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Hospital Quality and Demand: An Analysis of German Hospitals Using Distance-Metric Approach*

Hastane Kalitesi ve Talep: Mesafe-Metriği Yaklaşımıyla Alman Hastanelerinin Bir Analizi

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ABSTRACT

In this paper, we estimate an aggregate demand model for German hospitals using various quality measures extracted from mandatory quality reports. In doing so, we adopt the Distance-Metric approach. The estimates suggest that demand in obstetrics field is responsive to some measures of clinical quality. Finally, the results indicate weak spillovers in hospital demand arising from the clinical quality of closer competitors.

Keywords: Health care market, quality competition, distance metric, Germany

ÖZET

Bu makalede, zorunlu olarak yayımlanan kalite raporlarından elde edilen çeşitli kalite ölçüleri kullanılarak, Alman hastaneleri için bir toplam talep modeli tahmin edilmiştir. Bu tahmin yapılırken, Mesafe-Metriği yaklaşımı benimsenmiştir. Sonuçlara göre, kadın doğum alanında talep, bazı klinik kalite ölçülerine karşı duyarlıdır. Son olarak ampirik sonuçlar hastane talebinde, yakınlardaki rakip hastanelerin klinik kalitesinden ortaya çıkan zayıf taşma etkilerine işaret etmektedir.

Anahtar Kelimeler: Sağlık hizmetleri piyasası, kalite rekabeti, mesafe metriği, Almanya

1. INTRODUCTION

Quality is of vital importance in health care markets than in any other goods or services industry. First, the impact of the quality of the hospital care on an individual's contentment (in some cases on his/her survival) is huge. Second, quality is an essential factor in patients' choice, since consumers in health care do not face the full prices associated with their choices thanks to the widespread presence of health care insurance (at least in many developed countries). Accompanied by a recent shift away from regulatory policies towards competition in health care markets, this led scholars to claim that competition in hospital markets will mostly be based on quality rather than price, a notion which is known as "medical arms race" in the literature (Robinson and Luft, 1985).

However, for quality competition to work in hospital industry, informational problems should be eliminated. In general, a patient's information is incomplete after his personal search behavior and, as stated by Dranove and Sattertwaite (1992), a patient's estimate of a hospital's quality is noisy. Therefore, it is crucial to reduce or eliminate this noise. One possible solution might be developing credible quality measures for hospitals and their individual services, and publicizing the outcomes for these quality measures. If publication of credible quality measures informs patients or physicians that guide patients in their decisions on true quality, then we would expect the quality of hospitals to have a positive impact on hospital demand. In the current study, this hypothesis has been tested for German hospitals using quality data provided by the Federal Office for Quality Assurance (BundesgeschäftsstelleQualitätssicherung, or BQS).

Since 2005, the quality disclosure by hospitals is mandatory in Germany by law, and hospitals failing to gather data face financial penalties. The quality measures are constructed for procedures or diseases. It is considered that this is the largest database monitoring quality in the world (Busse et al., 2009). In the current study, we estimate an aggregate demand model for hospitals providing care in obstetrics at hospital level. In doing so, we incorporate various quality measures in obstetrics field that are obtained

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from the BQS dataset. Together with some clinical quality measures, we also have data on academic status of the hospital, organizational form, size of the hospital, number of specialist doctors, geographic location of the hospital, and number of inpatients in obstetrics field. Our findings on the analysis of the number of inpatients in obstetrics field indicate that quality is an important determinant of hospital demand. Stunningly, our estimation results also show that there are weak spillovers in hospital demand arising from the clinical quality of closer competitors.

This study contributes to the literature on health economics on several dimensions. The first strand of the literature to which this study contributes is the determinants of hospital demand. Hospital markets differ from other markets in many major ways: the product is differentiated vertically by quality, and horizontally by geographic location, there is exhaustive government regulation. Information is mostly imperfect, and many hospitals are not-for profit. Furthermore, many hospital markets are comprised of a relatively small number of hospitals interacting over a lengthy period, which in turn, designates a differentiated product oligopoly. This means that we might expect market power in these markets, even in the absence of any kind of anti-competitive conduct. In these markets, one might wonder if price is one of the major determinants of hospital demand as in other traditional models of demand. This might be correct under the settings in which the price is freely determined in the market or in which prices of medical services consumed are paid directly from the disposable income of patients. However, we know that there is extensive regulatory surveillance on prices of the medical services. Furthermore, even in the absence of strict price regulation, a clear majority of the population is covered by insurance in social welfare states, which makes patients less price-sensitive. This leaves us with the proposition that in the presence of a decreased role for price, quality might be the salient competitive factor in hospital markets, as dictated by the medical arms race (MAR) story, in which search is solely based on quality (Robinson and Luft, 1985).

