Strategic Differentiation of High-Tech Services in Local Hospital Markets

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Hanh Q. Trinh, PhD[1] and James W. Begun, PhD[2]

Abstract

This study assesses organizational and market factors related to high-tech service differentiation in local hospital markets. The sample includes 1704 nonfederal, general acute hospitals in urban counties in the United States. We relate organizational and market factors in 2011 to service differentiation in 2013, using ordinary least squares regression. Data are compiled from the American Hospital Association Annual Survey of Hospitals, Area Resource File, and Centers for Medicare and Medicaid Services. Results show that hospitals differentiate more services relative to market rivals if they are larger than the rival and if the hospitals are further apart geographically. Hospitals differentiate more services if they are large, teaching, and nonprofit or public and if they face more market competition. Hospitals differentiate fewer services from rivals if they belong to multihospital systems. The findings underscore the pressures that urban hospitals face to offer high-tech services despite the potential of high-tech services to drive hospital costs upward.

Keywords

hospital services, differentiation of services

What do we already know about this topic?
Unfettered hospital differentiation can contribute to escalating hospital expenditures, and past studies have identified several factors that are associated with higher degrees of hospital differentiation, most notably higher market competition.

How does your research contribute to the field?
We introduce a new measure of hospital differentiation, based on service offerings relative to each market rival, and we include multihospital system membership as an independent variable in our model.

What are your research's implications towards theory, practice, or policy?
Relatively promising from the standpoint of public policy and practice is the finding that multihospital system membership is associated with lower levels of differentiation, suggesting that system membership may create some counterbalance to forces associated with higher differentiation of services.

Introduction

High health care expenditures are a chronic problem in the United States. The high price of large numbers of sophisticated, high-technology (high-tech) services is a major contributor to US health care expenditures.[1,2] At the same time, convenient access to high-tech services improves hospital performance in the eyes of consumers. Controlling expenditures while assuring convenient access to high-tech services are conflicting public policy goals. Unfettered access to high-tech services, sometimes described more broadly as a "medical arms race," is counter to efficient distribution of health care resources.[3,4] It is important to identify forces that drive a potential "medical arms race" around high-tech services.

We analyze forces associated with high-tech service offerings from the perspective of hospitals' strategic choices about differentiation. Differentiation has been described as

[1]University of Wisconsin–Milwaukee, USA
[2]University of Minnesota, Minneapolis, USA

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Corresponding Author:
Hanh Q. Trinh, Health Care Administration, University of Wisconsin–Milwaukee, Northwest Quadrant B 6428, 2025 E Newport Avenue, Milwaukee, WI 53211-2906, USA.
Email: hanht@uwm.edu

"the ability to develop the right number, type, and distribution of services, programs, and products."[5] Differentiation around service offerings is particularly suitable in markets in which customers are not price-sensitive. Many hospital markets lack price sensitivity for a variety of reasons, including lack of transparency of prices, payment through third-party insurance, and oligopolistic markets.[6-8]

There are many ways to differentiate hospital services. Hospitals can emphasize the quality of their services, their high levels of patient satisfaction, or their centers of excellence around particular disease categories, such as women's health or cardiac care. Past studies of hospital differentiation have measured differentiation by the quantity and mix of services offered by a hospital.[7,9,10] For example, a widely used taxonomy of health systems uses breadth of tertiary acute services, breadth of long-term/chronic care services, and number of community orientation activities as measures of differentiation.[7,9,11] One study, by Luft and colleagues[7] measures service offerings relative to similar "peer group" hospitals. We follow the approach of Luft and colleagues[7] but consider service offerings relative to competitor hospitals, rather than "peer group" hospitals. We conceptualize differentiation as a difference in service offerings between a focal hospital and its competitors, measuring the number of services a focal hospital offers but each of its competitors does not. This allows for a fine-grained measure based on dyadic comparisons.

Past studies have identified several factors that are associated with higher degrees of hospital differentiation, most notably higher market competition.[7,8] It is important to establish (or not) that this finding holds in more recent times. Past studies have not included multihospital system membership in the analytic models. We include multihospital system membership in our model. In addition, it is important to know whether new measures of differentiation, such as the one used here measuring differentiation relative to rivals, affect results.

