Reacting to Rankings: Evidence from "America's Best Hospitals and Colleges" *

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Abstract

Rankings and report cards have become a popular way of providing information in a variety of domains. Limited attention and cognitive costs provide theoretical explanations for why rankings and report cards may be particularly appealing to consumers. In this study, I empirically estimate the magnitude of the consumer response to rankings in two important areas: hospital and college choice. In order to identify the causal effect of the rankings on consumer decisions, I exploit the available, underlying quality scores on which the rankings are based. Using aggregate-level data and flexibly controlling for the underlying quality scores, I find that hospitals and colleges that improve their rank are able to attract significantly more patients and students. This increased ability to attract patients and students is shown to result in a higher revenue stream for hospitals and a stronger incoming class for colleges. A further discrete-choice analysis of individual-level hospital decisions allows for a comparison between the effects of perceived quality (as reflected by the rankings) and hospital location. I discuss the heuristic that many consumers appear to be using when making their choices – reacting to ordinal rank changes as opposed to focusing strictly on the more informative, continuous quality score. This shortcut may be used by consumers due to limited attention or because the cognitive costs associated with using the continuous quality score are greater than the benefits. I provide bounds on how high these processing costs must be in order for the use of the ordinal rankings as a rule of thumb to be optimal.

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1 Introduction

Rankings and report cards have become a common way for firms to present a range of options to consumers as well as synthesize detailed information into a format that can be easily processed. Some popular examples include rankings of colleges (e.g. US News and World Report), restaurants (e.g. Zagat), companies (e.g. Fortune 500), bonds (e.g. Moody's), and hospitals (e.g. US News and World Report). Additionally, Consumer Reports ranks a wide variety of consumer products each year. Many ranking systems simply provide an ordered list while others use letter grades (A, B, C, etc.), stars (4-stars, etc.), or other grouping methods.

In this analysis, I explore the consumer reaction to the widely-dispersed hospital and college (undergraduate and graduate) rankings published by U.S. News and World Report (USNWR) magazine. Released annually since 1993 as "America's Best Hospitals", the magazine ranks the top 40-50 hospitals in each of up to 17 specialties. These hospital rankings followed from the success of USNWR's annual "Best Colleges" magazine issue, which since 1983 has ranked the top research and liberal arts colleges in the U.S. Since 1987, USNWR has also ranked the top graduate programs in law, business, medicine, and engineering.

While the USNWR rankings generate a significant amount of attention when released each year, the extent to which consumers use these rankings remains unclear. It is possible that the rankings simply confirm what consumers already learned as opposed to providing additional information. Additionally, in the case of hospital rankings, it has been argued that consumers of health care are unresponsive to changes in hospital quality because of potential restrictions such as distance from home, health plan networks, and doctor recommendations. Thus, evidence of a large consumer response to hospital rankings would provide insight into the hospital competition and anti-trust literature. More generally, given the importance of hospital and college choice decisions coupled with the vast amount of data and resources available to consumers in these markets, it may be surprising to find that consumers consider a third party's synthesis of several pieces of information into a single rank to be beneficial.

A fundamental challenge in estimating the causal impact that rankings have on consumer behavior is the possibility of rank changes being correlated with underlying quality that is observed by individuals but not by researchers. Estimates of the effect of rankings on consumer behavior may be biased if this endogeneity is not considered. To circumvent this problem, I exploit a special feature of the USNWR hospital and college rankings: the fact that along with the ordinal rankings, a continuous quality score is provided for each hospital and college. All number ranks are completely determined by simply ordering the continuous quality scores. If the rankings are not affecting consumer decisions, then variables indicating the ability that a hospital or college has to attract patients or students should be smooth rather than discontinuous as one hospital or school barely surpass another in rank. While flexibly controlling for the underlying continuous quality score, any jumps in patient volume or student applications that occur when a hospital or college changes rank can be considered a lower bound on the causal effect of the rankings.

Using this identification strategy, I estimate the effect of the hospital rankings on both patient volume and hospital revenues. The data used for this section of the analysis consist of all hospitalized Medicare patients in California and a sample of other hospitals around the country from 1998-2004. I begin by aggregating the data to the hospital-specialty level. Using a fixed-effects framework, and while flexibly controlling for the underlying continuous quality score from which the rankings are determined, I find that an improvement in a given hospital-specialties' rank leads to a significant increase in both the non-emergency patient load and the total revenue generated from non-emergency patients treated by the hospital in that specialty. The point estimates indicate that an improvement in rank by one spot is associated with an increase in both non-emergency patient volume and revenue of approximately 1%. As a robustness check, I show that changes in rank do not have an effect on emergency patient volume or revenue generated from emergency patients.

To better understand the effect of the rankings on hospital-choice decisions relative to other important factors of hospital choice such as distance to hospital, I use individual-level data to estimate a mixed-logit discrete choice model. While computationally more taxing than the commonly used conditional logit model, the mixed logit model provides a more flexible framework and is not prone to bias due to the independence of irrelevant alternatives (Train, 2003). Under this framework, I estimate the distribution of preferences over hospital quality (as represented by the hospital rankings) and geographic proximity. I also allow preference distributions to vary across individuals living in low and high-income zip codes. The results show that both the rankings and geographic proximity are important factors in the hospital-choice decisions of consumers. The average value to an individual of a one-spot change in rank is equivalent to the value placed on the hospital being approximately .15 miles closer to the individual. The analysis also indicates that the rankings have the largest effect on individuals who live nearby the hospitals that experience a rank change. There is little evidence that the distribution of preferences for distance or the rankings varies across individuals that live in low and high-income zip codes.

Overall, the results provide evidence that the USNWR hospital rankings have had a large effect on the hospital choices made by consumers of health care.[1] Assuming the sample of hospitals used in this analysis to be representative of the nation as a whole, these hospital rankings have led to over 15,000 Medicare patients to switch from lower to higher ranked hospitals for inpatient care resulting in over 750 million dollars changing hands over the past ten years.

A similar aggregate-level analysis is conducted to analyze the impact of USNWR college rankings on the ability of schools to attract high-quality students. Controlling for the underlying continuous quality score, I find that improvements in rank have a significant effect on the acceptance rates and the quality of incoming students (as measured by SAT, GMAT, LSAT, MCAT, and GRE test scores) for research and liberal arts undergraduate schools and for business, law and medicine graduate programs. I find no effect of the rankings on graduate engineering programs. I show that the size of these effects is economically large by comparing them to the effects of other economic variables that influence college-choice decisions.

