Occupational adjustment of the prospective payment system wage index

by Gregory C. Pope

In this article, the bias in the Medicare prospective payment system (PPS) hospital wage index that results from its failure to hold hospital occupation mix constant is examined. On average, the difference between the current PPS wage index and a fixed-occupation-mix Laspeyres index is small, approximately 2 percent. However, occupation-mix distortions are substantially larger for a small proportion of labor market areas, especially some in the South. Biases in the wage index resulting from its failure to appropriately account for labor substitution and intra-occupational worker characteristics are also analyzed but are not found to be significant.

Introduction

In 1983, the Health Care Financing Administration (HCFA) began phasing in the prospective payment system (PPS) to compensate hospitals for their inpatient treatment of Medicare beneficiaries. Instead of the previous retrospective cost-based reimbursement, most hospitals are now paid a flat rate per discharge based on the patient's diagnosis-related group (DRG). Recognizing that hospital care is provided in local markets with varying labor costs, payment is adjusted by a wage index defined for each metropolitan statistical area (MSA) and State rural area. The labor-related portion of the DRG payment, approximately 75 percent of the unadjusted total, is multiplied by the wage index for a hospital's location when payment is determined. Aside from Puerto Rico, fiscal year 1988 wage index values range from 1.49 for San Francisco to .70 for rural Alabama, implying a corresponding range of 76 percent $[((.75)(1.49)+.25)/((.75)(.70)+.25)-1]$ in DRG payments. The wage index values, therefore, significantly influence the amounts remitted to each hospital and area. The equity of PPS hinges on the accuracy of its wage index.

The wage index should measure only the relative opportunity cost of labor. In PPS, case-mix differences are paid for through the DRG relative value scale, and teaching and/or intensity effects are paid through the indirect teaching add-on, as well as different standardized amounts for urban and rural hospitals. If case mix and intensity are reflected in the PPS wage index, an unintentional double payment for these factors results.

As currently defined, the PPS wage index does not appropriately measure relative area labor costs. The current index is calculated by summing the total gross wages of all PPS-eligible hospitals in a labor market area (MSA or State rural area), then dividing by the total paid hours in that area (*Federal Register*, 1987). The resulting average hourly wage for each urban or rural area is standardized by a national average wage to derive the actual index values. (The fiscal year 1988 wage index is a blended average of values calculated using 1984 and 1982 data.) Because the current wage index is based on the average hourly wage in each area, areas with a more expensive occupation mix will have higher wage-index values than areas with a less expensive occupation mix. Area differences in the cost of a fixed basket of labor are confounded with variations in occupation mix, which may arise because of case mix, intensity of treatment, teaching status, or practice-style variations.

The purpose of this article is to precisely identify the differences between the current PPS wage index and a conceptually appropriate index, to describe what biases in PPS payments may result from these differences, and to provide evidence on the empirical significance of the differences. The first two sections of the article are purely conceptual, and the remainder of the article is empirical.

True wage index comparison

This section is a comparison of the PPS wage index to a theoretically ideal "true" index. The comparison reveals the conceptual limitations of the current procedure for calculating the PPS index. To simplify the analysis, only one representative hospital per labor market area, employing only labor to provide care, is assumed. Hospitals treat cases classified into 472 DRG's, denoted by the vector Y, at the quality or intensity of care level q. The representative hospital in labor market area i must pay hourly wages given by the vector W_i to hire different labor types (occupations). The minimum total cost of treating cases Y at quality level q facing wages W is denoted by $C(Y,q; W)$, the hospital cost function.

The true wage index indicates how the cost of providing the same hospital care varies from area to area because of differences in the wages of hospital labor.[1] More formally, the true index of labor costs in area 1 versus area 0 is the ratio of the minimum total cost of treating cases Y with intensity q facing wages W_1 to the minimum total cost of treating the same

[1]For a discussion of true, or Konüs, cost indexes, see Deaton and Muellbauer (1980), chapter 7.

cases at the same intensity facing wages W_0:

$$I(Y,q; W_1,W_0) = C(Y,q; W_1)/C(Y,q; W_0) \quad (1)$$

where
$I(.)$ = a true index of labor costs.

The PPS wage index, on the other hand, measures the labor cost of area 1 relative to area 0 as the ratio of the average hourly hospital wage in area 1 to the average hourly hospital wage in area 0. The average hourly wage in any area is the total labor costs of the representative hospital divided by the number of hours worked, or

$$AHW_i = (\Sigma_j w_{ij} \cdot L_j (Y_i, q_i; W_i))/(\Sigma_j L_j (Y_i, q_i; W_i)) \quad (2)$$

where
AHW_i = the average hourly wage in area i,
w_{ij} = the hourly wage of the jth labor type in area i,
$L_j(Y_i,q_i; W_i)$ = the number of hours of labor type j hired to treat cases Y_i at intensity q_i facing wages W_i, and the summation is over the different labor types.

Hence, the PPS wage index for area 1 versus area 0 is

$$PPSI (Y_1, q_1, Y_0, q_0; W_1, W_0) = AHW_1/AHW_0 =$$

$$\frac{\Sigma_j w_{1j} \cdot L_j (Y_1, q_1; W_1)/\Sigma_j L_j (Y_1, q_1; W_1)}{\Sigma_j w_{0j} \cdot L_j (Y_0, q_0; W_0)/\Sigma_j L_j (Y_0, q_0; W_0)} \quad (3)$$

where
$PPSI(.)$ = the current PPS wage index.

Compare the PPS wage index (equation 3) with the true index (equation 1). The true index is the ratio of the total cost of treating cases Y at intensity q facing different wages (W_1 versus W_0). The PPS index is the ratio of the average hourly costs of treating different cases (Y_1 versus Y_0) at different intensities (q_1 versus q_0) facing different wages. Cases requiring a large proportion of highly skilled hospital workers raise the average hourly wage; cases requiring low-skilled care lower the average hourly wage. Similarly, a greater quality of care plausibly requires a larger proportion of highly skilled workers, raising the average hourly wage. Because the PPS wage index is calculated from the average hourly wage, it reflects case mix and quality differences among areas in addition to pure wage variation.

In addition to failing to use a fixed reference output, the PPS wage index does not appropriately reflect cost-minimizing substitution among labor types. This failure occurs because it is based on the hourly cost of hospital care, rather than the total cost. Suppose the cost of low-skilled labor is identical in area 1 and area 0, but highly skilled labor is cheaper in area 1. Then the total cost of providing hospital care must be lower in area 1 than in area 0, and the

true wage index is less than one. However, to minimize costs, hospitals in area 1 should employ a more skilled occupation mix. For this reason, the average hourly wage will be higher in area 1. The PPS wage index of area 1 compared with area 0, the ratio of the average wages, incorrectly exceeds one. All other things being equal, the PPS wage index is too high in areas where highly skilled labor is relatively inexpensive.