Conceptual Model and Hypotheses

Several market and organizational characteristics can be expected to influence the decision to differentiate hospital services from those of rivals. We examine 7 of those characteristics, chosen for their explanatory power as well as their managerial and public policy relevance. We also include 5 control variables in our conceptual model.

First, geography plays a role in differentiation of services. Far distances serve as an effective geographical barrier to competition, sorting out real from potential competitors.[12,13] When there are no nearby competitors, hospitals do not face a direct competitive threat, as local residents have no choice but to use their services. In contrast, when hospitals are geographically close to one another, the level of competitive threat is more likely to be so intense that it prompts hospitals to differentiate services.[14] For these reasons, we hypothesize the following:

Hypothesis 1: Hospitals differentiate more services from other hospitals in their market area if their location is geographically closer.

Size is a critical organizational characteristic driving an organization's strategy and its outcomes.[15,16] Hospitals with larger bed size tend to have more resources and better quality outcomes and thus have the ability to adapt or develop strategies around their service offerings.[17] Larger hospitals tend to offer more elective services.[4] We hypothesize that larger hospitals are better equipped to offer differentiating services.

Hypothesis 2: Larger hospitals differentiate more services from other hospitals in their market area.

Size is important not only in an absolute sense; it is important in relationships with competitors. Asymmetrical relationships between rivals exist when one organization uses its resources and capabilities to dominate a relationship with a rival.[18,19] Usually the dominant firm has more resources and capabilities and can position itself in a way to maximize the capabilities that distinguish it from its competitors.[20,21] We therefore hypothesize the following.

Hypothesis 3: Hospitals with greater size relative to hospitals in their market area differentiate more services from those hospitals.

Due to their mission to serve the public, private nonprofit hospitals and public hospitals may be expected to offer more services to consumers, ceteris paribus, which in turn means that they have more differentiated services.[8] Nonprofit hospitals can distribute any profits by providing unprofitable services instead of distributing profits to shareholders.[22] We anticipate public or nonprofit ownership to result in more differentiation.

Hypothesis 4: Nonprofit and public hospitals differentiate more services from other hospitals in their market area.

Hospitals that join multihospital systems with multiple members in a local community may have better strategic coordination with other members of their system in the same community. In this way, system members are able to avoid direct competition and configure their services more effectively, with fewer differentiated services than hospitals without membership. This is particularly true for local hospital clusters in urban areas.[23-25] National systems with single hospitals in a community would not be subject to this coordination incentive.

Hypothesis 5: Hospitals in multihospital systems differentiate fewer services from other hospitals in their market area.

Hospitals that are affiliated with medical schools are likely to need sophisticated technology to meet the training needs of medical schools, particularly of specialist physicians. Teaching hospitals offer advanced clinical capabilities, care for disadvantaged urban populations, and lead in research and innovation, all of which increase the pressures for differentiation.[26,27]

Hypothesis 6: Teaching hospitals differentiate more services from other hospitals in their market area.

Other characteristics of the market are likely to influence the degree to which hospitals differentiate their services. Among those pressures is market competition, which prompts hospitals to protect or expand their market share with service differentiation.[3,4,8,28,29] We expect that more competitive markets will encourage hospitals to offer high-tech services that their rivals do not offer.

Hypothesis 7: Hospitals under greater competitive pressure differentiate more services from other hospitals in their market area.

We also use 5 control variables that likely affect the choice of differentiation as a strategy but are not of central interest in this study: case mix index, population density, community wealth, physician specialist density, and Medicare beneficiary density. Although we do not test hypotheses, we expect high values of these organizational and environmental characteristics to make differentiation a more feasible strategy. Markets with higher population density, case mix, consumer wealth, physician specialists, and potential consumers of specialized services should be more attractive locations for the strategy of high-tech differentiation.