Along with the estimated impact of the rankings, an interesting finding of this analysis is that many consumers are paying attention to the ordinal rankings when a more informative measure of quality is available. This simple heuristic adds to an expanding literature suggesting that consumers often use rules of thumb or shortcuts when making

[1] While I frequently refer to hospital-choice decisions being made by consumers, I cannot rule out the possibility that doctors, rather than patients, use the rankings when making referral decisions.

complex decisions (Kahneman and Tversky, 1982, Thaler, 1991). The fact that many consumers use the ordinal ranking even in the presence of the more cardinal measure helps to explain the stylized fact that many magazines and other companies often provide information in a ranking or report card format as opposed to more detailed measures at their disposure.

Are consumers acting optimally by using the ordinal ranks as a shortcut when making hospital or college-choice decisions? A consumer who uses only the ordinal rankings in making decisions may choose a hospital/college that, had the more informative continuous quality score been used, is inferior in expected utility to another. While this "suboptimal" outcome may occur, it may still be rational for a consumer to strictly use the ordinal rankings if there are cognitive costs involved with using the more cardinal measure (Simon, 1955). While this issue is very difficult to resolve, one question that I address in this paper is how much variation in hospital and college quality can be explained by the continuous score that cannot be captured by the ordinal rankings. Answering this question provides bounds on how high the processing costs of information must be in order for consumers to optimally consider only the ordinal ranking when making their decisions. I find that the processing costs to a consumer of using the cardinal measure rather than the ordinal ranking must be such that it is worth ignoring a change in the number of physicians who consider the hospital to be one of the top five in a given specialty by 1.3%. Similar bounds can be placed on the processing costs faced by college applicants who use only the ordinal rankings in the decision process.

The outline of this paper proceeds in the following manner: In Section 2, I review the literature on rankings and report cards. Section 3 provides background information about the specific USNWR hospital and college rankings studied in this analysis. In Section 4, I describe the data and empirical strategy employed. The results are presented in Section 5. Section 6 provides a discussion and concludes.

2 Literature Review

Theoretical Literature. Providing information in the format of rankings and report cards has become ubiquitous. Even when more detailed information about a set of options is available, firms will often synthesize the information into a much simpler rank or final score (Moody's bond ratings give scores like AA+ rather than a continuous score, composite SAT/ACT exam scores are given as opposed to the score received on each section of the exam, best-seller rankings are provided rather than the actual number of products sold, etc.). Two bodies of literature explain why consumers may express a demand for information to be presented in a ranking or report card format.

First, due to cognitive costs, consumers may prefer information at a higher aggregation level because it is simpler to process. It has been argued that consumers typically use at least a two-stage process when making a choice from a large set of options. The first stage of this process involves the formation of a consideration set from which a final choice will be made during the second stage.[2] When collecting and processing information about different options is costly, this two-stage process can be shown to be an optimal strategy for a rational agent (Hauser and Wernerfelt, 1990 and

[2] See Shocker et al. (1991) for a nice review of the literature on consideration set formation.

Roberts and Lattin, 1991). Simple heuristics, such as taking the highest ranked products in a particular attribute (e.g. quality or price) can be used when generating these consideration sets (Gilbride and Allenby, 2004 and Nedungadi, 1990). Thus, firms that simplify a massive amount of data into easily classified groups or a ranking are often performing the same task that consumers would themselves have done if the more detailed information had been provided.

The recent literature on limited attention also suggests a reason why consumers might be attracted to information presented in a rankings or groupings format. Agents with limited attention are expected to pay attention to information that is relatively salient in some way (Fiske and Taylor, 1991).[3] Thus, the basic prediction of the theory of limited attention is that agents will pay too much attention to salient stimuli (Barber and Odean, 2004 and Huberman and Regev, 2001) and too little attention to non-salient stimuli (Fishman and Pope, 2006, Pope, 2006, and DellaVigna and Pollet, 2006). Synthesizing information into a simple and salient ranking or grouping format may capture the attention of more consumers than a more complicated and detailed presentation of the information.

Empirical Literature. There is an emergent literature that has documented consumer and/or firm responses to published rankings and report cards in a variety of markets (Figlio, 2004, Jin and Leslie, 2003, and Pope and Pope, 2006). More specifically related to this paper, several researchers have studied the effects of rankings in both the hospital and college markets.

[3] They define salience to be X.

In the health-care industry, studies have addressed the impact of health-plan ratings on consumer choice (Wedig and Tai-Seale, 2002, Beaulieu, 2002, Scanlon et al. 2002, Chernew et al., 2004, Jin and Sorensen, 2005, and Dafny and Dranove, ?). The majority of these studies find a small, positive consumer response to health-plan ratings. Unlike health plan ratings, however, there is reason to question whether hospital choices can be influenced by quality ratings. Arguably, location is more of a factor to consumers in the hospital market than in the health plan market. Furthermore, many individuals are restricted in their hospital choices to hospitals referred to them by their primary-care physician or that are within their health plan's coverage. Because of these potential constraints, the hospital industry has received a considerable amount of attention in the competition and anti-trust literature (see Gaynor and Vogt (1999) and Gaynor (2006) for reviews of the literature on hospital competition). However, even with these restrictions, anecdotal and survey evidence suggest that hospital-choice decisions may be affected by quality rankings. For example, a survey in 2000 by the Kaiser Family Foundation found that 12% of individuals said that "ratings or recommendations from a newspaper or magazine would have a lot of influence on their choice" of hospital (Kaiser Family Foundation, 2000).

By far, the most studied hospital ratings system has been the New York State Cardiac Surgery Reporting System. Released every 12 to 18 months by the New York State Department of Health since 1991, this rating system provides information regarding the risk-adjusted mortality rates that each hospital experienced in their recent treatment of patients needing coronary artery bypass surgery. Studies estimating the consumer response to these ratings have produced mixed results. Cutler, Huckman, and Landrum

(2006?) showed a significant decrease in patient volume for a small percentage of hospitals that were flagged as performing significantly below the state average. However, they found or provided no evidence that hospitals flagged as performing significantly above average or that a hospital's overall rank had any impact on patient volume. Using a discrete-choice framework, Mukamel et al. (2005) also provided evidence suggesting that consumers' hospital choices were affected by these ratings. On the other hand, Jha and Epstein (2006) provide evidence that the data do not suggest any changes in the market share of cardiac patients due to the ratings. Schneider and Epstein (1996) present evidence that the use of a similar report card program started in Pennsylvania was limited by referring doctors. Schauffler and Mordavsky (2001) reviewed the literature on the consumer response to the public release of health-care report cards in general and reported, "the evidence indicates that consumer report cards do not make a difference in decision making…."

One further issue regarding the hospital market is whether or not hospitals are operating at full capacity. If they are already at full capacity, then an increase in the demand for their services (due to a better ranking) could not be found empirically by looking at patient volume. Keeler and Ying (1996) show that due primarily to technological advances through the 1980s, hospitals have substantial excess bed capacity. Further evidence of this fact is that even the best hospitals are advertising for additional patients on a regular basis. In a recent study, Larson, Schwartz, Woloshin, and Welch (2005), contacted 17 of the hospitals that were ranked most highly by USNWR and asked them if they advertise for non-research patients. 16 of the 17 hospitals reported that they do advertise to attract non-research patients.