A lot of ink has been spilled on quality measurement in health care markets. For various dimensions of quality, one can consider the presence of sophisticated medical equipment, well-educated staff (nurses, doctors, therapists, specialists etc.), amenities (the quality of the "hotel" services) as process measures of quality; ownership status (public, private, non-profit), academic status (teaching hospital) as structural measures of quality; and mortality rates as outcome measures of quality. Nevertheless, the emphasis of the most recent literature has been on measures of clinical quality. For instance, Gutacker et al. (2016) find that hospital demand is responsive to observed quality for hip replacement surgery in the United Kingdom. Similarly, in their analysis of hip replacement surgeries in the United Kingdom, Beckert et al. (2012) reveal that hospital demand increases with clinical quality. In brief, the relevant literature verifies the positive relationship between clinical quality and hospital demand (see Bundorf et al, 2009; Pope, 2009; Moscone et al, 2012; Gaynor et al, 2012; Varkevisser et al, 2012; Ruwaard and Douven, 2014; McConnell et al, 2016).

The second strand of the literature to which this study contributes is the literature on quality and (partially informed) or uninformed patients. One difficulty in establishing the link between hospital quality and demand is the presence of incomplete information a consumer has after his search behavior. As stated by Dranove and Sattertwaite (1992), a patient's estimate of a hospital's quality is noisy, which also has negative welfare implications on consumers' side. Therefore, it is crucial to reduce or eliminate this noise. One possible solution, as observed by Brook and Kosecoff (1988) and supported formally by the model of Dranove and Sattertwaite (1992), is developing credible quality measures for hospitals and their individual services, and publicizing the outcomes for these quality measures. In a similar vein, Ginsburg and Hammons (1988, p. 109) discuss that a critical component of a competitive health care system is government production of information on clinical quality. Our findings concur with these statements.

The study is organized as follows: the next section describes the institutional background, the data and the variables used in the study. Section 3 explains the empirical strategy and methodology. The results are presented in Section 4. Finally, Section 5 concludes.

2. INSTITUTIONS AND DATA

2.1. The German Health Care System

In this subsection, we briefly explain the German health care system and German hospital market. The German health care system is dominated by its statutory health insurance. As of 2008, this statutory health insurance scheme was operated by over 200 rival health insurance funds. Participation in one of these funds was obligatory for employees whose income were below a certain level (around €48,000 per year), the retired and the unemployed, and for other specific groups such as farmers etc. Contributions are determined as a percentage of income. Statutory health insurance scheme cover about 88% of the population. 10% of the population was covered by private health insurance, with civil servants and self-employed being the largest groups, which were excluded from the statutory health insurance. Less than 1% of the population had no insurance coverage.

General practitioners have no official gatekeeper function. More generally, patients are free to choose ambulatory care physicians and, hospitals if inpatient care is needed. Ambulatory care in all expertise areas is mainly provided by physicians working individually.

There are around 1,800 hospitals providing inpatient care and receiving diagnosis-related group payments from social health insurance funds and private health insurance companies in Germany. Following the definition of the Statistical Offices of the Lander, three hospital types are identified in Germany: public, private and non-profit hospitals.

2.2. Quality Reports and Data

The Federal Office for Quality Assurance (BundesgeschäftsstelleQualitätssicherung, or BQS) focuses on measuring quality in hospitals. Since 2005, the quality disclosure by hospitals in standardized format is mandatory in Germany by law (§ 137, paragraph 3, sentence 1, No. 4 SGB V.) every two years, and hospitals failing to gather data face financial penalties. If they report less than 80 percent of cases (revealed through the number of respective reimbursed cases), payment is reduced by 150 € per missing case. The quality measures are constructed for procedures or diseases. Busse et al. (2009) argue that this database is the largest database monitoring quality in the world. The data are aggregated and made public at the national level.

