Updated Variable-Radius Measures of Hospital Competition

Carole Roan Gresenz, Jeannette Rogowski, and José J. Escarce

Objective. To calculate variable-radius measures of hospital market size and create measures of competition for hospitals' markets.

Data Sources. Discharge abstracts from the 1997 State Inpatient Databases of the Healthcare Cost and Utilization Project (HCUP) linked with the American Hospital Association (AHA) Annual Survey, Area Resource File (ARF), InterStudy Regional Market Analysis database, and Medicare's Prospective Payment System Impact Files.

Study Design. Hospital radii capturing 75 and 90 percent of hospital admissions regressed against hospital and health care market characteristics and other local area characteristics, where the specification was designed to maximize predictive ability. The number of competing hospitals and the Herfindahl-Hirschman index (HHI) of competition were calculated for each hospital's market.

Data Collection Methods. Discharge abstracts were used to create actual radii for hospitals in nine states. These data were linked with other data describing hospital, health care market, and other characteristics.

Principal Findings. We explained 44.7 and 9.6 percent of the variation among urban and rural hospitals, respectively, in radii that capture 90 percent of patients, and slightly less of the variation in radii that capture 75 percent of patients. Population density; number of other hospitals in the local area; and hospital characteristics such as medical school affiliation, percentage of admissions that are Medicaid, case mix, and service offerings are important correlates of a hospital's market size.

Conclusions. Predicted radii and associated competition measures were created (matched to AHA hospital identifiers) for all nonfederal, short-term, general medical/surgical hospitals in the continental United States for which complete data were available in 1997 ($N = 4{,}806$) and are available from the authors.

Key Words. Hospital market structure, competition, patient travel patterns

Researchers have long been interested in understanding hospitals' behavior, and in particular the influence of competition on behavior (Dranove and White 1994). Various methods have been used to determine the area that defines a hospital's market and to then measure competitiveness within that market (Garnick et al. 1987). For example, hospitals' markets have been defined using geopolitical boundaries and with fixed-distance radii, but while convenient, such measures are largely insensitive to the certain variation in markets from differences across hospitals in attributes such as size, scope of

services offered, and population density in the hospital's locale. Alternatively, a hospital's market has been defined according to the geographic area from which the majority of its patients are drawn (Garnick et al. 1987). Phibbs and Robinson (1993) offer a patient-origin approach to market measurement. They define a hospital's market as the circular area surrounding the hospital that captures 75 or 90 percent of the hospital's patients. Using 1983 inpatient discharge data, actual radii of these circular markets are calculated for hospitals in California; radii are then constructed for hospitals nationwide using a predictive equation based on the observed relationship in California between actual radii and hospital and local area characteristics.

In this research, we follow Phibbs and Robinson in defining a hospital's market as the circular area capturing the majority of its patients and in summarizing market size with the length in miles of the circle's radii, with the ultimate goal of creating measures of the competitiveness of hospitals' markets so defined. We calculate actual radii for hospitals in nine states using 1997 inpatient discharge abstracts, and we predict radii for all nonfederal, short-term, general medical/surgical hospitals in the continental United States. We then calculate the number of hospitals and the Herfindahl-Hirschman index (HHI) of competition in each market.

Nearly two decades have passed since the time of the Phibbs and Robinson (1983) data, and changes in the health care marketplace in the intervening years—including the growth of managed care and shifts in reimbursement mechanisms for hospitals toward prospective payment—have been dramatic. Population shifts have also occurred that may have modified the demand for the services of certain hospitals. Thus, the size of hospitals' markets, and moreover competition in hospitals' markets, are likely to have changed significantly relative to two decades ago. Our nine-state database of discharge abstracts comprise 26 percent of all hospitals and 34 percent of the U.S. population. In addition, our analysis includes several innovations. We stratify by the urban or rural location of the hospital, since these two types of markets are fundamentally quite different. We also test for the influence of

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Address correspondence to Carole Roan Gresenz, Ph.D., RAND, 1200 South Hayes Street, Arlington, VA 22202-5050. Dr. Gresenz is an Economist at RAND. Jeannette Rogowski, Ph.D., is a Senior Economist at RAND, Arlington, VA. José J. Escarce, M.D., Ph.D., is Professor of Medicine, David Geffen School of Medicine at UCLA, and a Senior Natural Scientist at RAND, Santa Monica, CA.

managed care penetration in a market on hospital market size and explore the relationships between input prices, case mix, and intensity of treatment, and market size.