Methods

Sample and Data Set

In this study, the unit of analysis is a nonfederal, general acute hospital in an urban county, which represents the local market. The choice of county to define local market is less than ideal, as many markets for high-tech services can be expected to cross county boundaries. Nevertheless, the county can provide a first approximation of results and is common in the study of hospital markets.[30] "Urban" is defined as an area located inside the United States Census Bureau's "Core Based Statistical Areas" (CBSAs). The data on service differentiation are drawn from the 2013 American Hospital Association's (AHA) Annual Survey of Hospitals file. Data on organizational characteristics and environmental factors derive from the 2011 AHA Annual Survey of Hospitals file and the 2011 Area Resource File, and the Centers for Medicare and Medicaid Services. The 2-year period between organizational and environmental factors and differentiation should allow time for hospitals to adjust their strategy of differentiation.

The data set consists of 1704 general acute hospitals, compared with a total of 2861 general acute hospitals in 2013 in urban counties. There are 2 reasons for this difference. First, 809 hospitals are sole hospitals that do not exercise a strategy of service differentiation because there are no other hospitals in their county. Second, 348 hospitals are reported as acute in the AHA file but as nonacute in CMS data files. They were excluded from the sample.

Measurement: Dependent Variable

Differentiation is measured by pairing one hospital with each of its potential competitors one at a time. With each pairing, differentiation is the number of high-tech services that a focal hospital has but its potential competitor does not. This measurement makes it possible to understand which environmental pressures or organizational characteristics are associated with the way hospitals seek to differentiate from some hospitals, but not others. We include 40 services (see Table 1) reported in the AHA annual survey data file that require high technology, such as organ transplant, magnetic resonance imaging, cardiac surgery, robotic surgery, to capture a wide range of services. They are the type of services used by hospitals in their efforts to differentiate themselves from competitors.[28,31,32]

The algorithm first creates all possible pairs of hospitals in each county, and then counts the number of services the focal hospital offers that each of its potential competitors do not. The number of possible pairs is the number of permutations (P) on n hospitals located in the same county, taken 2 hospitals ($r = 2$) at a time in the following mathematical expression.[33]

$$n\,Pr = \frac{n!}{(n-r)!}$$

With this approach, the number of permutations increases substantially with an increase in the number of pairs of hospitals within the same county. For example, there are 2 permutations (AB and BA) with 2 hospitals A and B in the same county, 6 permutations (AB, BA, BC, CB, AC, and CA) with 3 hospitals A, B, and C, and so on. The original data in a vector form with 1704 hospitals were transformed into a new data set with a matrix form using the Structured Query Language (SQL) procedure in SAS to produce 11 264 possible pairs in which a focal hospital is paired with each of its competitors in the same community.

Because the permutation of a set of hospitals by definition is an ordered sequence, AB and BA are 2 different permutations. Within each permutation, the first hospital is treated as a focal one, and the second is its potential competitor. Services provided by these 2 hospitals are compared to identify which services the second hospital does not provide. These services are the ones that differentiate the focal hospital from the potential competitor. For example, suppose Hospital A provides services 1-7, while Hospital B offers

Table 1. Hospital High-Tech Services.

1.	MRI
2.	Diagnostic radioisotope facility
3.	Optical colonoscopy
4.	Full-field digital mammography
5.	Multislice spiral computed tomography 64+ slice
6.	Endoscopic retrograde
7.	Adult diagnostic/invasive catheterization
8.	Single photon emission computerized tomography
9.	Adult interventional cardiac catheterization
10.	Endoscopic ultrasound
11.	Adult cardiac electrophysiology
12.	ESWL
13.	Robotic surgery
14.	Adult cardiac surgery
15.	IMRT
16.	Ablation of Barrett's esophagus
17.	Esophageal impedance study
18.	Image-guided radiation therapy
19.	PET/CT
20.	Shaped beam Radiation System
21.	Stereotactic radiosurgery
22.	PET
23.	Computer-assisted orthopedic surgery
24.	Virtual colonoscopy
25.	Genetic testing/counseling
26.	Tissue transplant
27.	EBCT
28.	Other transplant
29.	Kidney transplant
30.	Intraoperative MRI (IMRT)
31.	Pediatric card electrophysiology
32.	Bone Marrow transplant services
33.	Pediatric diagnostic/invasive catheterization
34.	Pediatric interventional cardiac catheterization
35.	Pediatric cardiac surgery
36.	MEG
37.	Liver transplant
38.	Heart transplant
39.	Proton therapy
40.	Lung transplant

Note. MRI = magnetic resonance imaging; ESWL = extracorporeal shock-wave lithotripter; IMRT = intensity-modulated radiation therapy; PET = positron emission tomography; CT = computed tomography; EBCT = electron beam computed tomography; MEG = magnetoencephalography.

services 5-10. Then, Hospital A in permutation AB is differentiated by services 1-4, and Hospital B in permutation BA is differentiated by services 8-10. Hospital A has a differentiation score of 4 in the AB pair, and Hospital B has a differentiation score of 3 in the BA pair.