The standardized reports are also available online, which enables the public to search for information on quality by hospital or location. The main objective of these quality reports is to provide informational and decisional support to all interested persons, particularly to those in advance of receiving treatment in hospitals. The quality reports are also aimed at providing guidance to physicians and health insurers on the admission and continued care of patients.

For the quality measures, "*structured dialogue*" constitutes the main touchstones of the BQS procedure when evaluating the quality of hospitals. The quality indicator scores provide clues as to whether decent quality was achieved. Yet, it is difficult to make a comprehensive judgment about the quality of a hospital by referring to a single score. Therefore, it is important that the results are examined in more detail. This investigation is carried out by independent experts in relevant fields. In this process, it is determined whether the results are extraordinarily low and therefore the quality requirements are not met, and whether there are legitimate reasons for this.

2.3. Description of the Variables for Hospital Demand

This section describes the variables that are employed for the current hospital demand analysis. The summary statistics for these variables are displayed in Table 1. A quick scan of the summary statistics shows that the substantial majority of hospitals in the dataset are either public or nonprofit hospitals. %42 of hospitals in our sample are university or teaching hospitals. On the demand side, the average number of inpatients per hospital is about 753 during relevant year. The numbers on beds and specialist doctors indicate that the distribution of size of the hospitals in our sample is bimodal: there are very large and very small hospitals. As to the raw quality scores for quality measures, they range from 0 to 100. Finally, the average distance between a hospital providing care in obstetrics and its closest competitor is about 15 kilometers in Germany.

Obstetrics Demand

Total number of inpatients that received care in obstetrics during relevant year (*INPATIENTS*): Our demand measure is the total number of inpatients receiving care in obstetrics field.

Ownership Status

Following the definition of the Statistical Offices of the Lander, three hospital types are identified in Germany: public (*PUBLIC*), private (*PRIVATE*) and non-profit (*NONPROFIT*) hospitals. Accordingly, we include three dummy variables for each ownership status.

Table 1: Summary Statistics for Hospital Demand Analysis

Variable	Obs.	Mean	Std. Dev.	Min	Max
Obstetrics Demand					
INPATIENTS	1654	752.690	523.267	27	5668
Ownership Status					
PUBLIC	1860	0.429	0.495	0	1
PRIVATE	1860	0.150	0.357	0	1
NONPROFIT	1860	0.421	0.494	0	1
Academic Status					
ACADEMIC	1860	0.424	0.494	0	1
Size					
BEDS	1776	384.552	350.942	10	6885
SPECIALISTS	1736	75.845	367.265	1	6832
Process Measures of Quality in Obstetrics					
PEDIATRICIAN	1102	63.434	41.604	0	100
THERAPY	971	72.711	36.551	0	100
Outcome Measure of Quality in Obstetrics					
EETIME	1370	49.237	47.371	0	100
Geographic Location					
CLOSEST_HOSP	1833	15.365	10.859	0	49.821

Academic Status

Some hospitals are affiliated with medical schools or universities, and may even be owned by a university. These hospitals are called teaching hospitals (*ACADEMIC*), and they provide clinical education and training to future health professionals. Some of these hospitals also have research centers for innovative, experimental and technologically advanced services. At this point it should be mentioned that even though having a teaching hospital status does not measure quality directly, but it may be related to it. For instance, academic status may imply a higher quality because doctors are better there and might thus even proxy for quality in the eyes of patients.

Size

To control for size, we employ the *total number of beds in hospital* (*BEDS*) and *the total number of specialist doctors employed by hospital* (*SPECIALISTS*).

Measures of Quality in Obstetrics

We employ three measures of clinical quality in obstetrics field: presence of pediatrician in cases of premature infants, provision of prenatal corticosteroid therapy, and E-E-time in emergency cases of caesarean. The quality scores for these variables range between 0 and 100.

Presence of pediatrician in cases of premature infants (PEDIATRICIAN): Premature infants should be treated by specialized doctors. In this case, a pediatrician- specialist in pediatrics and adolescent medicine- should be present before and after the birth of these infants. Thus, the presence of pediatrician is an important quality indicator for a hospital providing health care in obstetrics.