While strong anecdotal evidence exists regarding the impact of rankings in the college market, there have been few empirical studies that attempt to estimate the magnitude of these effects. Ehrenberg and Monks (1999) provided the first thorough empirical investigation into whether students respond to USNWR college rankings by using data on a subset of schools that were ranked as undergraduate research or liberal arts schools. While their paper did not attempt to identify exogenous changes in rank, it did provide strong evidence suggesting that students responded (applications, yield, and SAT scores) to changes in school rankings. Meredith (2004) extends the analysis by Ehrenberg and Monks by looking at a wider range of scores and variables.

3 Rankings Methodology

"America's Best Hospitals". In 1990, USNWR began publishing hospital rankings, based on a survey of physicians, in their weekly magazine. Beginning in 1993, USNWR contracted with the National Opinion Research Center at the University of Chicago to publish an "objective" ranking system that used underlying hospital data to calculate which hospitals they considered to be "America's Best Hospitals". Every year since 1993, USNWR has published in their magazine the top 40-50 hospitals in each of up to 17 specialties. The majority of these specialties are ranked based on several measures of hospital quality, while a few continue to be ranked solely by a survey of hospital reputation[4]. This study focuses on the specialties that are ranked using characteristics beyond simply a survey of hospital reputation.[5]

[4] In 1993, the first year of the rankings, USNWR calculated "objective" rankings in the following specialties: Aids, Cancer, Cardiology, Endocrinology, Gastroenterology, Geriatrics, Gynecology, Neurology, Orthopedics, Otolaryngology, Rheumatology, and Urology. The following specialties were

In order for a hospital to be ranked in a given specialty by USNWR, it must meet one of three criteria: membership in the Council of Teaching Hospitals, affiliation with a medical school, or availability of a certain number of technological capabilities that USNWR each year considers to be important. Each year about 1/3 of the approximately 6,000 hospitals in the US meets one of these three criteria. Eligible hospitals are each assigned a final score, 1/3 of which is determined by a survey of physicians, another 1/3 by the hospital's mortality rate, and the final 1/3 by a combination of other observable hospital characteristics (nurses-to-beds ratio, board-certified M.D.'s to beds, the number of patients treated, and the specialty-specific technologies and services that a hospital has available). USNWR has made several changes to the methodology since the inception of the rankings. For example, in 1993, the mortality rate used to rank hospitals in each specialty was simply the hospital-wide mortality rate. Over the years, specialty-specific mortality rates began to be used for some specialties followed by risk-adjusted, specialty-specific mortality rates.[6] While methodological changes have been the source of changes in rank, much of the variation in the rankings across time can be attributed to changes in the underlying reputation, outcome, and hospital-characteristics data collected by USNWR.

After obtaining a final score for each eligible hospital, USNWR assigns the hospital with the highest raw score in each specialty a continuous quality score of 100%.

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ranked by survey: Ophthalmology, Pediatrics, Psychiatry, and Rehabilitation. In 1997, Pulmonary Disease was included as an additional objectively measured specialty. In 1998, the Aids specialty was removed. In 2000, Kidney Disease was added as an objectively ranked specialty.

[5] Unlike the other specialties that rank 40-50 of the top hospitals, the specialties ranked solely by survey typically only rank 10-20 hospitals. These specialties are not given a continuous score measure in the same way as the other specialties making the identification strategy used in this paper difficult. Furthermore, the specialties ranked solely by survey (ophthalmology, pediatrics, psychiatry, and rehabilitation) treat very few inpatients (the available data only contains inpatient procedures).

[6] A detailed report of the current methodology used can be found on USNWR's website at www.usnews.com/usnews/health/best-hospitals/methodology.htm.

The other hospitals are given a continuous quality score (in percent form) which is based on how their final scores compared to the top hospital's final score (by specialty). The hospitals are then assigned a number rank based on the ordering of the continuous quality scores. Figure 1 contains an example of what is published in the USNWR magazine for each specialty. As can be seen, the name and rank of each hospital is reported along with the continuous quality score from which the rank is generated. A subset of the other variables that are used to get the quality score are also provided in the magazine.

Are these hospital rankings popular? There are several indications that suggest that people pay attention to these rankings. First, conversations with doctors, patients, and academics in the field of health care indicate that most people associated with the health-care industry are aware of the rankings. Additionally, there have been several articles published in premier medical journals debating whether or not the methodology that is used in these rankings identifies true quality (Chen et al. 1999, Goldschmidt 1997, and Hill, Winfrey, and Rudolph 1997). A tour of major hospital websites illustrates that hospitals actively use the rankings as an advertising tool (for example see www.clevelandclinic.org and www.uchospitals.edu). Just two years after the release of the "objective" USNWR rankings, Rosenthal, Chren, Lasek, and Landefeld (1996) found survey evidence that over 85% of hospital CEOs were aware of and had used USNWR rankings for advertising purposes. Additionally, USNWR magazine has a circulation of over 2 million and the full rankings are available online each year for free suggesting that if interested, most people can easily gain access to the rankings.

"Best Colleges and Graduate Schools". In 1983, USNWR began publishing undergraduate college rankings in their weekly magazine. Beginning in 1987, USNWR annually ranked the top 25 national research universities and the top 25 national liberal arts colleges. In 1995, the top 50 schools in each of these two categories were ranked. In 1987, USNWR also began to analyze data in order to rank graduate schools of law, business, medicine, and engineering. Throughout the 1990s they also began to rank graduate programs of other disciplines.[7] This analysis focuses on the undergraduate research and liberal arts school rankings as well as the law, business, medicine, and engineering graduate school rankings that were published between 1990 and 2006.[8]

USNWR uses data on students and faculty along with a survey of academics to compute their undergraduate and graduate school rankings. While the exact methodology employed varies across disciplines and has changed slightly over time, the final rankings are generally computed by taking a weighted average of several sub-rankings that are created.[9] Depending on the discipline, sub-rankings may include: academic reputation, retention rate, faculty resources, student selectivity, financial resources, alumni giving, graduation-rate, and student placement outcomes. After a ranking is given to each of these categories, weights are placed on each sub-score ranking to come up with the continuous quality score for each school (where the top school each year is given a continuous quality score of 100% and every other school's score is related to that of the top school). The final rank is then computed by ordering the continuous quality score. The final ranks and the continuous quality scores are then published in USNWR magazine along with a subset of the individual variables used in the rankings process.

[7] The majority of the recent graduate school rankings rely solely on a survey of department reputation as opposed to using detailed data like that used for the law, business, medicine, and engineering rankings.
[8] Prior to 1990, a continuous quality score was not provided along with the ordinal rankings making it impossible to employ the identification strategy used in this paper. Rankings were analyzed for the top 50 schools in each of these categories when available.
[9] A detailed report of the current methodology used can be found on USNWR's website at http://www.usnews.com/usnews/edu/college/rankings/about/06rank_brief.php.