No single measure of a hospital's market is ideal for all research questions or other applications. The limitations of the variable-radius measure examined in this research include that the market for some hospitals may be poorly approximated with a circle, especially in cases where hospitals are close to topographical features such as a mountain range or river; that symmetry in competitiveness may be violated because not every hospital included in a particular hospital's market will necessarily include that reference hospital in their market; and that hospitals are either considered completely in or completely outside of a given hospital's market, which may bias measures of competitiveness toward zero (Kessler and McClellan 1999). Nonetheless, for most research questions, a variable-radius measure is superior to geopolitically defined or fixed-distance approximations of hospitals' markets, and for many research applications, updated and universally available variable-radii are likely to offer a reasonable balance between convenience and accuracy.

Data And Methods

Creating Hospital Radii

Following Phibbs and Robinson, we calculate two different measures of a hospital's market: The radius that captures 75 percent of a hospital's admissions and that captures 90 percent of patient admissions. These radii are the dependent variables in our analyses.

We generated radii measures using the 1997 State Inpatient Databases (SID) of the Healthcare Cost and Utilization Project (HCUP).[1] We construct our radii using SID from nine states (Arizona, California, Colorado, Florida, Iowa, New York, Oregon, Washington, and Wisconsin) for which we have information on the zip code of each patient discharged from the hospital. The distance between the hospital and a patient's home is measured as the distance between the centroid of the patient's zip code and the precise longitude and latitude of the hospital, based on the hospital's address.[2]

We selected only nonfederal, short-term stay, general medical/surgical hospitals. Hospitals were classified as short- or long-term stay based on American Hospital Association (AHA) criteria: A hospital is long-term stay if a separate long-term unit is reported and long-term admissions are greater than one-half of total admissions, or if a separate long-term unit is *not* reported and

the ratio of inpatient days to admissions is thirty or greater. Hospitals were identified as general medical/surgical based on each hospital's report of the type of service provided to the majority of admissions. There were a total of 1,297 nonfederal, short-term, general medical/surgical hospitals in the nine states covered by our data. We excluded 51 very small (less than 20 beds) hospitals in urban areas from analysis. Thus 1,246 hospitals were included in the estimation equations (of a total of 4,806 nonfederal, short-term stay, general medical/surgical hospitals in the United States in 1997).

Hospital and Health Care Market Characteristics

To explain the variation in market size across hospitals, we include hospital, market, and population characteristics. The primary objective of the paper was to construct measures of competition for U.S. hospitals based on a variable radius definition of hospitals' markets. Thus, our specification includes variables, such as those describing characteristics of patients who use the hospital, that help in obtaining the best prediction of market size despite the fact that they are potentially endogenous.

Hospital characteristics include the size of the hospital as measured by the number of hospital beds; whether the hospital is affiliated with a medical school, has a high ($>.25$) ratio of interns to beds, or is a member of the Council of Teaching Hospitals (COTH); ownership (public, private for-profit, or private nonprofit); percentage of patients discharged who are insured by Medicaid and percentage who are insured by Medicare; ratio of the number of hospital staff to the number of hospital beds; patients' average length of stay; case mix of patients (based on the Medicare case-mix index); and specific services offered, such as psychiatric, invasive cardiac, and radiation therapy services.[3] The environment in which a hospital operates also may affect the size of its market. We also control for the density of the population, number and type of local area hospitals, input price level in the area, and managed care penetration.[4] These independent variables were derived from several sources including the American Hospital Association (AHA) Annual Survey of Hospitals, Area Resource File (ARF), the Medicare Prospective Payment System Payment Impact File (PPS), and the InterStudy Regional Market Analysis database.[5] All characteristics are measured as of 1997. The variables and their respective sources are summarized in Table 1 along with descriptive statistics.