Prenatal corticosteroid therapy (THERAPY): As described by Stiles (2007, p. 1248) this therapy decreases morbidity and mortality in premature newborns by decreasing the likelihood of respiratory disease and dependence on mechanical respiratory support. This treatment is commonly recommended for women at risk for premature delivery between 24 weeks and 33 weeks of gestation.

E-E-time in emergency cases of caesarean (EETIME): An emergency caesarean section is a caesarean section, carried out as part of a maternal and child distress. It is necessary to end this crisis as quickly as possible, since the risk for permanent damage goes up with longer waiting times. The E-E time is the time lag between the moment at which the decision for emergency caesarean section is taken and the birth of the child. High rates of E-E-time over 20 minutes indicate organizational problems. Compliance with the 20-minute limit is one of the basic premises of a hospital with obstetrics department.

Geographic Location

Distance to closest hospital in kilometers (*CLOSEST_HOSP*): The geographic proximity of hospitals might also be an important determinant of hospital demand, as hospitals that are close to each other might steal patients from each other. To control for this, we also include distance to closest hospital in kilometers.

3. EMPIRICAL STRATEGY AND METHODOLOGY

3.1. Determinants of Demand in Obstetrics Field

In the analysis of the determinants of hospital demand, we restrict ourselves to a field: obstetrics. Obstetrics is the specialty of medicine concerned with the care of women during pregnancy, delivery and post-delivery. Thus, our product market definition can be described as "obstetrics services". This is different from a "cluster market" approach used by courts in defining the product market, where a product market is defined as "general acute care hospital services" (Gaynor and Vogt, 2000, p. 1423). As argued by Baker (1988) this approach might lead to the misrepresentation of the size of the relevant market if the fields in which hospitals are providing services are not substitutable. Consider the example given by Gaynor and Vogt (2000): if there are two hospitals, one of which specializing in cardiac care and another in oncology, and resources are not readily interchangeable on the supply side, then these two hospitals will seem to be competitors in "general acute care hospital services"; while they are operating in totally distinct product markets.

The difficulty with estimating demand for obstetrics care is that we do not have individual-level data, which prevents us from using a discrete-choice framework. Our aggregated hospital-level data does not allow us to estimate a choice model incorporating individual variation. However, one might raise the question of whether we can use an aggregate discrete choice model such as Berry (1994) and Berry et al. (1995), where the dependent variable is given by the market share of the product rather than the actual individual choices. Yet, the challenge here is the definition of the relevant (geographic) market when calculating the market shares. We cannot adopt a shipment-based approach such as Elzinga-Hogarty or Critical Loss Analysis to determine the relevant market, since we do not have individual-level data. On the other hand, political or census divisions are poor proxies for the relevant market, since people living close to the borders might prefer to go to the hospitals in the bordered geographical unit. Another method for the geographic market definition is the "radius" technique where a hospital's market is defined to be a geographical area, say, X (an arbitrary number) miles in radius around the hospital. However, the issue here is the possibility of overlapping markets, which makes it difficult to define relevant geographic markets in hospital care.

More recently, Pinkse et al. (2002) have developed the Distance Metric (DM) method, which does not require market share information unlike the methods mentioned above. The original DM model is based on a normalized-quadratic, indirect utility function in Gorman polar form and thus can be aggregated to obtain brand (in our case hospital)-level demands. Furthermore, the aggregation does not depend on the distribution of unobserved heterogeneity. Although the aggregation is easily obtained by assuming the Gorman polar form, all consumers are deemed to have the same marginal utility of income. The main idea behind the DM method is that the substitutability between brands depends on distance measures that are constructed using characteristics of brands. Stated more precisely, cross elasticity of price (quality in our case) is a function of some distance measure between two brands. In hospital case, one can promptly consider the distance between hospitals as a distance metric. Using this method, the hospital demand can be estimated as:

$$q_i = z_i\beta + k_i B + \xi_i \qquad [1]$$

where *q* is vector of quantity, *Z* is a matrix of observed hospital characteristics, *k* consists of observed quality measures, and ξ is unobserved error term. The off-diagonal elements of *B* are assumed to be functions of a vector of measures of the distance between hospitals in some set of metrics, $b_{ij}=g(d_{ij})$. Thus, the DM method not only deals with the famous dimensionality problem but also allows for cross-quality elasticities to be modeled more flexibly by specifying the cross-quality terms as a function of each hospital's location relative to each other.