Figure II contains an example of the national research university rankings that are published each year in USNWR magazine.

4 Data & Empirical Strategy

Hospital Data. Two main sources of hospital data are used in this analysis. First, I obtained individual-level data from California's Office of Statewide Health Planning & Development on all inpatient discharges for the state of California from 1998 to 2004. The data include demographic information about the patient (race, gender, age, and zip code) as well as information about the particular hospital visit (admission quarter, hospital attended, type of visit (elective/emergency), diagnosis-related group (DRG), length of stay, outcome (released/transferred/died), primary insurer, and total dollars charged). The second source of data used is the National Inpatient Sample (NIS) produced by the Healthcare Cost and Utilization Project from 1994 to 2002. This data contain all inpatient discharges for a 20% random sample of hospitals each year from certain states. States varied their participation in this program such that hospitals from some states are over represented in the sample. With the exception of the availability of individual zip codes, the data include similar information to that of the California data.

For the hospital analysis, I focus on Medicare patients. There are three main reasons why Medicare patients are an attractive group to consider when testing for a consumer response to the USNWR rankings. First, Medicare patients represent over 30% of all inpatient procedures. Second, Medicare prices are constant and cannot be adjusted by individual hospitals. By focusing on changes in Medicare patient volume, I eliminate any confounding effects that may result from hospitals that change their prices in response to rank changes. Third, in contrast with privately insured individuals (who may want to react to changes in a hospital's rank but can't because of network-provider limitations), Medicare patients have flexible coverage. While I focus on Medicare patients for these reasons, Appendix table 1 contains information regarding the effect of USNWR rankings on non-Medicare patients. The impact of the rankings on Non-Medicare patients, while smaller and less significant, is qualitatively similar to the effect found for Medicare patients. The sample of inpatient discharges is further restricted to patients who were admitted as non-emergency patients.[10] I assume that emergency patients should not be affected by the rankings since many of them arrived by ambulance or, for other emergency reasons, did not have the time to compare hospitals. While this analysis focuses on non-emergency patients, the effect of the rankings on emergency patients is reported as a robustness check. Table 1 provides a breakdown of the aggregate-level observations that are used in this analysis by state, year, and specialty. Table 2 presents the average number of patients that each hospital treats by specialty and patient type.

College Data. The data used in the college analysis portion of this analysis are gleaned from the information published by USNWR in their annual rankings issues. For most years, USNWR provides statistics on average test scores of the incoming class and the acceptance rates for the college that are ranked.[11] In this analysis, I use these two available variables as outcome measures representing a college's ability to attract and enroll students. Low acceptance rates can be achieved by both receiving more

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[10] Non-emergency patients are identified in the California data as patients "not scheduled within 24 hours or more prior to admission" and in the NIS as patients simply classified somehow as "non-emergency patients."

[11] The statistics that come out report information for the incoming class two years prior to the publication year.

applications and anticipating a higher matriculation rate. Average incoming student test scores (SAT, LSAT, GMAT, MCAT, and GRE) are a measure of the quality of students that a college is able to enroll.[12] Table 3 provides summary statistics for the schools that are used in the college analysis.

Empirical Strategy. A fundamental challenge with identifying the effect of rankings is the possibility that rank changes are correlated with changes in hospital quality that are observed by consumers but unobserved by the econometrician. The standard omitted variable bias formula indicates that this endogeneity will likely result in an estimated coefficient on the rank variable that is biased upward.

In order to circumvent this bias, I use an approach similar to a regression discontinuity design (Thistlewaighte and Campbell, 1960, Campbell, 1969, Angrist and Lavy, 1998, Hahn, Todd, and van der Klaauw, 2001, and Lee, 2001). Following Lee (2001), begin by considering the following econometric specification for the hospital case

(1) $$Pat_{jt} - \overline{Pat_j} = \alpha_t + \beta Rank_{jt-1} + \varepsilon_{jt}$$

where $Pat_{jt} - \overline{Pat_j}$ represents the deviation in the number of patients that hospital-specialty j was able to attract in year t from its average, $Rank_{jt-1}$ represents the Rank of hospital-specialty j that is used by individuals during year t, and ε_{jt} is an error term representing all other observable and unobservable determinants of $Pat_{jt} - \overline{Pat_j}$. For now we assume that the effect of rank on the deviation in patient volume to be linear and represented by β.

[12] For some tests, USNWR only reported the 25th and 75th percentiles rather than the average incoming student test score. The average of the 25th and 75th percentile scores was used to represent average test score in these cases.

The key feature to the strategy of regression discontinuity is that a deterministic function of $Rank_{jt-1}$ is known and observed. In the case of the USNWR rankings, $Rank_{jt-1}$ is completely determined by the continuous quality score given to each hospital-specialty. Without loss of generality, consider the situation where only two hospital-specialties exist: j and k. $Rank_{jt-1}$ is determined by the following function

$$(2) \qquad Rank_{jt-1} = \begin{cases} 1 & \text{if Quality Score}_{jt} > \text{Quality Score}_{kt} \\ 2 & \text{if Quality Score}_{\text{jt}} < \text{Quality Score}_{\text{kt}} \end{cases}$$

A simple comparison between the hospital-specialty that was ranked first and the hospital-specialty that was ranked second is

$$(3) \qquad E[Pat_{jt} - \overline{Pat_j} \mid Rank_{jt-1} = 1] - E[Pat_{jt} - \overline{Pat_j} \mid Rank_{jt-1} = 2] = \beta + Bias_t$$

where

$$(4) \qquad Bias_t = E[\varepsilon_{jt} \mid \text{Quality Score}_{\text{jt}} > \text{Quality Score}_{\text{kt}}] -$$

$$E[\varepsilon_{jt} \mid \text{Quality Score}_{\text{jt}} < \text{Quality Score}_{\text{kt}}]$$

The key assumption in the regression discontinuity approach is that the bias approaches zero when comparing the deviations in patient volume for hospitals that are just barely ranked differently than each other. I assume that ε_{jt} is continuous as the quality scores for the hospital specialties near each other

$$(5) \qquad E[\varepsilon_{jt} \mid \text{Quality Score}_{\text{jt}} \rightarrow \text{Quality Score}_{\text{kt}}^{+}] =$$

$$E[\varepsilon_{jt} \mid \text{Quality Score}_{\text{jt}} \rightarrow \text{Quality Score}_{\text{kt}}^{-}]$$

or more generally, I assume that

$$(6) \qquad E[\varepsilon_{jt} \mid \text{Quality Score}_{\text{jt}}] = g(\text{Quality Score}_{\text{jt}})$$

where $g(\text{Quality Score}_{jt})$ is continuous everywhere.