If relative wages are held constant, the difference between the true wage index and the PPS index resulting from the latter's failure to hold occupation mix constant can be demonstrated directly. Assume that the relative wages of occupations are identical in each labor market area, so that a single cost-of-living factor, COL_i for area i, determines area wage levels. Then, the average hourly wage in area i, AHW_i, can be decomposed into the product of the area cost-of-living factor, COL_i, and an area occupation-mix index, $OCCMIX_i$:

$$AHW_i = \Sigma_j w_{ij} \cdot L_{ij}/L_i = \Sigma_j w_{ij} \cdot m_{ij}$$
$$= \Sigma_j COL_i \cdot w_{.j} \cdot m_{ij} = COL_i \cdot \Sigma_j w_{.j} \cdot m_{ij}$$
$$= COL_i \cdot OCCMIX_i \quad (4)$$

where
w_{ij} = the wage rate of the jth occupation in the ith area,
L_{ij} = the paid hours worked by the jth occupation in the ith area,
$L_i = \Sigma_j L_{ij}$ = total paid hours in the ith area,

$m_{ij} = L_{ij}/L_i$ = proportion of total hours worked by jth occupation in ith area,
$w_{.j}$ = national average wage for the jth occupation, and
$OCCMIX_i = \Sigma_j w_{.j} \cdot m_{ij}$ = an occupation-mix index for area i.

The occupation-mix index is the proportion of hours worked by each type of labor in an area, weighted by the national average wage for that labor type, then summed. It is a fixed-weight measure of the costliness of an area's mix of labor. With relative wages constant, the true wage index is simply the ratio of any area's cost-of-living factors, COL_i/COL_j for areas i and j.[2] Equation (4) shows that the PPS wage index, AHW_i/AHW_j, equals the true wage index only if each area's occupation-mix index is the same. Areas with an expensive occupation mix have inappropriately high PPS wage index values, and inexpensive occupation-mix areas have inappropriately low values. Moreover, equation (4) implies that, if relative wages are constant, the percentage deviation

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[2]Formally, this is true because cost functions (equation (1)) are homogeneous of degree one in input prices. See Varian (1978), chapter 1. Intuitively, costs cannot be lowered by substituting labor types, so occupation mix should be identical everywhere. Hence, only the cost-of-living factor determines area labor production costs.

of the PPS index from the true index equals the percentage difference of occupation-mix indexes. Or, if the PPS and true indexes are standardized by the national average wage, then their percentage difference equals the deviation of the occupation-mix index from 1.0:

$$[COL_i \cdot OCCMIX_i - COL_i]/COL_i = OCCMIX_i - 1.0. \quad (5)$$

This relationship proves useful in the subsequent empirical work.

Current wage index biases

The previous section established that the current PPS wage index is not a conceptually appropriate index of wages. This section briefly analyzes the biases in DRG payments that may result from the current wage index. Ignoring numerous add-ons, exceptions, and distinctions, the basic PPS payment formula is:

$$R_{ij} = RVS_j \cdot [WI_i \cdot SAC_l + SAC_{nl} \quad (6)$$

where
R_{ij} = reimbursement to the ith hospital for a discharge in the jth DRG,
RVS_j = the "relative value scale" for the jth DRG, an index of the costliness of the jth DRG relative to other DRG's,
WI_i = the PPS wage index for the ith hospital,
SAC_l = the national labor-related standardized amount, and
SAC_{nl} = the national non-labor-related standardized amount.

By equation (6), biases in the wage index translate directly into incorrect payments: Hospitals in areas with inappropriately high wage indexes are overpaid, and hospitals in areas with inappropriately low indexes are underpaid. Because the labor-related standardized amount is approximately three times the non-labor-related standardized amount, the percentage bias in DRG payment is about three-quarters the percentage bias in the wage index.[3] The absolute amount of overpayment or underpayment is greater, the higher the RVS, i.e., the more expensive the DRG. The wage index also has indirect effects on payments because it is used to deflate base-year hospital costs or charges in the computation of the RVS and the labor-related standardized amount. In a separate appendix available from the author, it is shown that these indirect effects do not modify the conclusion that biases in the wage index are translated into payments essentially as indicated by equation (6).

Only in the extreme case—when all discharges in a DRG occur in the same labor market area—do the direct and indirect effects of biases in the wage index cancel, so that payment is correct.

Inappropriately high wage index values resulting from an expensive occupation mix are most likely to occur in large MSA's, especially those with a preponderance of teaching hospitals. Teaching and large urban hospitals treat a more difficult case mix using an intense level of care. (See Cromwell et al. (1987) for evidence on case-mix and intensity differences among urban-rural and teaching-nonteaching hospitals.) In addition, teaching hospitals employ a high proportion of highly paid residents and physicians. Small MSA's and State rural areas where, on average, the case mix is simpler and treatment is less intense are most likely to have inappropriately low wage indexes. Another reason to expect an inexpensive occupation mix in these areas is that relative wages for skilled personnel are likely to be high. In addition to urban-rural differences, some entire geographic regions may be underpaid relative to others, if regional practice-style variations result in occupation-mix differences.

Laspeyres wage index comparison

The comparison of the PPS wage index and a Laspeyres wage index in this section is undertaken in two parts. For 23 large MSA's, the Bureau of Labor Statistics (BLS) collects detailed wage and employment data for occupations comprising roughly one-half of all hospital employment. For these MSA's and occupations, fixed-weight (Laspeyres) and average hourly wage (simulated PPS) indexes are constructed and compared in the following section. Then, American Hospital Association (AHA) data on occupation mix for all workers in PPS-eligible hospitals are used to construct occupation-mix indexes for all labor market areas. Data on wages by hospital occupation are not available for every area. However, by equation (4), if relative occupational wages are constant across areas, the percentage difference of the PPS index and a Laspeyres (or a true) index equals the percentage difference of occupation-mix indexes. Evidence is presented later in this article that variation in relative hospital wages across the 23 BLS MSA's is quite limited. If relative wages are approximately constant across all areas, variations in occupation mix are a good proxy for differences between the PPS index and a Laspeyres index. Occupation-mix differences are discussed in the section "National occupation-mix comparison."

Twenty-three large metropolitan areas

The data used in this section are from the *Industry Wage Survey: Hospitals, August 1985* (Bureau of Labor Statistics, 1987). The BLS studied a size-weighted probability sample of private and State and local government hospitals in 23 of the largest MSA's. (Only private hospitals were studied in

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[3]This statement is strictly true only for wage index values near 1.0. For index values greater than 1.0, the percent bias in payment will exceed .75 of the percent bias in the wage index, and vice versa for index values less than 1.0.