Our specification is similar to Phibbs and Robinson (1993), but a key difference is that we separately estimate markets for hospitals in metropolitan

Table 1: Descriptive Statistics for U.S. Short-Term General Hospitals

Variable	*Data Source*	*Mean for Rural Hospitals*	*Mean for Urban Hospitals*
Population density (persons per square mile)	ARF	45.79	1,965.7
No hospitals within 15 miles	AHA		0.10
1–3 hospitals within 15 miles	AHA		0.32
4–7 hospitals within 15 miles	AHA		0.19
8–25 hospitals within 15 miles	AHA		0.27
26 or more hospitals within 15 miles	AHA		0.12
No hospitals within 30 miles	AHA	0.11	
1–3 hospitals within 30 miles	AHA	0.37	
4–6 hospitals within 30 miles	AHA	0.37	
7 or more hospitals within 30 miles	AHA	0.14	
Adjacent to metro area	ARF	0.55	
<50 beds	AHA	0.59	0.10
51–100 beds	AHA	0.24	0.15
101–200 beds	AHA	0.14	0.30
201–400 beds	AHA	0.03	0.32
More than 400 beds	AHA	0.00	0.14
Price index	PPS	0.89	1.02
Affiliated with medical school	AHA	0.02	0.31
Major teaching hospital	AHA	0.00	0.10
COTH hospital	AHA	0.00	0.11
COTH hospital exists within 100 miles	AHA		0.92
Nonprofit hospital	AHA	0.50	0.67
For-profit hospital	AHA	0.09	0.20
Public hospital	AHA	0.41	0.13
Case mix	PPS	1.11	1.41
HMO penetration rate	InterStudy	(NA)	0.39
Share of hospital admissions that are Medicaid	AHA	0.14	0.15
Share of hospital admissions that are Medicare	AHA	0.52	0.41
Staff-to-bed ratio	AHA	4.19	4.75
Average length of stay (days)	AHA	5.86	5.44
Transplant services	AHA	0.02	0.15
Burn unit	AHA	0.01	0.05
Trauma center	AHA	0.15	0.27
Geriatric services	AHA	0.31	0.53
Pediatric services	AHA	0.47	0.65
Intensive care services	AHA	0.64	0.94
Neonatal services	AHA	0.08	0.41
Reproductive services	AHA	0.69	0.81
Psychiatric services	AHA	0.19	0.49
Invasive cardiac services	AHA	0.12	0.60
Radiation therapy services	AHA	0.10	0.41
Postacute care services	AHA	0.71	0.72
Outpatient services	AHA	0.97	0.99
Emergency department	AHA	0.96	0.97
Basic imaging services	AHA	0.91	0.98
Specialized imaging services	AHA	0.39	0.73
Disease-specific care services	AHA	0.50	0.84

areas (those in MSAs) and nonmetropolitan areas. We term the former "urban" and the latter "rural" hospitals. In preliminary runs, we found significant differences between hospitals in the two locales in the roles of various factors in explaining hospital market size, and we found that our overall ability to explain the variance in radii was dramatically improved in split compared to joint regressions.[6]

The specifications for urban and rural hospitals are slightly different: Indicator variables measuring quintile of population density in the county are included for rural and urban hospitals, but the urban specification includes an indicator for whether a hospital is one of the most densely populated areas in the country (top 5 percent).[7] Very few hospitals in nonmetropolitan areas were COTH members or were classified as major teaching hospitals based on their intern-to-bed ratio, and very few offered transplant services or had a burn unit. These variables were excluded from the rural specification. In addition, the distribution of the number of hospitals within particular radii varied dramatically for urban and rural hospitals. As a result, we characterize the local competition with the number of hospitals within a 15-mile radius in the urban specification and with the number within 30 miles in the rural specification. The fraction of patients who are insured by Medicaid or Medicare is parameterized differently for urban and rural hospitals: We found the fit of the model improved in the rural regression when the Medicaid and Medicare shares were characterized as either falling in the top half or bottom half of the distribution of the shares across rural hospitals. Finally, few rural hospitals had more than 400 beds, so the two top categories of bed size distribution were collapsed in the rural regression.