In this paper, I assume (6) is true and therefore, control for a flexible parameterization of the quality score when estimating the impact of a rank change on patient volume. Flexibly controlling for the continuous quality score will control for changes in hospital quality that are observed by individuals but not by the researcher and allow for the identification of breaks that occur in the dependent variable when a hospital changes rank.

It is worth noting that the estimates that this analysis obtains for the effect of USNWR rankings represent a lower bound of the impact that these rankings have on consumer's hospital and college choice decisions. I am unable to identify how many decisions are made by consumers who are paying attention to the continuous quality score. After controlling for the rankings, it is impossible to parse out whether any remaining predictive power that the continuous quality score has on patient volume is due to omitted variable bias or the direct reaction of individuals to the continuous quality score.

Aggregate-Level Hospital Analysis. I begin by aggregating the hospital data to create a panel dataset at the hospital-specialty-year level. Thus, I create counts for the number of Medicare inpatients treated in a given specialty at a given hospital for each year that the data is available. All hospital-specialty groups that received a USNWR rank in the prior year were included in the sample. Diagnosis related group codes (DRGs) were used to classify each individual into a specialty. [13] Hospital-specialty rankings for

[13] The matching between DRGs and specialties was chosen to be the same as that used by USNWR when measuring patient volume by specialty. See the USNWR methodology report for the this matching procedure, www.usnews.com/usnews/health/best-hospitals/methodology.htm.

AIDS and Kidney Disease were not used because USNWR did not consistently rank these specialties during the sample period. Furthermore, hospital-specialty rankings for Endocrinology, Otolaryngology (Ear, Nose and Throat), and Rheumatology were also dropped because rarely did hospitals treat any non-emergency inpatients in these specialties. All other hospital-specialty-year groups from the remaining eight specialties that treated at least ten non-emergency and emergency patients were included in the analysis[14].

The timing of the rankings release must be considered. Over the sample period, the rankings were released in a Fall Issue of USNWR. The available data contain the quarter of admission for each patient. Some time must be allowed for individuals to see the newest rankings, make appointments, and be admitted for non-emergency care. The data are restricted to individuals who are admitted between January and June of each year. Thus, I am estimating the effect of rankings released in the fall of a given year on the number of individuals admitted in the first half of the following year.[15]

The baseline econometric specification used is the following

(7) $$Y_{jt} = \alpha_j + \delta_t + \beta Rank_{jt-1} + g(QualityScore_{jt-1}) + \varepsilon_{jt}$$

where Y_{jt} represents either the log number of Medicare discharges or the log total revenue generated from Medicare patients at hospital-specialty j during the first or second quarter of year t. $Rank_{jt-1}$ is the USNWR rank of hospital-specialty j in year t-1. As was

[14] These specialties include cancer, digestive, gynecology, heart, neurology, orthopedics, respiratory, and urology. Hospital-specialties with non-emergency and emergency-patient counts of less than 10 cases were dropped in order to reduce the noise involved with hospitals that treated very few inpatients and to be consistent with the individual-level analysis results which also eliminates hospitals for which less than 10 cases were treated.

[15] The appendix table presents the regression results if patients from the 3rd quarter of the year (who may or may not be using the new fall rankings) are also included. The results remain unchanged.

mentioned in the previous section, the continuous quality score is included flexibly as a cubic polynomial.

The continuous quality scores included in both the hospital and college regressions are adjusted from those that are directly reported in the magazine. The problem with using the continuous scores directly from the magazine is that since the scores are a percentage of the number-one-ranked hospital or college's score, the scores of all hospitals can shift up or down from year to year if the number-one-ranked hospital or college's score changes. Thus it would be easy to show that the ordinal rankings continue to have an effect even after including the continuous quality scores (because they are so noisy across years). So, rather than including the continuous quality score as reported, I normalize the quality score by dividing by the average quality score of the top 40 ranked hospital-specialties each year for the hospital regressions and by the average quality score of the top 25 colleges (by discipline) each year for the college regressions. Thus the regressions control for the relative continuous quality score of each hospital as they should.

Specifications other than Equation (1) may be relevant. For example, a change in rank by a hospital-specialty towards the top of the list may have a larger consumer response than a change in rank by a hospital-specialty in the 20-50 range. To check for this, a specification using ln(rank) is used. Ln(rank) appears to have an equally good fit as linear rank, however, linear rank is included in the main tables for ease of interpretation (the ln(rank) results can be seen in the appendix table).[16] It is possible that achieving a better rank than another hospital-specialty in your state has a larger impact

[16] If consumers only consider hospitals that are nearby, then it makes sense that log(rank) does not have a better fit since consumers are not always using the rankings to choose between the top-ranked hospitals, but rather to choose between other hospitals that may be ranked anywhere in the rankings.

than surpassing the rank of a hospital that is on the other side of the country. The appendix table contains a specification that includes a hospital-specialty's state rank along with the overall rank. While the coefficient on state rank is in the direction hypothesized even when controlling for overall rank, unfortunately, hospital ranks within states did not vary enough to obtain very precise estimates. Estimates from specifications that control for the quality score even more flexibly (quality score interacted with year and specialty dummies as well as controlling for the standard deviation change in quality scores as opposed to difference from the mean) are also provided in the appendix table. While these specifications reduce the power of the regression the overall rank effect appears to be robust to these inclusions.

Aggregate-Level College Analysis. The baseline specification for the college analysis can be similarly represented as

(8) $$Y_{jt} = \alpha_j + \delta_t + \beta Log(Rank)_{jt-1} + g(QualityScore_{jt-1}) + \varepsilon_{jt}$$

where Y_{jt} represents either the acceptance rate (in percentage terms) or the average test scores of the incoming class in year t for school j. $Log(Rank)_{jt-1}$ is the USNWR rank of college j in year t-1. A cubic polynomial of the continuous quality score is included.

In the college analysis, the log of rank fit the data much better than a linear specification. Intuitively this seems reasonable if more students are competing for the top schools. Once again, estimates from specifications that control for the quality score more flexibly (quality score interacted with year as well as controlling for the standard deviation change in quality scores as opposed to difference from the mean) are provided in Appendix Table X.

Individual-level Hospital Analysis. Using the available individual-level data, I estimate a discrete-choice model of hospital choices. An individual-level analysis can provide additional information that cannot be obtained through the aggregate analysis. First, a major factor in hospital choice decisions, proximity of hospital to the patient's home, can be explicitly controlled for in the analysis. Controlling for distance in the discrete-choice model not only increases precision, but allows me to obtain an estimate for the impact of distance on hospital choice which can then be compared to the impact of rank changes.