Atlanta, Miami, Milwaukee, Portland, and Washington, D.C.) Hospitals within the scope of the survey accounted for approximately 40 percent of all non-Federal hospital workers. The BLS sample is similar to PPS-eligible hospitals, except that it includes psychiatric, children's, chronic disease, and long-term hospitals. However, general hospital employees comprise 87 percent of the BLS sample and short-term hospital employees 94 percent (Bureau of Labor Statistics, 1987).

The BLS collected data on a sample of 47 hospital occupations "selected to represent the wide variety of pay levels and activities of hospital employees, other than physicians, managers, and executives" (Bureau of Labor Statistics, 1984). (To reduce the share of workers in PPS-exempt psychiatric hospitals and units, two occupations—psychiatric aides and psychiatric social workers—were eliminated from the analysis here.) The occupations selected usually accounted for roughly one-half of total hospital employment in each area. Although having data on all occupations would be preferred, the BLS sample includes most of the medical or technical categories in which the occupation-mix effects of case mix and intensity variations are most likely to be manifest. In particular, all skill levels of nursing—registered nurses, licensed practical nurses, and nursing aides— are included, so that substitution effects in this most numerous category of hospital employees are captured. A number of nonmedical professional and nonprofessional categories were surveyed, although they are underrepresented in comparison to the nursing and medical workers. The BLS sample should fairly accurately measure occupation-mix and Laspeyres-PPS wage-index differences for workers other than administrators and physicians, while reflecting nursing-mix variations especially well.

The BLS collected average hourly earnings and number of employees separately for full-time and part-time workers but did not collect hours worked. In constructing wage rates or employment counts for this analysis, part-time employees were weighted one-half of full-time workers to create full-time equivalents (FTE's). In most cases, the full-time and part-time wages were quite similar.

A Laspeyres wage index was constructed for the BLS-sampled occupations in the 23 MSA's. The Laspeyres index compares the cost of a fixed basket of labor across areas. It can be written as the sum over occupations of base-area cost shares multiplied by wage relatives. Algebraically:

$$I_1(W_1, W_0, FTE_0) = \frac{\sum_j w_{1j} \cdot FTE_{0j}}{\sum_j w_{0j} \cdot FTE_{0j}} = \sum_j \frac{(w_{0j} \cdot FTE_{0j})}{\sum_j w_{0j} \cdot FTE_{0j}} \cdot (w_{1j}/w_{0j})$$

$$= \sum_j (CS_{0j}) \cdot (w_{1j}/w_{0j})$$

where

$I_1(.)$ = the Laspeyres wage index for area 1 relative to the base area 0,

w_{ij} = the wage rate for the jth occupation in the ith area,

FTE_{0j} = the number of FTE's in occupation j in the base area,

CS_{0j} = the jth occupation's share of the total wage bill in the base area, and

$w_{1j} \cdot w_{0j}$ = the wage of the jth occupation in area 1 relative to the base area.

For the Laspeyres index cost shares, the average MSA shares of each occupation in total wages were used. Wages were measured relative to an MSA average. Hence, the base "area" of the fixed-weight Laspeyres index is implicitly an MSA average. The Laspeyres index for each MSA is shown in the first column of Table 1.

For comparison with the Laspeyres index, a simulated PPS index for each MSA was constructed by dividing the wage bill for all BLS occupations by the total number of FTE's. The simulated PPS index values are given in the second column of Table 1. The third column is an occupation-mix index for each MSA constructed by summing the proportions of FTE's in each occupation weighted by the MSA average wage (following equation (4)). The final column gives actual fiscal year 1988 wage-index values for each MSA. To facilitate comparison, all indexes are standardized to have a mean of 1.0.

The actual PPS wage-index values (column 5) are not directly comparable to the values in columns 1 and 2. The actual values are based on all occupations, on hours worked rather than FTE's, and on 1984 and 1982 HCFA wage survey data, but the BLS data are for 1985. However, the similarity of the actual and simulated PPS index values (the average absolute difference is .03) supports the validity of comparing columns 1 and 2 to infer the magnitude of the effect of occupation-mix variations on the PPS index.

The simulated PPS and Laspeyres indexes (columns 1 and 2) are directly comparable, because they are calculated from the same data. Only the method of computation differs: The Laspeyres index holds occupation mix constant, the simulated PPS index does not. For these 23 large MSA's, the simulated PPS index differs from the more conceptually appropriate Laspeyres index by only 1.7 percent, on average. If true for all occupations, this difference in wage indexes implies a 1.3-percent error in payments, on average, from using the current wage index rather than a Laspeyres index. Although this percent difference is small, because of the multibillion-dollar scope of the PPS program, the dollar amount of overpayment or underpayment is not trivial.[4]

Moreover, the range of percentage differences of the simulated PPS and Laspeyres indexes is considerably larger than the average deviation.

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[4]For example, an MSA with 10,000 beds, 80-percent occupancy, a 40-percent Medicare share of days, and an 8-day Medicare average length of stay would have 146,000 Medicare admissions per year. With an average payment of $4,000 per case, 1.3 percent of total PPS payments is $7.6 million.

Table 1

Hospital wage and occupation-mix indexes for 23 large metropolitan statistical areas: United States, 1985

Metropolitan statistical area	Laspeyres wage index[1] (1)	Simulated PPS wage index[1] (2)	Occupation-mix index[1] (3)	Geometric wage index[1] (4)	Fiscal year 1988 PPS wage index[2] (5)
Boston	.985	.984	1.003	.983	.977
Buffalo	.857	.831	.976	.857	.877
New York	1.114	1.091	.976	1.113	1.181
Philadelphia	.998	.988	.998	.988	.986
Atlanta	.859	.857	.996	.860	.830
Baltimore	.902	.881	.997	.903	.918
Dallas	.864	.880	1.013	.862	.863
Houston	.908	.900	.993	.905	.890
Miami	.951	.931	.986	.949	.916
Washington	.976	.982	1.010	.976	.997
Chicago	.968	.963	.995	.968	1.011
Cleveland	1.024	1.008	.986	1.025	.977
Detroit	.999	.984	.984	1.000	.984
Kansas City	.902	.893	.991	.903	.908
Milwaukee	.946	.955	1.011	.946	.941
Minneapolis	1.030	1.055	1.023	1.030	1.012
St. Louis	.936	.919	.984	.937	.917
Denver	1.020	1.049	1.027	1.021	1.077
Los Angeles	1.122	1.107	.989	1.120	1.124
Oakland	1.288	1.313	1.021	1.289	1.265
Portland (Oreg.)	1.043	1.092	1.043	1.046	1.019
San Francisco	1.306	1.297	.992	1.306	1.348
Seattle	1.015	1.044	1.026	1.015	.984
Mean	1.000	1.000	1.000	1.000	1.000
Average percentage deviation from Laspeyres index	—	1.7	[3]1.5	0.1	—

[1]Based on data from 1985 BLS Industry Wage Survey: Hospitals (Bureau of Labor Statistics, 1987).
[2]Values taken from the Federal Register (1987), then standardized to have a mean of one.
[3]Average deviation from 1.0.
NOTE: PPS is prospective payment system.