Prediction

Using the estimated coefficients, we predicted radii capturing 75 percent and 90 percent of discharges for each nonfederal, short-term, general hospital in the United States. For a small number of hospitals, predicted radii were negative or very close to zero. We assigned these radii the first percentile value of the distribution of predictions if that value was positive and otherwise assigned the smallest nonnegative value. If the resulting imputed value for a 75 percent radius was greater than a predicted 90 percent radius, the imputed value was set to the 90 percent radius (likewise if an imputed 90 percent value was less than a predicted 75 percent radius). The 75 percent radius was imputed for 1.4 percent and the 90 percent radii for 2.2 percent of the 4,806 hospitals for which radii were predicted.

Sensitivity Analyses

Our main radius measure is based on the total number of discharges excluding babies born in hospitals (to avoid double-counting admissions for birth). We tested the sensitivity of our results to other radius measured based on discharges (1) excluding patients younger than 18, (2) excluding patients younger than 18 and transfers, and (3) excluding patients younger than 18, transfers, and admissions of mothers for delivering babies. The radii are highly correlated (correlations range from .941 to .997) and the results were robust to the various radii used.

Ultimately, we did not include the health maintenance organization (HMO) penetration rate in the final specification. The HMO penetration was only available for urban areas and thus could not be included in the rural regressions. In the urban regression, the variable added no explanatory power, a finding consistent with other studies (White and Morrisey 1998; Mobley and Frech 2000). We note, however, that the HMO penetration rate is a relatively coarse measure and is not likely to fully account for the potential influence of managed care on hospitals' markets.

We tested a variety of parameterizations for nearly every variable, including a score of the number of services offered by a hospital and categorical variables associated with different distribution cut-points for variables such as the price index, staff-to-bed ratio, and average length of stay. Finally, we tested models that included state fixed-effects to assess whether unmeasured attributes of different states affected hospitals' radii.

Measures of Competition

For each hospital, we calculated the number of competitors, equal to the number of hospitals situated within the predicted radius, and the HHI, calculated as the sum over hospitals within the predicted radius of each hospital's squared market share based on hospital beds.[8]

RESULTS

Table 2 describes the actual radii calculated for the hospitals in our nine-state sample. For urban hospitals, 75 percent radii range from less than 1 to 78 miles, and the mean is 10.4 miles. Among rural hospitals, 75 percent radii have a larger mean (14.2 miles) compared to urban hospitals, and range from less than 1 to 259 miles. Ninety percent radii are larger than 75 percent radii. Among urban hospitals, 90 percent radii range from less than 1 to 179 miles

Table 2: 75 Percent and 90 Percent Radii for Urban and Rural Hospitals: Descriptive Statistics

	Urban Hospitals	*Rural Hospitals*
75% Radii		
Median	8.5	12.9
Mean	10.4	14.2
SD	8.5	14.6
Min.	0.2	0.2
Max.	78.4	259.1
90% Radii		
Median	15.7	19.9
Mean	21.5	25.2
SD	19.7	20.5
Min.	0.4	1.0
Max.	179.3	282.8

and have a mean of 21.5 miles. Radii are again larger for rural hospitals, with a range from 1 to 283 miles and a mean of 25.2 miles.