In the current setting, the distance measure employed is the inverse of the distance, or closeness, between two hospitals. More specifically, this metric is calculated as 1 / [1+2 * (distance between hospitals j and k)]. This measure of closeness changes between zero and one; with a value of one if both hospitals are in the same postcode. Consequently, to create average rival quality in obstetrics, the vectors *PEDIATRICIAN*, *EETIME*, and *THERAPY* are pre-multiplied by distance matrix.

3.1.1. Econometric Issues

A potential problem with quality indicators is that the quality might not be accurately measured due to the possibility that there might be selective reporting by hospitals. That is, the hospitals might omit reporting cases which might decrease the quality scores. Given that hospitals must report no less than 80 percent of cases to avoid financial penalties, the remaining 20 percent offers discretion to hospitals to manipulate the cases to report. Thus, the hospitals can underreport the cases systematically, which introduces a measurement error on quality into our model. Even worse, this measurement error is highly likely to be correlated with unobserved error term, which would lead to biased estimates for the coefficients on quality.

To check if this is really the case, we have examined the documentation rates in obstetric fields. The results indicate that the average documentation rate by hospitals in obstetrics field is 98.86 percent, which is quite high. Thus, we argue that there would be very little measurement error due to selective reporting if any. One might also raise, *inter alia*, the question of whether some hospitals manipulated the cases they report instead of underreporting. One way to detect is to refer to the evaluations by the structured dialogue. More specifically, classifications of 13 and 14 in the structured dialogue indicate that there are errors in the documentation. When we look at the structured dialogue evaluations for the three quality indicators in obstetrics, among the total of 4558 quality indicators for the whole sample of hospitals, only 51 of them indicate manipulation of cases by the hospital, which is a very small figure. Thus, even though there might be potential problems due to underreporting or manipulation of the cases, we argue that this will not dampen the reliability of the estimates of the quality coefficients in a considerable way.

The endogeneity of product characteristics has always been a great concern in any estimation of demand in industries with differentiated products. If the quality is partially observed, and there is unobserved quality included in the error term, then the estimates of the quality coefficients will be biased if the unobserved quality is correlated with the observed quality measures. This correlation between observed and unobserved quality might be the result of hospitals setting quality based on the demand factors. In her analysis of a random-coefficients discrete-choice model of hospitals, Tay (2003) argues that this bias is less noteworthy compared to the case in which there are price regressors in the model. Her argumentation is as follows: suppose the quality variables are increasing in actual quality. This would lead to an upward bias that would yield larger coefficient estimates on quality. On the other hand, if exclusion of unobserved quality measures results in under-measurement of the overall quality, then the overestimation of the observed quality would counterbalance this, and the demand reacts to quality differences in a non-overly biased way. Furthermore, she also argues that quality takes some time to adjust, as relevant medical equipment must be bought and medical staff must be trained. Therefore, it is implied that quality choices of hospitals follow past demand patterns instead of current demand conditions.

Endogenizing quality choice is a complex and cumbersome extension. The expenses for enhancing quality should be incorporated in the hospital's maximization problem, and this requires detailed data. Furthermore, what exactly the hospitals maximize - profits, utility, output- should be considered for the strategic quality choice of hospitals to be modeled. Yet, this is problematic since nonprofit hospitals do operate in the industry, too. According to Tay (2003), due to these difficulties, no empirical study has endogenized quality choice of hospitals in a demand model.

As to our study, even though we acknowledge the necessity of employing instruments, the potential set of instruments is quite limited in our dataset. Cost-shifters for the quality might be good candidates for instruments. However, we do not have access to that information. For the moment, we can only think of using the raw quality scores of other quality indicators within the same hospital. Put in an industrial organization context, we are planning to use the quality of a product a firm produces as an instrument for the quality of another product. The identifying assumption is that while there is a correlation between the quality indicators, the demand shocks in obstetrics is uncorrelated with the quality of the services provided in other fields such as hip endoprostheses. Having performed instrumental variable (IV) estimation, we also perform the relevant endogeneity and validity tests.