Portland's simulated PPS index exceeds its Laspeyres index by about 5 percent, and Buffalo's simulated PPS index is about 3 percent below its Laspeyres index. This range of 8 percent, if it were true for all occupations, implies approximately a 6-percent overpayment of Portland hospitals relative to Buffalo hospitals.

In Table 1, we also confirm that the deviation of the occupation-mix index from unity is an accurate measure of the percentage difference of the simulated PPS and Laspeyres indexes. It was previously argued that, if relative wages are constant across areas, the difference of the occupation-mix index from 1.0 equals the percentage difference of the PPS and true wage indexes (equation (5)). If relative wages are constant, the Laspeyres index equals the true index, because costs cannot be lowered by varying occupation mix (see footnote 2). The average difference of the occupation-mix index from 1.0 is 1.5 percent, nearly equal to the 1.7 percent average difference of the simulated PPS and Laspeyres indexes. Moreover, inspection of the values for individual MSA's shows that the relationship is accurate for most of them as well. This correspondence forms the basis of the analysis in the following section.

In sum, for the BLS-sampled occupations in these 23 large MSA's, on average, a Laspeyres wage index does not differ substantially from a simulated PPS index. But it might be expected that case mix, intensity, and occupation mix would be similar in large MSA's. A greater difference in occupation mix is expected between large MSA's and small MSA's or rural areas.

National occupation-mix comparison

The comparison of a simulated PPS wage index to a Laspeyres index in the previous section was limited by lack of data on occupations accounting for one-half of all hospital workers and for areas other than the 23 large MSA's. In this section, a comprehensive source of data on hospital employment is used to create occupation-mix indexes for urban, rural, regional, and PPS labor-market area classifications of the hospital work force. The 1984 AHA annual survey collected, for a complete census of hospitals, full-time and part-time employee counts in 35 occupational categories. Unfortunately, no area hospital wage data by occupation are available to match the AHA employment counts. However, if relative occupational wages are constant across areas, an occupation-mix

index will accurately portray differences between the PPS and a Laspeyres (or a true) index across areas.

For the analysis, PPS-similar hospitals, defined as Medicare-certified, short-term, general non-Federal hospitals (AHA service code 10), plus similar obstetrics-gynecology, orthopedic, and other specialty hospitals (AHA codes 44, 45, 47, and 49) were selected from the AHA data base. Part-time workers were weighted one-half of full-time workers to create FTE's. (Ideally the occupation-mix indexes should be created using hours worked rather than FTE's. However, the FTE index will not differ from the hours index even if hours per FTE varies among areas, unless hours vary differentially by occupation.) Because, in most cases, the HCFA wage survey data used to create the PPS wage index do not include contract labor, to maintain comparability, AHA contract labor counts were excluded. Proportions of FTE's in each occupation were weighted by the MSA average wages derived from the BLS industry wage survey, then summed to create the occupation-mix indexes (equation 4). The BLS does not report wages for several of the AHA occupational categories, most importantly administrators, physicians, residents, and the residual categories of all other professional personnel and all other (nonprofessional) personnel. These wages were imputed by regressing total hospital payroll on FTE's in an aggregated set of occupational categories for all PPS-similar hospitals. Details of this regression are in a separate appendix available from the author. Several other AHA categories without BLS wages were assigned the BLS wage of a similar category. For example, recreational therapists were assigned the occupational therapist wage and audiologists were assigned the speech therapist wage.

In Table 2, descriptive statistics on the data used to create the occupation-mix indexes are shown. The AHA occupation categories are listed first. In some cases, categories with the same wage weight are combined. The first numerical column gives the wage used to weight the FTE proportion. The next seven columns show the proportion of hospital FTE's in each occupation for national total, urban-rural, and four census region classifications of the hospital work force. The final column is the coefficient of variation (CV) of each occupational proportion across the PPS labor-market areas, a measure of the variability of the proportion of workers in that occupation employed in the different areas.

In Table 3, occupation-mix indexes for urban-rural areas of the Nation and of the nine census divisions are presented. The set of index values not in parentheses is for all occupations. However, hospital-based physicians may or may not be reflected in the PPS wage index, depending on whether hospitals consider their compensation salary costs when submitting their Medicare Cost Reports. Because it is unclear to what extent physicians are included in the HCFA wage survey versus the AHA payroll data, a second set of index values that excludes physicians and dentists is presented in parentheses in Table 3. Residents are also excluded from the second set of

index values. All indexes are standardized to equal 1.0 for the occupation mix of all hospital workers nationally.

Nationwide, urban hospitals have a 4.2-percent more expensive occupation mix than rural hospitals including physicians and residents, but only a 2.3-percent more expensive mix excluding them. Assuming these differences are representative of the deviation of the PPS wage index from a Laspeyres index, they imply that, on average, urban hospitals are overpaid relative to rural hospitals by at least 3 percent because of the current wage index's failure to control for occupation mix, or by at least 1.8 percent if physicians and residents are excluded. (These figures—3 and 1.8 percent—are lower bounds, assuming that rural hospitals were paid using the same standardized amounts as urban hospitals and had wage index values near 1.0 on average. Taking account of the lower rural standardized amounts and wage indexes, the actual payment biases are closer to 4 percent and 2.5 percent, respectively.) Regionally, the urban Northeastern States (New England and Middle Atlantic) have the most expensive occupation mixes, 3 percent above the national average, if physicians and residents are included. However, when these categories are excluded, the urban Northeast occupation mix is only 1 percent above average, indicating that most of the richer mix is the result of teaching hospitals with their high proportions of physicians and residents on the payroll. With physicians and residents excluded, the rural New England and urban Mountain areas have the richest occupation mixes, but they are less than 2 percent more expensive than the national average. The rural East South Central and West South Central Divisions have the least expensive occupation mixes, whether physicians and residents are included or not. Their indexes range from 4 to 6 percent below the national average. With physicians and residents included, the difference of 9.5 percent between the occupation-mix indexes of the urban Northeast and the rural West South Central Divisions implies that, on average, urban northeastern hospitals are overpaid by 7.1 percent, relative to rural West South Central hospitals because of wage index bias. (Again, this is a lower bound.) However, with physician and residents excluded, the occupation-mix difference between rural New England or the urban Mountain Division and the rural West South Central Division is only 6.3 percent, implying a relative payment bias of 4.7 percent.