Tables 3 and 4 provide regression results for urban and rural hospitals respectively. For urban hospitals, we explain 39.6 percent of the variance in the radii that captures 75 percent of patients, and 44.7 percent of the variance in the 90 percent radii. We are less successful in explaining the variance in rural hospitals' radii (adjusted R-squared = 8.3 for 75 percent radii and 9.6 for 90 percent radii). The circular approximation of hospitals' markets may be less well suited for rural hospitals. The results are largely robust to whether the 75 or 90 percent measure is used. For ease of exposition, our discussion focuses on the 75 percent measure.

For urban and rural hospitals alike, we find that higher population density is correlated with a smaller hospital radius. Hospitals in the most densely populated areas in the country (density in the top five percent of all metropolitan areas) have radii 6.5 miles shorter than hospitals in the least dense of urban areas. Likewise, hospitals in the most dense of rural areas have radii on average 9.2 miles shorter compared to those in the least dense areas.

The presence of other hospitals also is related to the market size of both urban and rural hospitals: Radii are 3.4 to 4.9 miles shorter among urban hospitals surrounded by more than three other hospitals within 15 miles and are 7 miles shorter among rural hospitals surrounded by more than six other hospitals within 30 miles. For urban hospitals, specific characteristics of nearby hospitals also matter: The existence of a COTH hospital within 100 miles of an urban hospital is associated with a radius on the order of 4 miles

Table 3: Regression Results for Urban Hospitals

	75% Radii		*90% Radii*	
	Coefficient	*SE*	*Coefficient*	*SE*
21st–40th percentile population density	1.44	(0.90)	0.02	(1.75)
41st–60th percentile population density	− 1.35*	(0.77)	− 6.41***	(1.69)
61st–80th percentile population density	− 2.00**	(0.96)	− 8.96***	(2.16)
81st–95th percentile population density	− 2.81***	(1.00)	− 8.95***	(2.51)
96th–100th percentile population density	− 6.52***	(1.60)	− 16.71***	(3.98)
1–3 hospitals within 15 miles	− 1.29	(1.59)	− 2.55	(2.57)
4–7 hospitals within 15 miles	− 3.42**	(1.63)	− 5.01*	(2.72)
8–25 hospitals within 15 miles	− 3.97**	(1.76)	− 5.26*	(3.05)
26 or more hospitals within 15 miles	− 4.92**	(1.97)	− 10.38**	(4.06)
51–100 beds	− 1.03	(1.07)	− 0.28	(1.86)
101–200 beds	− 0.22	(1.11)	0.61	(1.94)
201–400 beds	− 1.15	(1.19)	− 0.42	(2.32)
More than 400 beds	− 1.77	(1.60)	− 2.11	(3.23)
Price index	− 0.29	(2.22)	1.48	(4.52)
Affiliated with medical school	1.94***	(0.70)	6.16***	(1.74)
Major teaching hospital	3.25***	(1.43)	4.73	(3.46)
COTH hospital	11.75	(10.09)	38.37**	(16.68)
COTH hospital within 100 miles	− 3.90***	(1.49)	− 13.39***	(2.61)
COTH hospital* COTH hospital w/in 100 miles	− 10.64	(10.29)	− 33.73**	(16.62)
Nonprofit	2.05***	(0.78)	5.62***	(1.56)
For-profit	2.46***	(0.91)	7.57***	(1.99)
Case mix	16.82***	(2.44)	38.09***	(4.24)
Share of hospital admissions that are Medicaid	− 5.15**	(2.01)	− 7.47*	(4.38)
Share of hospital admissions that are Medicare	− 1.68	(2.45)	− 8.70	(5.63)
Staff-to-bed ratio	0.06	(0.18)	0.04	(0.37)
Average length of stay	− 0.03	(0.05)	0.00	(0.13)
Transplant services	3.79***	(1.07)	11.07***	(2.81)
Burn unit	3.12*	(1.74)	1.21	(3.42)
Trauma center	− 0.23	(0.76)	− 0.92	(1.70)
Geriatric services	− 0.63	(0.51)	− 1.02	(1.16)
Pediatric services	0.02	(0.50)	− 2.34**	(1.13)
Intensive care services	− 1.18	(1.40)	− 1.79	(2.87)
Neonatal services	0.17	(0.66)	− 0.28	(1.36)
Reproductive services	− 0.93	(0.83)	− 2.08	(1.93)
Psychiatric services	1.15**	(0.54)	2.66**	(1.30)
Invasive cardiac services	− 1.80***	(0.51)	− 2.98***	(1.05)
Radiation therapy services	− 0.24	(0.65)	− 0.30	(1.39)
Post-acute care services	− 0.34	(0.42)	− 1.14	(1.31)
Outpatient services	7.18***	(2.42)	11.69**	(5.84)
Emergency department	− 2.41**	(1.00)	− 4.44*	(2.52)
Basic imaging services	− 1.76	(1.45)	− 3.25	(3.42)
Specialized imaging services	− 0.53	(0.49)	0.70	(0.96)
Disease-specific care services	0.43	(0.62)	0.25	(1.17)
Constant	− 1.72	(4.29)	− 2.86	(8.97)
Adjusted R-squared	39.55		44.73	