The average number of differentiated services in all hospital pairs in this sample is 6.58 (see Table 3), meaning that the average focal hospital has 6.58 services (out of the list of 40) that other hospitals in the county do not have. A higher value for a focal hospital corresponds to higher differentiation of the focal hospital from other hospitals in the county; a lower value means lower differentiation.

Measurement: Independent Variables

Geographical distance. Geographical distance is the distance between the focal hospital and each of its potential competitors. Geographic Information System (arcGIS) is used to calculate the straight line distance between pairs of hospitals.

Hospital size. Hospital size is measured as the number of staffed beds.

Size asymmetry. Size asymmetry is measured as a ratio of staffed bed size of a focal hospital to the bed size of its potential competitor.

Ownership. Ownership status is measured with 1 representing nonprofit or public, and 0 representing for-profit.

Multihospital system membership. Membership is measured with 0 representing no membership, and 1 representing membership in a multihospital system. Systems include local, regional, and national systems.

Teaching affiliation. Teaching hospitals are those with residency training approval by the Accreditation Council for Graduate Medical Education or membership in the Council of Teaching Hospitals of the Association of American Medical Colleges.

Local market competition. Local market competition is measured at the county level as 1 = Herfindahl-Hirschman index (HHI), which is the sum of the squared proportions of each hospital's admissions to total admissions within the same county.

Control Variables

Case mix index. A hospital's case mix index represents the average diagnosis-related group (DRG) relative weight for that hospital. It is calculated by summing the DRG weights for all Medicare discharges and dividing by the number of discharges.

Population density. Population density is the population of the county in thousands divided by the area in square miles.

Community wealth. Community wealth is measured as income in thousands divided by the population of the county.

Physician specialist density. Specialist density is total specialist physicians per 1000 population in the county.

Medicare beneficiary density is the ratio of Medicare recipients to the county population.

Measures and sources are summarized in Table 2.

Table 2. Variables, Measures, and Sources.

Variables	Measures	Sources
Dependent variable		
Differentiated services	Number of high-tech services that a focal hospital provides while its potential competitor does not	AHA Annual Survey
Independent variables		
Geographic distance	Log of distance in miles between focal hospital and its potential competitor	AHA Annual Survey; arcGeographic Information System
Bed size	Log of staffed beds	AHA Annual Survey
Size asymmetry	Log of ratio of hospital bed size over its potential competitor	AHA Annual Survey
Nonprofit/public ownership	0: no, 1: yes	AHA Annual Survey
Multihospital system membership	0: no, 1: yes	AHA Annual Survey
Teaching affiliation	0: no, 1: yes	AHA Annual Survey
Market competition	1: Herfindahl-Hirschman Index (HHI) within county	AHA Annual Survey
Control variables		
Case mix index	Medicare case mix index	Centers for Medicare and Medicaid Services
Population density	Log of population of county in thousands divided by areas in miles	Area Resource File
Community wealth	Log of per capita income in thousands within county	Area Resource File
Specialist density	Log of number of physician specialists per 1000 population	Area Resource File
Medicare beneficiary density	Log of number of Medicare beneficiaries per 1000 population	Area Resource File

Note. AHA = American Hospital Association.

Table 3. Descriptive Statistics and Correlation Matrix of Study Variables (n = 11264).