Although the Table 3 index values reveal broad urban-rural and regional occupation-mix variations, the PPS wage index values are calculated for much smaller labor market areas, MSA's, and State rural areas. Occupation-mix variation may be expected to be greater across smaller areas. In Table 4, the distributional statistics on occupation-mix indexes calculated for all labor market areas, 316 MSA's, and 49 State rural areas are shown. (Puerto Rico was included in Table 5 because it has been incorporated into PPS, but other outlying areas such as the Virgin Islands were not. New Jersey and Rhode Island

Table 2

Descriptive statistics on data used to create occupation-mix indexes for all labor market areas: United States

		Proportion of full-time equivalents							
		National			Regional				
Occupation	Wage weight[1]	All	Urban	Rural	Northeast	South	North Central	West	Coefficient of variation[2]
		Percent							
Total	—	100.00	100.00	100.00	100.00	100.00	100.00	100.00	—
Administrators	$31.80	0.99	0.95	1.23	1.05	0.87	1.10	0.99	47.3
Physicians/dentists	27.07	0.86	0.98	0.24	1.75	0.42	0.81	0.52	146.8
Medical/dental/residents	13.28	1.98	2.32	0.27	3.00	1.41	1.90	1.53	136.7
Registered nurses	12.40	22.76	23.18	20.59	22.87	21.66	22.65	25.09	14.1
Licensed practical nurses	8.92	6.86	6.13	10.58	5.50	8.68	6.27	6.01	38.5
Ancillary nursing personnel	7.36	8.54	8.10	10.76	7.65	10.08	8.59	6.77	37.5
Physician assistants, nurse practitioners, and psychologists	15.24	0.19	0.21	0.08	0.29	0.16	0.16	0.12	177.2
Medical records administrators	14.44	0.21	0.18	0.39	0.17	0.24	0.22	0.21	51.1
Medical records technicians	8.29	1.13	0.99	1.82	0.98	1.23	1.10	1.20	48.9
Pharmacists	15.55	0.93	0.95	0.84	0.82	0.95	0.95	1.05	24.6
Pharmacy technicians	7.42	0.78	0.78	0.77	0.57	0.89	0.87	0.75	36.5
Medical technologists	11.63	2.73	2.74	2.66	2.72	2.70	2.73	2.80	27.6
Other laboratory personnel	9.17	2.08	2.10	1.98	2.05	2.19	2.06	2.00	37.9
Dieticians	11.53	0.37	0.37	0.34	0.37	0.33	0.42	0.37	34.3
Dietetic technicians	7.42	0.79	0.58	1.84	0.53	1.06	0.80	0.63	104.7
Radiographers/other radiologic personnel	10.05	2.65	2.60	2.87	2.49	2.87	2.56	2.61	26.8
Radiation therapy technologists	11.48	0.12	0.13	0.09	0.12	0.12	0.12	0.13	127.2
Nuclear medicine technologists	11.55	0.23	0.24	0.20	0.24	0.23	0.24	0.22	40.9
Occupational/recreational therapists	11.45	0.24	0.27	0.09	0.23	0.17	0.29	0.36	91.3
Physical therapists	11.97	0.50	0.52	0.43	0.52	0.43	0.49	0.67	51.0
Occupational/physical therapy assistants and aides	7.36	0.47	0.45	0.58	0.34	0.48	0.58	0.46	47.2
Speech pathologists and audiologists	12.41	0.09	0.09	0.05	0.11	0.04	0.10	0.11	110.2
Respiratory therapists	9.82	0.89	0.93	0.68	0.72	0.89	0.83	1.26	48.5
Respiratory therapy technicians	7.42	0.01	0.73	1.06	0.55	0.96	0.84	0.71	56.3
Medical social workers	12.40	0.48	0.51	0.30	0.67	0.36	0.46	0.45	46.9
All other professional/ technical personnel	11.96	6.27	6.66	4.29	6.77	5.50	6.70	6.34	51.7
All other personnel	9.06	36.08	36.30	34.95	36.86	35.10	36.22	36.63	14.4

[1]Weight for administrators, physicians, dentists, residents, all other professional personnel, and all other personnel imputed from payroll regression. All other wages are average wages in 23 Bureau of Labor Statistics metropolitan statistical areas. Dietetic and respiratory therapy technician wage is assumed equal pharmacy technician wage, and occupational/physical therapy aides wage is assumed equal to ancillary nurses wage.

[2]Of proportion of full-time equivalents, across the prospective payment system labor market areas, multiplied by 100.

NOTE: Totals may not add to 100.00 because of rounding.

SOURCES: American Hospital Association: Data from the Annual Survey of Hospitals, 1984; (Bureau of Labor Statistics, 1987).

Table 3

National and regional urban-rural occupation-mix indexes[1]: United States, 1984

Area	Urban	Rural
National	1.007	.966
	(1.004)	(.981)
Regional:		
New England	1.030	1.014
	(1.011)	(1.019)
Mid Atlantic	1.028	.985
	(1.009)	(.995)
South Atlantic	.996	.962
	(.998)	(.973)
East North Central	1.006	.968
	(1.005)	(.985)
East South Central	.977	.949
	(.987)	(.964)
West North Central	1.012	.974
	(1.011)	(.991)
West South Central	.970	.940
	(.983)	(.958)
Mountain	1.010	.971
	(1.017)	(.988)
Pacific	1.008	.986
	(1.014)	(1.005)

[1]Index equals 1.0 for the occupation mix of all hospital workers nationally.

NOTE: Numbers in parentheses are index values excluding physicians and dentists and medical or dental residents.

SOURCES: American Hospital Association: Data from the AHA Annual Survey, 1984; (Bureau of Labor Statistics, 1987).

Table 4

Distributional statistics of labor market area occupation-mix indexes[1]: United States, 1984

Statistic	All employees included	Physicians and residents excluded[2]
Number	365	365
Mean	0.988	0.997
Standard deviation	0.027	0.022
Average percent deviation from national occupation mix	2.3	1.7
Percentiles:		
100 (Maximum)	1.118	1.058
99	1.049	1.050
95	1.031	1.032
90	1.021	1.023
75	1.006	1.011
50 (Median)	0.987	0.999
25	0.970	0.983
10	0.951	0.966
5	0.944	0.959
1	0.931	0.948
0 (Minimum)	0.914	0.932

[1]Index equals 1.0 for the occupation mix of all hospital workers nationally.
[2]Dentists and dental residents are also excluded.