4. RESULTS

Table 2 reports baseline estimation results for various specifications. In all specifications, fixed year and region effects are included as well. The reported robust standard errors obtained by Huber/White/sandwich estimators are in parenthesis. Table 3 displays results of the instrumental variable (IV) regression due to the potential endogeneity of the quality discussed in the previous section. The list of instruments includes the raw quality scores for the quality indicators of antibiotic prophylaxis in case of hysterectomy, thrombosis prophylaxis in case of hysterectomy, guideline conformity indication in case of bradycardic cardiac dysrhythmias, guideline conformity system choice in case of bradycardic cardiac dysrhythmias, indication in case of coronary angiography: ischemia symptoms, and achieving the main objective of intervention in PCI. These instruments are chosen based on the criteria that demand shocks in obstetrics are most unlikely to be correlated with the quality scores for these variables. Even though we cannot completely rule out a possible correlation, the test for overidentifying restrictions does not reject the validity of these instruments. More importantly, the p-value for the endogeneity test implies that we can treat quality as exogenous. The non-endogeneity of the quality might be explained by the argument of Tay (2003) expressing that quality takes some time to adjust, meaning that quality choices of hospitals follow past demand patterns instead of current demand conditions.

Table 2: Baseline Estimation Results

Dep. Var.: INPATIENTS	**OLS (1)**		**OLS (2)**		**OLS (3)**		**OLS (4)**	
CONSTANT	882.7216	***	573.8834	***	793.1979	***	409.5229	***
	(61.5063)		(75.5092)		(118.8304)		(73.5267)	
Ownership Status								
PUBLIC					-13.5963		-214.3726	***
					(43.2592)		(42.8154)	
PRIVATE					-276.5469	***	-310.1432	***
					(73.6524)		(73.2974)	
Academic Status								
ACADEMIC					148.3910	***	54.8576	
					(38.0850)		(35.0558)	
Size								
BEDS							0.6883	***
							(0.0796)	
SPECIALISTS							0.0363	
							(0.0232)	
Process Measures of Quality in Obstetrics								
PEDIATRICIAN	3.6824	***	3.5761	***	3.2851	***	2.3200	***
	(0.5194)		(0.5204)		(0.5105)		(0.4787)	
THERAPY	2.9665	***	2.7872	***	2.4185	***	1.1998	*
	(0.5526)		(0.5492)		(0.5442)		(0.4782)	
Outcome Measure of Quality in Obstetrics								
EETIME	0.9554		0.6622		0.7018		0.8576	
	(0.6386)		(0.6713)		(0.6650)		(0.5406)	
Geographic Location								
CLOSEST_HOSP			-11.5742	***	-10.3250	***	-5.2262	**
			(1.7584)		(1.7024)		(1.6905)	
YEAR FIXED EFFECTS	YES		YES		YES		YES	
REGION FIXED EFFECTS	YES		YES		YES		YES	
Observations	702		689		691		675	
Adj. R^2	0.47		0.49		0.52		0.65	

*: Significant at 10 % level, **: significant at 5 % level, ***: significant at 1 % level.

Turning to the baseline estimation results as can be seen from Table 2, the coefficient on *PRIVATE* in all specifications are negative and significant at 1 % level implying that private hospitals attract less demand in obstetrics compared to nonprofit hospitals, everything else being equal. On the other hand, the coefficient on *PUBLIC* is negative and statistically insignificant in the third specification, whereas it enters negatively and statistically significantly (at 1 % level) to the regression equation in the fourth specification. As to the academic status of the hospitals, the coefficient on *ACADEMIC* enters positively and statistically significantly at 1 % level to the regression equation in the third specification. Albeit being statistically insignificant, the coefficient on *ACADEMIC* is positive in the fourth specification. These findings suggest that teaching hospitals (*ACADEMIC*) appear to attract more demand compared to non-teaching hospitals, ceteris paribus.