	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Differentiated services	6.58	6.87	1.00												
2. Geographic distance in miles (log)	2.29	.97	−.03	1.00											
3. Power asymmetry (log)	.01	1.21	.68	−.01	1.00										
4. Nonprofit/public ownership	.75	.43	.20	−.07	.20	1.00									
5. Multihospital system membership	.76	.42	−.01	−.03	.06	−.06	1.00								
6. Bed size (log)	5.39	.88	.50	−.13	.67	.35	.09	1.00							
7. Case mix index	1.62	.26	.40	−.16	.20	−.04	−.02	.24	1.00						
8. Teaching hospital	.39	.49	.36	−.24	.31	.26	.04	.50	.28	1.00					
9. Market competition	.86	.14	.02	.33	−.01	−.08	−.01	.09	.08	−.02	1.00				
10. Population density (log)	.58	1.12	.05	−.04	.00	.05	.00	.19	.07	.21	.55	1.00			
11. Community wealth (log)	3.86	.19	.03	−.02	.01	.06	−.03	.08	.05	.11	.21	.44	1.00		
12. Specialist density (log)	.96	.43	.08	−.21	.01	.17	.01	.23	.09	.32	.14	.50	.58	1.00	
13. Medicare beneficiary density (log)	5.23	.21	−.01	−.07	−.01	.20	.02	.10	−.14	.00	−.29	−.29	−.16	.07	1.00

Analytic Method

To test the hypotheses, an ordinary least squares regression analysis is used to estimate the relationship between independent variables and the level of hospital service differentiation. Variables with positively skewed distribution are logged. Descriptive statistics and correlation coefficients for all variables are reported in Table 3. A degree of correlation is observed among some of the independent variables, pointing to a mild problem of multicollinearity, which is common in multiple regression studies. The highest coefficients are the positive correlations between bed size and power asymmetry (.67) and between specialist density and community wealth (.58). A test for multicollinearity showed the largest variance indicator as 2.37, far less than 10, the value that might raise concern if exceeded.

Findings

Results of the regression analysis are displayed in Table 4. The probability of the fit of the whole model is .0001, indicating a strong fit of the data to the model.

Table 4. Parameter Estimates (Gammas) for Effects of Independent Variables on Differentiated Services (n = 11264).

	Differentiated services	
	Hypothesized	Actual unstandardized coefficients (standard errors)
Independent variables		
Geographic distance	−	0.293 c (0.051)
Bed size	+	0.309 c (0.078)
Size asymmetry	+	3.329 c (0.049)
Nonprofit/public ownership	+	1.069 c (0.112)
Multihospital system membership	−	−0.610 c (0.102)
Teaching affiliation	+	1.473 c (0.109)
Market competition	+	0.874 a (0.444)
Control variables		
Case mix index		6.940 c (0.182)
Population density		0.061 (0.057)
Community wealth		−0.873 b (0.291)
Specialist density		0.120 b (0.044)
Medicare beneficiary density		0.007 a (0.002)
a: Significant at the 0.05 level		
b: Significant at the 0.01 level		
c: Significant at the 0.001 level		
Adjusted R^2 = 0.5419; F = 1110.97; $P < .0001$; n = 11264		

The regression results indicate the effects of organizational characteristics and environmental pressures on service differentiation. Of the 7 hypotheses, 6 are supported, as 6 variables are related to differentiation as hypothesized: size asymmetry, nonprofit/public ownership, multihospital system membership, bed size, teaching affiliation, and market competition. However, geographic distance among hospitals is positively related, rather than negatively related, to differentiation.

Control variables all are significantly related to differentiation, with case mix, population density, specialist density, and Medicare beneficiary density all positively related to differentiation, but community wealth negatively related to differentiation.

Discussion

The results of the empirical analysis largely support the conceptual model and hypothesized relationships between organizational and market characteristics and hospital high-tech service differentiation. Hospitals vary their levels of high-tech service differentiation based on their relationships with rivals and their own structural characteristics, including their size, teaching and ownership status, and system membership. The positive associations of size and teaching affiliation with differentiation are not surprising, given the increased likelihood that high-tech services will be in demand in larger hospitals and in teaching hospitals. Nonprofit and public hospitals have higher incentives to pursue service differentiation than for-profit hospitals. They are more likely than for-profit hospitals to offer services that may not be profitable, given the secondary primacy of the profit motive in their strategic decision-making (relative to for-profit hospitals). They also may perceive more pressure to respond to specialized consumer demand, given their service mission.