I estimate a mixed-logit discrete choice model (McFadden and Train 2000, Train 2003). The mixed-logit model can be thought of as a flexible extension to the more traditional conditional logit model (McFadden, 1974). Unlike the conditional logit model, the mixed-logit model estimates random coefficients on the product characteristics in the indirect utility function. The allowance of random taste variation eliminates the need for assuming the independence of irrelevant alternatives assumption, which is likely to be violated in a model of hospital choice. In order to obtain this increased flexibility in substitutions patterns, the mixed-logit model has a more complicated functional form whose likelihood function does not have a closed-form solution. However, recent advances in simulation techniques have made estimating mixed-logit coefficients possible even for large datasets. Thus, mixed-logit models have recently been used, particularly in the industrial organization and marketing literatures, to model a variety of choice models (see for example Berry, Levinsohn, and Pakes, 1995, Train 2006, Nevo 2001, Hastings, Kane, and Staiger 2005).

The specific mixed-logit model I use, which can easily be generated from a standard random utility framework (see Train X), has choice probabilities that can be expressed in the following form

(8) $$P_{ijt} = \int \left(\frac{e^{\beta x_{ijt}}}{\sum_{j} e^{\beta x_{ijt}}}\right) f(\beta) d\beta$$

where P_{ijt} represents the probability that person i chooses hospital-specialty j in year t. x_{ijt} includes variables relating to each hospital (e.g. rank) as well as individual-hospital characteristics (e.g distance from the individual's home to the hospital). The probability that i chooses each of the possible alternatives is a weighted average of the logit formula (with a linear indirect utility function) evaluated at different values of β according to the density function $f(\beta)$. $f(\beta)$ is called the mixing distribution for which the standard logit model is a special case. In this analysis, I use the normal distribution as the mixing distribution for both the distance and rank of the hospital.[17] Through numeric integration, the log likelihood function of Equation (8) can be maximized to yield estimates of both the mean and variance of β.

I use only the California data to estimate the mixed-logit model since the patients' zip code is not available in the NIS data. Using patient and hospital zip codes, I calculate the distance between each patient and every hospital in California.[18] The resulting data set is much too large to work due to computational constraints. In order to limit the number of observations, I reduce the dataset to patients admitted for a heart procedure.[19]

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[17] Alternatively, a log normal distribution can be used which would force the coefficients of both the distance and rank variables to be positive.
[18] This is done by using the latitude and longitude of the patient and hospital's zip-code centroids.
[19] I chose the heart specialty for two reasons. First, the majority of studies looking at health-care rankings focus on heart patients (e.g. studies of the New York State Coronary Artery Bypass Surgery Report-Card

This reduces the sample to 127,141 non-emergency Medicare patients that were admitted to one of 374 hospitals in California between January and June from 1998-2004. However, this sample continues to be too large to work with (more than 47.5 million patient-hospital pairs). Thus, I further reduce the sample by eliminating patients of hospitals that received less than 10 patients per year. 12,498 patients (9.8%) and 210 hospitals were eliminated resulting in the elimination of approximately 18.8 million patient-hospital observations. I proceed by generating a 25% random sample of these patient-hospital observations leaving me with 28,647 patients and 4,698,108 patient-hospital observations – a large, yet feasible number with which to estimate a mixed-logit model. I report results for both the mixed-logit model and for comparison I also present the results from a conditional logit model. I include alternative-specific constants (dummy variables for each hospital) and the continuous quality score (cubic) in all specifications. I also test for differences in preference distributions across low and high income zip codes. Using 2000 census data, I identify patients who live in zip codes whose reported median income is in the top or bottom 25th percentile for the state of California. The results of the mixed-logit model are presented separately for each of these two samples.

5 Results

Aggregate-Level Hospital Results. Following the specification in Equation (7), Table 4 presents the first set of results from the aggregate hospital-level analysis. Column (1) provides the results from the simple OLS analysis of lagged overall rank on

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System). Second, as can be seen from the summary statistics, hospitals treat more heart patients than patients from any other specialty.

the log number of non-emergency Medicare discharges. The rank variable was inverted such that an increase in rank represents an improvement in rank. The estimate suggests that an increase (or improvement) in rank for a specific hospital-specialty by one spot increases the patient volume treated by that hospital-specialty by .88% (significant at all conventional levels). Column (2) illustrates the positive relationship between log patient volume and the linear continuous quality score. When both rank and the linear continuous quality score are included in Column (3), the point estimate for the continuous quality score is cut to 1/3 of its previous level and the rank variable keeps both its size and significance. Column (4) includes a cubic of the continuous score without affecting the size or significance of the rank variable. Columns (5)-(8) analogously present the effects of the rank and continuous quality score on emergency Medicare patients. Rank changes do not appear to be associated with changes in emergency patient volume. Table 5 presents results similar to those of Table 4, except in this case the dependent variable is the log total revenue generated from either non-emergency or emergency Medicare patients. Once again, an improvement in rank by one spot is associated with approximately a 1% increase in total revenue for non-emergency patients even after flexibly controlling for the continuous quality score. No effect is found on emergency patient revenue.

Table 6 presents the effect of rank changes (while controlling for the continuous quality score) on non-emergency Medicare patient volume by each of seven specialties (the gynecology specialty drops out due to insufficient observations). The results suggest that no single specialty is driving all of the results presented in Tables 4 and 5, and in fact, all but one point estimate suggests that improvements in rank increase patient volume. While almost no estimates are significant due to the small samples, the specialties with the largest point estimates are cancer and urology.

Individual-Level Hospital Results. Table 7 presents the results from the mixed-logit model specification using individual-level hospital choices. Column (2) provides estimates for the mean effect of the overall rank and distance to hospital variables. Column (3) provides the standard deviations of the random coefficients. While controlling for alternative specific constants and the continuous quality score (cubic), I find that individuals significantly increase the probability of attending hospitals that experience improvements in rank. The results further indicate that the probability of choosing a hospital increases with the geographic proximity of the hospital to the patients' zip codes. The estimated standard deviations for these effects (Column (3)) illustrate that essentially no individuals place negative values on improvements in rank or hospitals being closer. The conditional-logit estimates presented in Column (1) are very similar to the coefficients from the mixed-logit model. Column (4) present the conditional logit estimates including a distance and rank interaction term. The results suggest that nearly all of the patients who are being affected by the rankings are those that live nearby to the hospital.

Are the magnitudes of the effects found in the individual-level analysis comparable to the aggregate-level analysis? Interpreting the marginal effect of a rank change at the average values of the explanatory variables yields an increase in probability of 0.000075 for an improvement in rank by one spot. Multiplying this probability increase by the average total number of heart patients each year indicates that a hospital that improves its rank by one spot should expect approximately 1.5 more patients (.2%

change in heart patient volume on average). This result is slightly smaller, yet consistent with the aggregate-level results presented in the previous section.