Notes:

*$p \leq .10$; **$p \leq .05$; ***$p \leq .01$.

Robust standard errors reported.

Table 4: Regression Results for Rural Hospitals

	75% Radii		*90% Radii*	
	Coefficient	*SE*	*Coefficient*	*SE*
21st–40th percentile population density	−5.74	(4.03)	−7.72	(4.72)
41st–60th percentile population density	−8.36*	(4.32)	−11.21**	(4.93)
61st–80th percentile population density	−7.12*	(3.99)	−10.96**	(4.84)
81st–100th percentile population density	−9.22*	(4.78)	−8.91	(7.84)
Adjacent to a metropolitan area	−3.10*	(1.60)	−5.33**	(2.05)
1–3 hospitals within 30 miles	−5.00	(3.53)	−4.65	(4.29)
4–6 hospitals within 30 miles	−5.90*	(3.55)	−7.32*	(4.41)
7 or more hospitals within 30 miles	−7.34**	(3.48)	−8.93*	(4.64)
51–100 beds	−0.45	(1.54)	−1.36	(2.77)
101–200 beds	−3.64	(2.73)	−7.46	(5.80)
201 or more beds	−0.63	(2.89)	2.25	(9.46)
Price index	3.72	(18.33)	35.10	(32.87)
Affiliated with medical school	5.66	(3.67)	4.03	(7.53)
Nonprofit	4.22	(2.91)	4.45	(3.23)
For-profit	5.44	(3.97)	5.35	(4.64)
Case mix	3.06	(9.86)	14.17	(14.77)
High Medicaid/hospital admissions ratio	−4.49	(3.69)	−3.28	(4.36)
High Medicare/hospital admissions ratio	−3.89	(2.54)	−3.98	(3.07)
Staff-to-bed ratio	−0.04	(0.06)	0.01	(0.08)
Average length of stay	−0.18	(0.11)	−0.19	(0.13)
Trauma center	−1.93	(2.91)	−1.49	(3.71)
Geriatric services	−0.56	(1.19)	−0.57	(1.89)
Pediatric services	−3.12	(3.03)	−2.23	(3.58)
Intensive care services	4.01	(3.81)	3.56	(4.32)
Neonatal services	4.41*	(2.64)	7.71**	(3.89)
Reproductive services	2.09	(2.25)	−0.03	(3.22)
Psychiatric services	6.24**	(2.50)	6.12	(4.24)
Invasive cardiac services	2.55	(1.56)	4.10	(3.31)
Radiation therapy services	0.97	(2.20)	0.04	(3.18)
Postacute care services	−2.65	(2.51)	−2.42	(3.06)
Outpatient services	4.73*	(2.67)	2.40	(4.18)
Emergency department	−2.38	(3.82)	−2.92	(8.04)
Basic imaging services	3.28	(1.99)	5.00	(3.55)
Specialized imaging services	−3.43*	(2.03)	−4.76	(3.09)
Disease-specific care services	−1.30	(1.77)	−0.86	(2.46)
Constant	18.35*	(9.61)	−4.28	(27.95)
Adjusted R-squared	8.34		9.60	

Notes:

*$p \leq .10$; **$p \leq .05$; ***$p \leq .01$.