SOURCES: American Hospital Association: Data from the Annual Survey of Hospitals, 1984; (Bureau of Labor Statistics, 1987).

do not have State rural areas.) As in Table 3, index values are presented both including and excluding physicians and residents. Including physicians and residents, on average across the 365 labor market areas, the occupation-mix indexes differ from the national occupation-mix index of 1.0 by 2.3 percent. If relative wages are constant among areas, the PPS wage index differs from a Laspeyres index by the same percentage on average. Excluding physicians and residents, the average deviation is 1.7 percent, the same average deviation previously calculated for 23 large MSA's using the BLS data.

As expected, the range of occupation-mix indexes across labor market areas is greater than across national urban-rural areas or regional divisions.[5] The difference between the 99th and the 1st percentile is 12.7 percent, considerably larger than the range of urban-rural or regional differences. Excluding physicians and residents, occupation-mix variation is somewhat compressed, but the 99th-1st percentile difference is still 10.8 percent. These differences imply that the labor market areas with the most expensive occupational mixes are overpaid relative to the areas with the least expensive mixes by roughly 8 to 10 percent, because of the failure of the PPS wage index to hold occupation mix constant. Compared with a labor market area with the national occupation

mix, the areas with the most expensive mix are overpaid by 3 to 4 percent, and the areas with the least expensive mix are underpaid by 5 to 6 percent.

Both Southern State rural areas and many small southern MSA's have inexpensive occupation mixes and appear to be particularly disadvantaged by the current wage index. Examples, with their occupation-mix index values (including physicians and residents) are: Laredo, Texas (.914); Albany, Georgia (.929); Brownsville-Harlingen, Texas (.930); Pine Bluff, Arkansas (.932); rural Oklahoma (.932); rural Tennessee (.933); rural Texas (.938); and rural Kentucky (.940). The index values and relative standing of these areas are not changed significantly by excluding physicians and residents. Conversely, with physicians and residents included, many of the most expensive occupation mixes are in northeastern MSA's, e.g., New York, New York (1.060); State College, Pennsylvania (1.050); Rochester, New York (1.048); and Boston, Massachusetts (1.042). Excluding physicians and residents, a number of the most occupationally expensive labor market areas are small MSA's in the Western or North Central Regions, e.g., Salem, Oregon (1.056); Grand Forks, North Dakota (1.051); Cedar Rapids, Iowa (1.050); and Bellingham, Washington (1.049). This last set of MSA's generally has expensive occupation mixes because of high proportions of administrators, registered nurses, and other professionals, and low proportions of nonprofessionals.

In sum, the average deviation of the current PPS wage index from a conceptually appropriate Laspeyres index across the PPS labor market areas is small, probably about 2 percent, implying an average payment bias of about 1.5 percent. However, for

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[5]The maximum index value (including physicians and residents) of 1.12, for Charlottesville, Virginia, is an outlier created by a high proportion of physicians and residents reported by the University of Virginia hospitals there. This value does not appear to be a data error, because high proportions of physicians and residents are reported for Charlottesville, Virginia in the AHA *Hospital Statistics* for every year after 1982.

certain labor market areas, the deviation is more serious, implying a significant payment bias. Some areas may be overpaid relative to others by as much as 10 percent because of occupation-mix variation. To the extent that physician and resident salaries are included in the current wage index, a substantial fraction of occupation-mix bias can be eliminated by excluding them. Even if this is accomplished, a significant bias will remain in some cases. In particular, many Southern State rural areas and small MSA's employ inexpensive occupation mixes and appear to be disadvantaged by the current wage index, even if physicians and residents are eliminated.

Labor substitution

It was shown previously that the current PPS wage index does not appropriately account for substitution among labor categories in response to variations in their relative wages. Similarly, the Laspeyres index, which holds occupation mix constant, does not capture labor substitution. To minimize costs, hospitals should employ relatively more of those types of labor that are relatively less expensive in their area. Unless different types of hospital labor cannot be substituted, the Laspeyres index overstates the amount of labor cost variation among areas and is not equivalent to the true index of wages as previously defined.

The importance of labor substitution for the PPS wage index depends on two factors: the substitutability of different labor types and the degree of relative wage variation among areas. Little is known about labor substitution possibilities in the provision of hospital services. Sloan and Steinwald (1980) found that hospitals substitute registered nurses and licensed practical nurses, but data problems limited the accuracy of their analysis. However, the BLS industry wage survey does provide data on wages by hospital occupation for 23 large MSA's. The strategy followed in this section is to simulate the impact of labor substitution on the wage index by computing, using the BLS data, wage indexes allowing for different degrees of substitution. Large differences would indicate that, in constructing an appropriate PPS wage index, holding occupation mix constant may not be enough; substitution effects must also be accounted for.

As is well known, the Laspeyres index (defined in equation (7)) corresponds to the Leontief technology, which postulates no substitution among labor types. Two other important correspondences are between the geometric index and the Cobb-Douglas technology, and between the Tornquist index and the translog technology. The Cobb-Douglas technology assumes a moderate degree of substitution, a unitary elasticity of substitution among all labor types. The geometric index is consistent with these substitution possibilities (Diewert, 1976). It is defined as:

$$ln (I_g) = \sum_j (CS_j) \cdot ln (W_{1j}/W_{0j}) \qquad (8)$$

where
ln indicates the natural logarithm of the quantity in parentheses;

I_g = the geometric wage index of areas 1 and 0;
CS_j = the cost share of the *j*th labor type in total labor costs[6]; and
W_{ij} = the wage of the *j*th labor type in the *i*th area.

The translog technology is less restrictive than the Leontief or the Cobb-Douglas technologies: It provides a second-order approximation to a technology with arbitrary substitution possibilities (Christensen, Jorgenson, and Lau, 1973). Diewert (1976) and Caves, Christensen, and Diewert (1982) show that the Tornquist index is consistent with the "flexible" translog structure. This index is calculated as:

$$ln (I_t) = \sum_j (1/2) \cdot (CS_{1j} + CS_{0j}) \cdot ln (W_{1j}/W_{0j}) \qquad (9)$$

where
I_t = the Tornquist wage index of areas 1 and 0; and
CS_{ij} = the cost share of the *j*th labor type in the *i*th area.

The Tornquist index is identical to the geometric index except that, instead of a single cost share for each labor type in all areas, the cost shares in the two areas being compared are averaged. The cost share variation reflects labor substitution in response to relative wage differences.

The ignorance about hospital labor substitutability would seem to imply that a Tornquist form should be used for the PPS wage index, because it is consistent with the widest range of substitution possibilities. However, the Tornquist index assumes that hospital output is the same in every area. Otherwise, cost-share differences may reflect case-mix or intensity differences, not labor substitution. Because identical case-mix and intensity across areas is an untenable assumption, in practice the Tornquist index suffers from the same problems of reflecting hospital output differences that the current PPS index does. Therefore, this index was not calculated.