Aggregate-Level College Results. Following the specification in Equation (8), Tables 8 and 9 present the results of USNWR college rankings on acceptance rates and test scores of incoming classes. Table 8 presents the simple OLS results while Table 9 controls for the cubic of the continuous quality score. The odd numbered columns indicate the effect of an improvement in rank on the following year's acceptance rates. Since the explanatory variable in this case is log rank, the results must be interpreted in percentage terms. An improvement in rank by 20% (e.g. 5^{th} to 4^{th} or 25^{th} to 20^{th}) decreases the acceptance rate at undergraduate research universities by approximately .6%. The acceptance rates results are smaller but still significant for undergraduate liberal arts, law, and business schools and insignificant for schools of medicine and engineering. The effect of an improvement in rank by 20% increases the average SAT test score at undergraduate research universities by approximately 1.6 points. Similar calculations can be performed to interpret the effect of rank changes on test scores from other college types. The test score results are significant for in for all college types with the exception of engineering (whose results are, if anything, in the opposite direction). The results in Table 9 are very similar to those found in Table 8. With the exception of schools of medicine, including the cubic continuous quality score does not significantly reduce the estimated effect of the rankings on acceptance rates and test scores.

6 Discussion and Conclusion

Magnitude of Results. The results provide evidence that USNWR hospital-specialty rankings have had a significant effect on the hospital-choice decisions of consumers. The estimates suggest that each rank change is associated with approximately a 1% change in non-emergency Medicare patient volume and revenue. In order to fully understand the total number of people whose hospital-choice decisions were affected by these rankings, it is necessary to know how volatile the rankings are. On average, the rank of each of the hospital-specialties in my sample changes by 5.49 spots each year. Thus, the USNWR rankings on average account for a change in over 5% of non-emergency Medicare patients in each of these hospital-specialties each year. A precise count of the number of hospital switches that took place because of the rankings can be calculated by summing up the rank changes and multiply them by the number of patients and the percent of patients affected,

(9) $$\sum_{jt} 1\% * |(Rank_{jt} - Rank_{jt-1})| * \text{Non-emergency Patients(per year)}_{jt}.$$

In order to estimate the exact number of people in this sample whose hospital-choice decisions were affected by the rankings, the resulting number from Equation 9 should be divided in half because individuals that choose a higher ranked hospital over a lower ranked hospital are essentially being counted twice (a decrease in patient volume in the lower ranked hospital and an increase in patient volume at the higher ranked hospital). This calculation results in an estimated 1,788 non-emergency Medicare patients who adjusted their hospital choice because of the rankings in my sample. A similar calculation can be done to calculate the amount of revenue affected by the rankings. An estimated 76 million dollars of revenue was transferred from hospitals that decreased in rank to hospitals that increased in rank in my sample. Given that my sample only represents a small portion (about 10%) of the entire population of hospitals and years that the USNWR has ranked, these numbers underestimate the effect that the USNWR hospital rankings have had nationwide. Assuming my sample to be representative of the other hospitals ranked by USNWR, it is estimated that these rankings influenced over 15,000 hospital-choice decisions made by Medicare patients and 750 million dollars in revenue between 1993 and 2004.

Market Efficiency. A question that I do not address in this analysis is whether the USNWR hospital and college rankings have led to more efficient health-care and college outcomes. For hospitals, the rankings have the potential to impact the efficiency of health care in many ways. Better matching of high-risk patients with better hospitals, better hospitals receiving a larger market share, and providing hospitals with the incentive to work harder in order to improve or keep their rank high may all contribute to more efficient outcomes. On the other hand, the rankings may be detrimental to overall efficiency by providing hospitals with the incentive to turn away high-risk patients or to inefficiently devote time and resources into activities simply to try and improve their rank rather than improve quality of care.[20] Due to the gradual emergence of the USNWR rankings in the early 1990's, lack of data during that time period, and a proper control group, I am unable to perform an analysis similar to that of Dranove, Kessler, McClellan, and Satterthwaite (2003) who conduct a before-and-after study of the New York State Coronary Artery Bypass Surgery Report-Card System. While I have no evidence regarding the matching of patients to hospitals and changes in

[20] Because of the perverse incentives that the rankings may give to hospitals and colleges who care about their rank, recent research has focused on other ranking systems that may be less difficult to manipulate. Avery, Hoxby, Glickman (?) created a revealed-preference ranking of colleges (based on individual, tournament-style decisions) and Kessler (?) produced a revealed-preference ranking of hospitals (based on travel distance).

hospital incentives, I do show that hospitals that are ranked higher (and have lower risk-adjusted mortality rates) receive a larger market share.

Similarly, it is difficult to address whether USNWR college rankings have had a positive or negative effect on the college market. Jin and Whalley (?) and Ehrenberg (?) each analyze the effects that the rankings have had on the schools involved. Yet, the overall efficiency impact of these rankings remains unclear.

Individual Efficiency. Are individuals using the information revealed in the rankings in an efficient manner? An interesting finding in this analysis is that consumers are reacting to changes in ordinal rank as opposed to simply using the continuous quality score in their decisions. There are several reasons why an optimizing consumer may choose to ignore the more cardinal measure. First, some consumers may receive information about the ordinal rank of a hospital or college without access to the continuous quality score (e.g. advertisements that only report the ordinal rank). Thus, the consumer would have to take extra time to find the magazine or look online to get the actual continuous scores. Second, some consumers may not care just about the quality of the hospital or college that the ranks represent but the rank itself. While this seems unlikely for the hospital rankings, it is very possible that high school students gain utility from the rank of the college even after controlling for the quality signal that it represents. Finally, even if the consumer has access to the continuous score and only cares about quality, the cognitive costs associated with processing the continuous score may be higher than the benefits. Understanding how much information consumers are ignoring by using only the continuous score can provide lower bounds on how high these processing costs must be.

Using a cross section of one year of hospital rankings, there is on average a 1.52% difference in the continuous quality score between each rank. A health-care consumer who uses only the ordinal ranking therefore on average neglects the amount of information that is able to adjust the continuous quality score by 1.52%. Table 10 provides a regression of the continuous quality score (in percentage terms) on the main two components that make up this score – reputation (% of surveyed physicians who indicated the hospital-specialty as one of the top five hospitals in that specialty in their opinion) and risk-adjusted mortality rate (actual deaths/expected deaths).[21] As can be seen calculated from the regression coefficients in column (1), a difference in continuous quality score of 1.52% can be generated by an additional 1.3% of the physicians surveyed indicating that in their opinion the hospital is one of the best five hospitals in a given specialty. A 1.52% difference in quality score can also be generated by a change in the risk-adjusted mortality rate of approximately .25. Thus, consumers that pay attention to only the ordinal rankings on average ignore some combination of these two effects. However, columns (2) and (3) illustrate that reputation explains over 95% of the variation in the quality score while risk-adjusted mortality rates explain less than .1%. Thus, the true bound that can be placed on the processing costs that people (who are using the rankings to begin) must incur in order to optimally ignore the continuous quality score, is a change in the percentage of physicians recommending the hospital of 1.3%.