Table 3: Instrumental Variables Estimation Results

Dep. Var.: INPATIENTS	IV (1)	IV (2)	IV (3)	IV (4)	IV (5)
CONSTANT	-70.4544	236.0103	112.9486	382.0437	116.4562
	(368.9170)	(368.1521)	(367.3357)	(274.4514)	(424.2190)
Ownership Status					
PUBLIC			150.3668 **	-67.6230	-220.0000 **
			(56.6230)	(52.0602)	(68.8407)
PRIVATE			-69.5123	-160.0000	-250.0000 *
			(117.7404)	(116.3126)	(102.1241)
Academic Status					
ACADEMIC			157.4444 *	138.8154 **	51.5300
			(67.1368)	(51.1167)	(56.4214)
Size					
BEDS				0.7946 ***	0.8231 ***
				(0.1581)	(0.1239)
SPECIALISTS				0.0254	0.0125
				(0.0531)	(0.0526)
Process Measures of Quality in Obstetrics					
PEDIATRICIAN	3.2421	3.1355	2.1130	3.8619	6.8956
	(4.9942)	(4.7076)	(4.5112)	(3.2362)	(5.6376)
THERAPY	10.4807	8.9428	9.2390	-0.9920	-3.3692
	(7.4796)	(7.5726)	(7.3943)	(5.2523)	(9.2398)
Outcome Measure of Quality in Obstetrics					
EETIME	-2.7070	-2.7235	-3.0216	0.6207	-0.9196
	(5.7425)	(5.5212)	(5.2375)	(3.9871)	(4.0138)
Geographic Location					
CLOSEST_HOSP		-12.1783 ***	-12.2513 ***	-5.1805 *	-6.2112 *
		(2.5644)	(2.6714)	(2.3753)	(2.9101)
YEAR FIXED EFFECTS	YES	YES	YES	YES	YES
REGION FIXED EFFECTS	NO	NO	NO	NO	YES
p-value for endogeneity test	0.031	0.230	0.326	0.278	0.597
p-value for overidentifying restrictions	0.964	0.873	0.811	0.676	0.357
Observations	384	376	376	374	374
Adj. R^2	0.03	0.11	0.14	0.45	0.63

*: Significant at 10 % level, **: significant at 5 % level, ***: significant at 1 % level.

The results further suggest that size matters in hospital demand. An increase in the number of beds is linked to the increased demand, as the coefficient on *BEDS* is positive and statistically significant (at 1%) in the fourth specification. On the other hand, even though a greater amount of specialist doctors seems to be associated with higher demand, its impact is imprecise.

The coefficients on quality measures indicate that quality is an important determinant of hospital demand. An increase in the quality score for the presence of pediatrician in cases of premature infants *(PEDIATRICIAN)* is associated with higher demand, since the coefficient on *PEDIATRICIAN* is statistically significantly (at 1% significance level) positive in all specifications. In like manner, there is also compelling evidence from all specifications that the provision of the prenatal corticosteroid therapy, a therapy which reduces morbidity and mortality in premature newborns, is linked to higher demand for hospitals providing care in obstetrics, as the coefficient on the quality score *(THERAPY*) is statistically significantly (at 1 % and 10 % levels) positive in all specifications. Finally, as an outcome measure of the clinical quality in obstetrics, the provision of quality in terms of the E-E-time in emergency cases of caesarean (*EETIME*) has no precise effect on hospital demand, since the coefficient on *EETIME* is statistically insignificantly positive in all specifications.

Interestingly, our estimation results indicate that the impact of the distance to closest hospital in kilometers (*CLOSEST_HOSP*) on hospital demand is negative. The coefficient on *CLOSEST_HOSP* enters statistically significantly (at 1 % and 5 % levels) to all regressions with a negative sign. One possible explanation for this finding is that in some rural areas the markets are so isolated that even the closest hospitals are too far away to channel the demand away from those monopoly hospitals located in those isolated markets.

Table 4 displays the estimated distance-metric-demand equations. These equations are separated into three parts: the intercepts, the own-quality terms, and the cross-quality terms that depend on the distance measures. To be able to estimate these equations, we have restricted ourselves to the hospitals for which there is no missing value for quality information. One might raise the issue of selection problem here. However, there is no institutional reason that would lead us to think that the missing values are not random (e.g., large hospitals are not willing to provide data), which would imply a selection problem.

First, let us consider the own-quality terms. As in the earlier findings, these slopes are all positive. However, their magnitude and statistical significance is reduced in the DM estimations. The coefficient on the quality score for the provision of the prenatal corticosteroid therapy *(THERAPY*) is statistically significant (at 10 % level) in all specifications. The coefficient on *PEDIATRICIAN* is positive and statistically significant (at 10 % level) in the first and third specifications, while it is positive and statistically insignificant in the third specification. As an outcome measure of the clinical quality, *EETIME* enters positively and statistically insignificantly to the regression equations in the first and second specifications.