Robust standard errors reported.

shorter compared to a hospital with no nearby COTH hospital. For the 90 percent radii, the magnitude of the association varies depending on whether the hospital itself was a COTH member or not: COTH competition is associated with radii 13 miles shorter if the reference hospital is a non-COTH hospital, compared to 9 miles if the hospital is itself a COTH hospital.

Other hospital characteristics were also associated with market size among urban hospitals. In particular, radii were larger among teaching hospitals (+1.9 miles for hospitals affiliated with a medical school and +3.3 miles for major teaching hospitals), and markets were larger among private compared to public hospitals (+2 miles for private nonprofit, +2.5 miles for private for-profit). Special services offered by urban hospitals are also related to market size: A burn unit is associated with radii 3.1 miles longer; likewise for transplant services (3.8 miles) and psychiatric services (1.2 miles). Hospitals offering one or more of specialized outpatient services (physical rehabilitation services, urgent care services, outpatient surgical services, or hospital-based outpatient center services) have radii more than 7 miles larger than hospitals that do not provide any such services. Urban hospitals that serve a relatively large proportion of Medicaid patients have smaller radii. Finally, case mix is a highly important correlate of hospital market area—hospitals with more severely ill patients (high case-mix values) have larger radii. Severely ill patients may have, or be willing, to travel farther to find highly specialized medical services, and thus the case-mix variable may be capturing the influence of unmeasured hospital service offerings. We caution, however, that the case-mix variable is only for the Medicare population; whether a measure of the case mix of hospitals' general population would show similar results is uncertain.

In comparison, and as foreshadowed by the difference in the R-squared statistics between the urban and rural regressions, few measured factors contribute to explaining the market size of rural hospitals. Beyond population density and local area hospital competition, only hospitals' service offerings have an additional explanatory role. Neonatal, psychiatric, and outpatient service offerings all are associated with a larger reach of a rural hospital.[9]

Table 5 provides predictions for the 75 percent and 90 percent radii for short-term, nonfederal, general hospitals in the United States and descriptive statistics for the two measures of competition calculated (number of competing hospitals and HHI). Hospital market size as defined by the 75 percent radii averages 12.2 miles, with a range from 0.04 miles to 44.2 miles. The average number of competing hospitals is 3.2, with more than half of hospitals in the United States having either zero or one competitors. Mean and median HHI were similar, at .65 and .62 respectively.

Table 5: Predicted Radii and Competition Measures for U.S. Short-Term General Hospitals

		Measures of Competition	
	Predicted Radii	*Number of Hospitals within Radii*	*HHI*
75% Radii			
Median	11.3	1.0	0.62
Mean	12.2	3.2	0.65
SD	6.5	7.7	0.35
Min.	0.04	0	0.016
Max.	44.2	103	1.0
90% Radii			
Median	21.0	3.0	0.34
Mean	22.8	8.2	0.44
SD	12.2	16.0	0.34
Min.	0.21	0	0.01
Max.	105.1	174	1.0

Markets defined by 90 percent radii are larger and thus more hospitals are considered competitors. Ninety percent radii average 22.8 miles and range between 0.21 and 105.1 miles and these markets have on average 8.2 competitors, with half of hospitals having between zero and three competitors. Likewise, the HHI for the market as defined by the 90 percent radii was smaller—indicating more competition—compared to the market defined by the 75 percent radii. The average HHI was .44 and half of hospitals had an HHI of .34 or lower.

