, and that did not initiate service in 1999 to beneficiaries of any zip codes that were not also served in 1996, can be classified as having *contracted its service area* if service in the dropped zip codes satisfy the 20% threshold.
- Second, an HHA that continued to serve in 1999 beneficiaries of all zip codes previously served in 1996, and that initiated service in 1999 to beneficiaries of other zip codes, can be classified as having *expanded its service area* if the added zip codes satisfy the assumed 20% thresholds for 1996 and 1999.
- Third, an HHA that discontinues service to some zip codes and/or newly expands service to other zip codes can be classified as having a *stable service area* if

neither of the assumed 20 % beneficiary service thresholds for 1996 and 1999 is met.

The assumed 20 % beneficiary service threshold alone is not sufficient, however, to classify those HHAs that contracted or expanded their service areas vis-à-vis *both* discontinuing service to beneficiaries of some zip codes and initiating service to beneficiaries of other zip codes between 1996 and 1999. Here the *relative magnitudes of beneficiary service volume* in zip codes dropped and added must be considered. It seems reasonable to generally expect that HHAs contracting their service areas should have served *many more* beneficiaries in 1996 in the zip codes dropped from its service area than they later served in newly added zip codes in 1999. Likewise, HHAs expanding their service areas should serve *many more* beneficiaries in newly served zip codes in 1999 than they served in 1996 in zip codes dropped from its service area.

While any definition of *many more* will be arbitrary, *many more* was defined in this study to be *at least five times larger*. That is, to be classified as contracting its service area, an HHA must have served five times as many beneficiaries in 1996 in the zip codes dropped from its service area than it later served in 1999 in newly added zip codes. Similarly, classification of expanded service area required that beneficiaries in newly added zip codes outnumber those in dropped zip codes by a factor of five. All remaining HHAs that both dropped and added zip codes from their service areas that did not meet these relative service volume requirements were temporarily assigned to a residual category.

Given that arbitrary assumptions were employed in the classification process, sensitivity analyses were performed to assess the sensitivity of the initial assignments to marginal changes in the assumed classification parameters. The service area data of HHAs with parameter-sensitive classifications that served at least 500 beneficiaries

annually were manually compared with the norms of HHAs comprising the shifted categories. As a consequence of these comparisons, 24 HHAs in the unassigned residual category were reclassified. Ten of these HHAs were reassigned to the *contracted service area* category, and 14 of them were reassigned to the *expanded service area* category. This left 342 HHAs exhibiting modest changes in their service areas that could not be classified as expanded or contracted service areas. These 342 residual HHAs were assigned to the *stable service area* category given the relatively modest changes in their service areas.