Relatively promising from the standpoint of public policy is the finding that system membership is associated with lower levels of differentiation relative to rivals. System members may be less pressured to attain a wide range of high-tech services because those services are provided by other system members. Hospitals that join multihospital systems are unlikely to add more services to their current portfolio if their members within the same market are willing to share services with them.[34] This interpretation is complicated by the fact that other system members may or may not be considered "rivals" in the traditional sense. Our data do not distinguish rivals that are same-system members from rivals that are not.

The findings indicate that hospital strategic behavior also is associated with the hospital's relationships with potential rivals, including the level of market competition. One dimension of these relationships is the geographic distance from rivals. We hypothesized that hospitals differentiate more services from nearby hospitals. However, the results suggest that geographic proximity between hospitals is associated with lower rather than higher service differentiation. There are 2 interpretations for how this result may emerge over time: (1) rationalization of services over a wide geographic area or (2) imitation. Regarding the first interpretation, the need for a specific high-tech service increases if a focal hospital is distant from other hospitals

offering that service. For example, an outlying hospital in a county is more likely to offer a service if it is more distant from a cluster of central city hospitals that already offer that service. Regarding imitation, nearby hospitals that compete with one another may imitate the differentiation strategy of a competitor. As all hospitals one by one continue adding more services over a period of time, they unintentionally turn the process of differentiation into a process of duplication. However, pressures for imitation are less intensive when hospitals are geographically far apart. The imitation interpretation is consistent with institutional theory in which hospitals tend to copy each other's strategy[35] and also is consistent with the medical arms race phenomenon, whereby hospitals compete with each other by imitation in the adding of new services.[3,4,29]

In addition, size asymmetry is associated with the decision to differentiate services. With larger bed size relative to a rival, hospitals usually have more resources not only in materials such as high-tech equipment, but also in human capacity with knowledge and skills to use the equipment. As explained by resource dependence theory, these resources are a source of power over other organizations.[36] With these extra resources, larger hospitals are able to select services of their choice that bring more revenues and expand market share without fear of imitation from smaller rivals. They can take advantage of their dominant position to expand their market share with service differentiation.

From the standpoint of public policy, as noted in the introduction, it is important to identify forces that drive a potential medical arms race around high-tech services. We have identified structural factors (size, teaching affiliation, nonprofit/public ownership, independent hospital status) and market relationships (market competition, size relative to rivals) that are associated with higher differentiation of services. Any assessment of the public policy effects of higher differentiation needs to use research designs that better assess causality and that include information on costs, prices, and quality.

Limitations and Future Research

There are several limitations to the present study. The use of county to define local market area is one important limitation. More sophisticated analyses would address the different geographic reach of different services and different hospitals, and the situation of hospitals located near county borders.[37] The county provides a very rough approximation of a high-tech service area. Future analysis also should refine the measure of multihospital system membership, particularly to take into account the differences among local, regional, and national systems. Second, as noted above, the use of a cross-sectional design constrains the understanding of causality. Longitudinal studies would offer a better understanding of the causes and effects of the strategy of service differentiation.[38] Hospital markets have changed substantially since 2013, particularly with the advent of value-based purchasing by insurers. While many properties of the markets remain stable (eg, consolidation into systems, oligopoly, nonprice competition), the strategic choice of differentiation faces new market imperatives today.

Additional variables would strengthen the conceptual model. One market characteristic we did not include is the ability of hospitals to set high prices in their markets. Although, likely, this is associated with high market share, it may be a distinctive explanatory variable. Our measure of geographic distance could be improved by the use of travel time rather than straight line mileage. Finally, our high-tech services list was culled by the authors from the AHA list of services to represent perceptions in 2013. The items on our list would be improved if they were more comprehensive and mutually exclusive, weighted by volume or cost, and updated to realities of the new marketplace.

Conclusion

This study offers a better understanding of hospital competition in local markets where a few rivals compete for the same clients with similar services. By comparing a hospital's services with each of its potential competitors one at a time, this study is able to better examine the complex nature of services differentiation. The findings underscore the roles of market competition, geographical proximity, and size asymmetry as hospitals strategize about service differentiation in the effort to be a dominant player in the oligopolistic market.

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ORCID iD

Hanh Q. Trinh https://orcid.org/0000-0002-7409-2943

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