The market sizes we predict are larger, exhibit more variability, and span a wider range compared to those that Phibbs and Robinson (1983) estimate. Despite the differences in estimated market size, our mean HHI estimates are nearly equivalent to Phibbs and Robinson's. However, we estimate a smaller average number of competitors (3.2 versus 3.9 for the 75 percent radii and 8.2 versus 9.7 for the 90 percent radii) and a smaller median HHI for markets defined by the 75 percent radii (.62 versus .84).

CONCLUSIONS

The size of a hospital's market is influenced by a number of factors including hospital characteristics and features of the local health care market. Using data from the 1997 SID for nine states, we find that population density; number of other hospitals in the local area; and hospital characteristics such as medical

school affiliation, percentage of admissions that are Medicaid, and service offerings are important correlates of a hospital's market size. These findings are consistent with the earlier work of Phibbs and Robinson. Our updated estimation shows, however, that the influence of population density and local hospital competition vary significantly depending on whether the hospital is in an urban or rural location, and further, that characteristics of urban hospitals such as ownership and COTH status have an association with hospital market size.

Using the results from the nine states, we generated radii that capture 75 percent and 90 percent of a hospital's patients for all nonfederal, short-term, general hospitals in the United States in 1997. We then calculated the number of competitors and HHI in each hospital's market thus defined. A public use file with predicted variable-radii and associated measures of competition based on 1997 data is available from the authors. Data and documentation are also available on the RAND website at http://www.rand.org/publications/WR/WR 103/.

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NOTES

1. The SID are one component of the family of administrative databases that comprise the HCUP and currently contain the universe of the inpatient discharge abstracts for 28 states.
2. Hospital coordinates were calculated by a commercial vendor of mapping services (ETAK).
3. The Medicare case-mix index was normalized by dividing by the mean case mix in 1997 for all hospitals. Phibbs and Robinson (1983) include cost per admission as an explanatory variable, but we do not. Rather, to facilitate interpretation, our specification accounts for the component factors that this variable may be capturing, including case mix, availability of technologies, intensity of services received and input prices.
4. We combine the wage and capital price indices in the PPS data into one measure of the variability in prices across locations. Medicare applies the wage index to labor's share of operating costs (currently set at 71 percent), and applies the capital cost index (also known as the Geographic Adjustment Factor, or GAF) to capital costs. Based on analysis of 1994–1998 National Hospital Panel Survey data, the Medicare Payment Advisory Committee (2001) estimates 92 percent of total hospital costs are

operating and the remaining 8 percent are capital costs. We apply this ratio to derive the combined price index: price *index = .92((.71*wage index)+.29) + .08(capital cost index).*

5. The PPS files are prepared by the Center for Medicaid and Medicare Services (CMS), formerly the Health Care Financing Administration (HCFA).
6. We also tested regressions stratified by ownership type (public/private for-profit/private not-for-profit) within the urban/rural stratum and performed Chow tests for structural differences. In each case (three comparisons for rural and three for urban), we could not reject the null hypothesis of structural similarity.
7. For rural hospitals, we also tested specifications with zip code population density or fixed-distance density (15 and 30 miles) instead of county population density, but the county population density measures provided the best fit.
8. We also constructed HHIs based on hospital admissions instead of hospital beds, but the correlation between the two measures of competition was .99. We only describe the hospital beds-based HHI.
9. In models that included dummy variables indicating state, individual coefficients ranged from less than one-half of a mile (.41 miles) to 4.6 miles in the urban 75 percent radii specification, but were insignificant. However, an F-test showed some evidence of the joint significance of the state fixed effects ($F = 1.79$, $p = .08$). In the 75 and 90 percent radii regressions for rural hospitals, state fixed effects were neither individually nor jointly significant. In the 90 percent radii regression for urban hospitals, the coefficients on some state dummy variables were significant: Average radii among urban hospitals in California, Florida, and New York were smaller compared to the reference state (Arizona). Jointly, the state fixed effects had some explanatory power ($F = 1.19$, $p = .06$).

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