The geometric index, on the other hand, presumes constant cost shares and thus does not measure area case-mix and intensity differences. In fact, the geometric index provides an excellent comparison to the Laspeyres index, because it can be calculated from the same components of national cost shares and wage relatives. Only the mathematical form of the index differs: The Laspeyres index is additive, but the geometric index is multiplicative.

The geometric wage index (equation (8)) was calculated for the 23 BLS MSA's, using the MSA average cost shares and the wage relatives previously described. The geometric and Laspeyres indexes for the 23 MSA's are presented in Table 1. Comparing

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[6]An implication of the Cobb-Douglas's unitary elasticity of substitution is that the cost shares are the same in every area.

the two indicates how the assumption of a moderate degree of substitution (the geometric index) versus no substitution (the Laspeyres index) affects the hospital wage index. The difference between the two indexes is negligible. On average, it amounts to only 0.1 percent. The largest difference, for Philadelphia, is just 1.0 percent. Hence, assuming a moderate degree of substitution makes virtually no difference in the wage index for these MSA's. Unless the degree of substitution among occupational categories is large, the fixed-weight Laspeyres index is close to the true, substitution-adjusted wage index.

The close similarity of the Laspeyres and geometric indexes suggests that relative occupational wages do not vary much among the 23 MSA's. A principal-components analysis was used to determine the degree of relative wage variation. (A description of principal-components analysis can be found in Mulaik, 1972.) If relative wages are constant, one underlying relative wage scale, or principal component, will account for all observed wage variation among the 23 MSA's. In the estimation, each occupation's wages were weighted by its average MSA cost share to reflect the average relative importance of occupations in hospital employment (and in the Laspeyres or geometric wage indexes). The result is that one principal component accounts for 97 percent of the variance in the weighted occupational wages. The conclusions of the principal-components analysis do, of course, depend on the particular weighting scheme used. Very different weights, and thus different conclusions, might be reached from an analysis of hospitals that employ occupational proportions that are different from the national average.

The primary conclusion of this section, therefore, is that, unless labor substitution possibilities are great, taking account of them when computing the PPS wage index is unimportant, because relative hospital wages vary little among areas. A corollary is that a single wage index can be reasonably used for all hospital types for which the occupational proportions do not differ greatly from the national average. In addition, area differences in the occupation-mix index previously analyzed are an accurate measure of the percentage difference between the current PPS wage index and a Laspeyres index. These findings are not definitive, because they are based on occupations accounting for one-half of hospital employees in 23 MSA's. However, the sample of occupations and MSA's is large and representative enough so that the findings are highly suggestive.

Beyond occupational adjustments

The labor categories used to construct an area wage index should be as homogeneous as possible, so that pure labor cost variation is isolated from area differences in the characteristics of the work force. The preceding empirical analysis has treated occupational categories as defining discrete "labor types" that account for all differences among workers. If so, workers in the same occupation should

be paid similarly in a labor market. However, to the contrary, the MSA occupational earnings distributions presented in the BLS industry wage survey show a large range of hourly earnings of workers within one occupation. For example, the wages of general duty registered nurses range from $8 to $15 per hour in the Dallas MSA, which is typical. Presumably these wage differences are related to worker characteristics such as experience, credentials, skills, and ability. In addition to occupation-mix differences, the current PPS wage index is biased by area differences in within-occupation worker characteristics. Further, any wage index constructed from average occupational wages, such as the Laspeyres and geometric indexes analyzed in the preceding section, suffers from the same failure to hold constant within-occupation worker characteristics.

The minimum hospital entrance wages for registered nurses (RN's) and licensed practical nurses (LPN's) reported (Bureau of Labor Statistics, 1987) are an alternative measure of labor cost variation. Nurses paid the entrance wage should form a more homogeneous class of labor than all nurses with respect to experience (none) and skills. For general duty RN's, the BLS reports entrance wages separately for nurses with and without a bachelor's degree, so credentials can be held constant also. Consistent with the hypothesis that they are a more homogeneous category, entrance RN's are paid a much narrower range of wages than are all RN's. In Dallas, hospital entrance RN wages range only from $8 to $9.50, compared with the $7 pay range for all RN's.

Although entrance wages are an interesting alternative to average wages, they do not necessarily represent only pure labor cost variation. Labor economists have found that, all other things being equal, employees of large firms are paid more than employees of small firms (Krueger and Summers, 1986). Furthermore, unions may impose wage scales and wage floors. Therefore, area variations in hospital size and unionization probably affect the typical entrance wage. Moreover, the BLS collected formal minimum entrance wages. A hospital may establish a formal minimum, but pay few employees, even new hires, at this rate in practice. For these reasons, a comparison of entrance and average wages is informative, but entrance wages are not a perfect alternative or standard against which average wage variation can be evaluated.

In Table 5, the average wage, the median hospital entrance wage, and their ratio for general duty RN's and LPN's in each of the 23 MSA's surveyed by the BLS are shown. If the average-entrance wage ratio differs significantly among MSA's, the entrance wages indicate significantly different relative labor costs than do average wages. If so, and if entrance wages are a purer measure of labor costs, the average-wage-based PPS index misstates true labor cost variation. It appears that this is not the case. Differences in the average-entrance wage ratio of .08 for RN's and .12 for LPN's are not meaningful, because the BLS reports entrance wages in 50-cent ranges. Within these

Table 5

Average wage, median entrance wage, and ratio of average wage to median entrance wage for general duty registered nurses and licensed practical nurses: United States, 1985