The second part of the equations examines the substitutability of hospital services in obstetrics care in terms of quality. The coefficients in this part represent the impact of one unit increase in the raw quality scores of rival hospitals on a hospital's obstetrics care demand. It is surprising to see that the coefficients on the cross-quality terms are mostly positive (except *CROSS EETIME*). This finding indicates that there are spillovers in hospital demand arising from the clinical quality of closer competitors. Yet, the sizes of these externalities are imprecise, as none of these quality terms are statistically significant.

Finally, we consider the intercepts in the last part. In all specifications, it is seen that nonprofit hospitals (*NONPROFIT*) attract higher hospital demand compared to private (*PRIVATE*) and public (*PUBLIC*) hospitals. Likewise, academic status (*ACADEMIC*) has a positive but weak effect on the number of inpatients. Furthermore, the number of inpatients is higher in those hospitals where there are more beds (*BEDS*) and specialist doctors (*SPECIALISTS*).

Table 4: Distance Metric Demand Equations

Dep. Var.: INPATIENTS	DM (1)		DM (2)		DM (3)	
Own Quality						
PEDIATRICIAN	1.7286	*	1.3299		1.4258	*
	(0.8357)		(0.7495)		(0.7198)	
THERAPY	2.3421	*	1.7506	*	1.8262	*
	(0.9196)		(0.7874)		(0.7861)	
EETIME	0.0769		0.8759			
	(1.2464)		(1.0378)			
Cross Quality						
CROSS PEDIATRICIAN	2.0620		0.7216		0.9870	
	(3.8203)		(3.0448)		(2.6746)	
CROSS THERAPY	0.2925		1.6017		1.1454	
	(3.3717)		(2.9421)		(2.3861)	
CROSS EETIME	-0.1279		-0.3772			
	(1.3347)		(0.9534)			
Intercept						
PUBLIC			-268.7546	***	-265.6573	***
			(57.1560)		(56.6188)	
PRIVATE			-510.8008	***	-509.1757	***
			(140.1550)		(139.2222)	
ACADEMIC			99.8960		100.9043	
			(54.7388)		(54.5932)	
BEDS			0.6797	***	0.6782	***
			(0.1058)		(0.1054)	
SPECIALISTS			0.0790	*	0.0789	*
			(0.0377)		(0.0376)	
CONSTANT	183.3919		781.1229	***	774.9170	***
	(145.7173)		(161.1404)		(163.9699)	
REGION FIXED EFFECTS	YES		YES		YES	
YEAR FIXED EFFECTS	YES		YES		YES	
Observations	388		381		381	
Adj. R^2	0.54		0.72		0.72	

*: Significant at 10 % level, **: significant at 5 % level, ***: significant at 1 % level.

5. CONCLUDING REMARKS

In the current study, we estimate an aggregate demand model for hospitals providing care in obstetrics. In doing so, we use the distance-metric (DM) approach and utilize quality measures in obstetrics field that are obtained from the BQS dataset. In this respect, our paper is the first study that operationalizes qualitative differentials and physical distances among hospitals to model substitution patterns in hospital demand.

Our results suggest that quality is an important determinant of hospital demand. These findings concur with the findings of recent studies in the literature, which suggest that hospital demand is responsive to quality. More interestingly, our estimation results indicate that there are weak spillovers in hospital demand arising from the clinical quality of closer competitors. A close competitor with elevated levels of clinical quality attracts patients not only for itself but also for neighboring hospitals. This is quite an interesting result that has not been detected by other studies in the literature.

These results have clear implications for the design of antitrust policy in hospital industry. Apparently, the working of quality is different from that of price in determination of the demand. Furthermore, when assessing mergers in health care industry, one should also consider the potential externalities in the form of spillovers arising from the quality of the competing hospitals.

END NOTES

*<u>**Legal Disclaimer**</u>: The data on hospital quality used in this work were obtained from quality reports (2006 and 2008) produced by the hospitals according to § 137 Abs.3 Nr.4 SGB V. A complete set of quality reports is available at www.g-ba.de.

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