Metropolitan statistical area	Registered nurses			Licensed practical nurses		
	Average wage	Median entrance wage[1]	Ratio of average to entrance wage[2]	Average wage	Median entrance wage[1]	Ratio of average to entrance wage[2]
Boston	$12.23	$9.50-10.00	1.25	$9.07	$7.00-7.50	1.25
Buffalo	10.05	9.00-9.50	1.09	7.62	6.50-7.00	1.13
New York	12.74	12.00	1.06	9.74	8.50-9.00	1.11
Philadelphia	11.70	10.00-10.50	1.14	8.70	7.50-8.00	1.12
Atlanta	10.56	8.50-9.00	1.21	7.15	5.50-6.00	1.24
Baltimore	10.63	8.50-9.00	1.21	8.59	6.50-7.00	1.27
Dallas	10.56	8.50-9.00	1.21	7.49	6.00-6.50	1.20
Houston	11.24	9.00-9.50	1.22	8.04	5.50-6.00	1.40
Miami	11.77	9.00-9.50	1.27	8.51	6.00-6.50	1.36
Washington	11.54	9.00-9.50	1.25	8.82	6.50-7.00	1.31
Chicago	11.39	9.50-10.00	1.17	8.79	7.00-7.50	1.21
Cleveland	12.39	10.50-11.00	1.15	8.89	7.50-8.00	1.15
Detroit	11.79	10.00-10.50	1.15	9.37	7.50-8.00	1.21
Kansas City	11.08	9.00-9.50	1.20	8.11	6.00-6.50	1.30
Milwaukee	11.36	9.00-9.50	1.23	8.42	6.50-7.00	1.25
Minneapolis	12.64	10.50-11.00	1.18	8.69	7.00-7.50	1.20
St. Louis	11.09	9.00-9.50	1.20	8.48	7.00-7.50	1.17
Denver	12.06	9.50-10.00	1.24	9.03	7.00-7.50	1.25
Los Angeles	13.64	11.50-12.00	1.16	9.65	8.00-8.50	1.17
Oakland	15.49	12.50-13.00	1.21	10.78	10.00	1.08
Portland (Oreg.)	12.47	10.00-10.50	1.22	8.98	7.00-7.50	1.24
San Francisco	15.43	13.00-13.50	1.16	10.79	10.00-10.50	1.05
Seattle	12.16	10.00-10.50	1.19	8.30	7.50-8.00	1.07
Average	—	—	1.19	—	—	1.21

[1]Median of formally established minimum entrance wages among private and State and local government hospitals studied by Bureau of Labor Statistics in each metropolitan statistical area. For registered nurses, median is for nurses with a bachelor's degree.
[2]Ratio of average wage to the midpoint of the entrance wage range. Because the median entrance wage is a range, differences in the ratio of .08 or less for registered nurses, and .12 or less for licensed practical nurses are not necessarily significant.

SOURCE: (Bureau of Labor Statistics, 1987).

limits of accuracy of the data, the entrance and average wages indicate similar relative labor costs for most MSA's.[7]

For some cities, basing a wage index on entrance rather than average wages would make a substantial difference. Examples are New York for RN's and San Francisco and Houston for LPN's. However, these differences appear to arise from the confounding labor market factors already mentioned, rather than differences in worker characteristics. New York pays high entrance wages relative to average wages and pays lower skilled occupations relatively highly, resulting in compressed occupational wage scales relative to other MSA's (Bureau of Labor Statistics, 1987). Union compression of wage scales may account for the high relative compensation of low-end workers: New York hospital workers are highly unionized relative to other MSA's (Bureau of Labor Statistics, 1987). In San Francisco, hospital workers are also highly unionized. Houston hospitals, on the other hand, pay almost no LPN's at the median hospital formal entrance wage (Bureau of Labor Statistics, 1987); thus, the entrance wage is artificially low relative to the average wage. When the average and entrance wage indicate different relative costs as a result of nonworker characteristics, the

average wage is preferred for use in a wage index, because it is the "bottom line" that a hospital must pay. In sum, the nursing entrance wages do not provide any evidence that average wages significantly misrepresent pure labor cost variation or that entrance wages are a superior alternative. An urban-rural analysis might find larger differences between relative average and entrance wages because of larger differences in the average experience, credentials, and skills of rural versus urban hospital workers.

Conclusion

The bias in the PPS wage index resulting from the lack of an adjustment for occupation mix is not large, on average. The evidence presented in this article indicates that the average difference between the current PPS index and a fixed occupation-mix Laspeyres index is about 2 percent. However, the bias is considerably larger for a small proportion of labor market areas. Hospitals in some areas may be overpaid relative to hospitals in other areas by as much as 10 percent because of occupation-mix distortions in the current wage index. Hospitals in Southern State rural areas and small southern MSA's appear to be particularly disadvantaged by the current index.

The PPS wage index also does not appropriately account for cost-minimizing substitution among labor

[7]For RN's, the average-entrance wage ratio is within ± .05 of the average ratio of 1.19 for 18 of the 23 MSA's. For LPN's, the ratio is within ± .10 of the average for 18 MSA's.

types or intra-occupational experience and skill-mix differences. However, at least in large MSA's, relative hospital occupational wages vary little, so substitution effects are unlikely to be important. Furthermore, for the same areas, the ratio of average nursing wages to entrance wages is generally about the same, indicating that intra-occupational labor differences are not an important source of wage index bias.

A substantial fraction of potential occupation-mix bias in the current wage index could be eliminated by ensuring that physicians and residents are not included in the hospital salary data used to compute the index. Because these two occupations are highly paid and their proportions of the hospital labor force vary greatly, they have a relatively large effect on average wage differences among areas. In fact, HCFA has already computed an adjusted gross wage index that excludes the salaries of interns, residents, and hospital-based physicians. However, HCFA concluded that the adjusted gross wage index was less accurate than an index based on gross hospital salaries, because many hospitals had difficulty in excluding the categories of workers necessary to define the adjusted gross wage index (*Federal Register*, 1985). Further effort to exclude the salaries of physicians and residents from the PPS wage index is warranted.

Even with physicians and residents excluded, significant occupation-mix variation remains. In particular, many southern hospitals have inexpensive occupation mixes, aside from physicians and residents. Collecting and verifying wage data for a large number of hospital occupations in all labor market areas in order to construct a fully occupation-adjusted index would be a difficult and expensive task. Gathering data on a small number of numerically important and homogeneous categories, in particular the nursing occupations, would be more feasible. Use of this area wage data, together with national occupation weights and a residual category, would eliminate much of the remaining occupation-mix bias. Thus, we support the efforts of HCFA

(through its Form 339) to assess the feasibility of a wage index that takes hospital occupation mix into account (*Federal Register*, 1987).

The current PPS wage index could be refined in a number of ways, including fringe benefits in addition to wages, defining more exact labor market areas, controlling for occupation mix, and adjusting for labor substitution and for intra-occupational worker differences. In this article, I have examined the latter three refinements and concluded that, in general, they would result in rather minor changes in the current index. The current PPS wage index can be used with confidence in most cases. However, the degree of occupation-mix bias in the index is not independent of the definition of the labor market areas. The Prospective Payment Assessment Commission has recommended that the PPS labor market areas be redefined, dividing MSA's into urbanized and nonurbanized areas and State rural areas into urbanized and nonurbanized counties (Prospective Payment Assessment Commission, 1987). If HCFA accepts this recommendation, the occupation-mix bias in the wage index could be exacerbated. The fewer hospitals over which occupation mix is averaged, the more variation in occupation mix across labor market areas probably will be created. For this reason, when considering redefinition of the labor market areas, HCFA should weigh the greater market area accuracy attainable through narrower geographic definitions against the larger occupation-mix bias that would likely be created.

Acknowledgment

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