A similar cross section analysis can be performed for the college rankings. Using the undergraduate research schools, the average difference in the continuous quality score between each rank is 0.59%. Table 11 presents the results from a regression of the

[21] The data for these two components were taken directly from the magazine issue. The factors that make up the other third of the continuous quality score vary by discipline and are not all provided in the magazine. Thus, only reputation and risk-adjusted mortality were used.

continuous score on the available factors that make up the score. A difference in continuous quality score of .59% can be generated by an increase in the average reputation of a school by .37 (reputation is the average score (between 1 and 5) given by presidents, provosts, and deans of universities). Similar calculations can be made using the estimates in Table 11 which illustrate how the 0.59% difference in continuous quality score can be driven by other factors that are used in the rankings process.

Conclusion. Overall, the results from this analysis suggest that USNWR rankings of hospitals and colleges have had a significant impact on consumer decisions. The estimates that are provided in this analysis may prove useful to both hospital and college administrators as well as researcher interested in these markets (e.g. anti-trust regulators).

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Figure 1.

GYNECOLOGY.

Gynecology, derived from the Greek for woman, has a wide-ranging focus. Gynecologists deal with infertility and menopause-related problems, sexually transmitted diseases and cancers of the reproductive tract. Usually intertwined with obstetrics, top gynecology departments can draw from a variety of subspecialists.

EXCLUSIVE 1993 RANKINGS

REGION KEY: Northeast South West Midwest

Rank	Hospital	Overall score	Reputational score	Mortality rate	Residents to beds	Technology score	R.N.'s to beds	Board-certified M.D.'s to beds	Inpatient operations to beds
1	**Mayo Clinic,** Rochester, Minn.	100.0	20.6%	0.65	NA	16	0.86	1.40	21.9
2	**Johns Hopkins Hospital,** Baltimore	96.8	19.7%	0.76	0.44	16	1.28	0.97	14.7
3	**University of Texas (M. D. Anderson Cancer Center),** Houston	93.4	18.9%	0.77	0.21	11	1.92	0.55	12.2
4	**Brigham and Women's Hospital,** Boston	86.0	16.1%	0.74	0.62	17	0.77	1.20	20.1
5	**Memorial Sloan-Kettering Cancer Center,** New York	69.7	11.4%	0.71	0.32	10	1.29	0.52	17.9
6	**Duke University Medical Center,** Durham, N.C.	67.8	11.0%	0.85	0.38	19	1.37	0.59	13.6
7	**UCLA Medical Center,** Los Angeles	64.1	7.5%	0.78	1.29	17	1.61	1.64	16.8
8	**Massachusetts General Hospital,** Boston	63.6	9.0%	0.78	0.47	19	1.20	1.06	19.3
9	**Cleveland Clinic**	59.3	7.7%	0.75	0.50	14	1.44	0.36	20.4
10	**Los Angeles County–USC Medical Center**	58.1	9.3%	0.94	0.03	13	1.18	0.14	31.1
11	**University of Chicago Hospitals**	57.6	7.3%	0.90	0.77	17	1.53	0.74	17.5
12	**Columbia-Presbyterian Medical Center,** New York	51.5	6.0%	0.75	0.30	16	1.01	0.63	7.6
13	**Hospital of the University of Pennsylvania,** Philadelphia	49.0	4.2%	0.83	1.06	15	1.18	0.94	15.0
14	**University of Washington Medical Center,** Seattle	47.6	3.5%	0.74	0.31	15	1.88	1.86	15.0
15	**Yale–New Haven Hospital,** New Haven, Conn.	47.2	5.4%	0.96	0.43	13	1.22	1.23	12.9
16	**Parkland Memorial Hospital,** Dallas	46.4	6.0%	1.24	0.72	13	0.93	1.16	10.9
17	**Roswell Park Cancer Institute,** Buffalo	45.7	2.4%	0.63	0.30	10	1.69	0.39	30.8
18	**University of California, San Francisco Medical Center**	45.7	2.8%	0.76	0.32	17	1.85	1.59	19.0
19	**Northwestern Memorial Hospital,** Chicago	45.2	4.7%	0.93	0.40	14	1.16	1.00	14.6
20	**Stanford University Hospital,** Stanford, Calif.	45.2	4.4%	0.94	0.72	14	0.85	1.56	15.8
21	**New York Hospital–Cornell Medical Center,** New York	44.4	3.5%	0.72	0.36	15	0.88	0.95	11.0
22	**University of Virginia Medical Center,** Charlottesville	43.3	2.4%	0.85	0.78	17	1.70	0.44	16.4
23	**Beth Israel Hospital,** Boston	42.7	3.4%	0.75	0.01	13	1.36	0.83	14.1
24	**Thomas Jefferson University Hospital,** Philadelphia	42.0	1.0%	0.68	0.71	17	1.41	1.11	16.5
25	**University of North Carolina Hospitals,** Chapel Hill	41.9	2.7%	0.93	0.55	15	1.78	0.91	15.0
26	**New England Medical Center,** Boston	41.8	1.7%	0.75	0.58	13	1.66	1.70	15.9
27	**Mount Sinai Medical Center,** New York	41.6	2.0%	0.78	0.52	16	1.58	1.18	12.8
28	**Barnes Hospital,** St. Louis	41.5	3.6%	0.74	0.41	5	0.79	0.85	11.2
29	**Georgetown University Hospital,** Washington, D.C.	40.9	1.8%	0.76	0.34	15	1.60	1.29	16.3
30	**Cedars-Sinai Medical Center,** Los Angeles	40.3	2.9%	0.83	0.24	15	0.99	1.13	17.7
31	**Baylor University Medical Center,** Dallas	39.9	3.4%	0.94	0.14	14	1.23	0.49	18.7
32	**University of Miami Hospital and Clinics**	39.6	1.5%	0.64	0.00	4	0.93	5.92	9.3
33	**Indiana University Medical Center,** Indianapolis	39.4	0.0%	0.64	0.37	17	1.82	0.90	17.6
34	**University of Wisconsin Hospital and Clinics,** Madison	39.3	0.5%	0.68	0.65	16	1.25	0.67	18.2
35	**University of California, Irvine Medical Center,** Orange	38.6	2.8%	1.04	NA	15	1.97	1.73	11.6
36	**New York University Medical Center,** New York	38.4	1.0%	0.64	0.20	12	1.15	1.15	13.6
37	**University of California, Davis Medical Center,** Sacramento	38.2	0.5%	0.94	0.63	18	2.59	0.60	16.1
38	**Rush-Presbyterian–St. Luke's Medical Center,** Chicago	38.1	1.0%	0.75	0.61	16	1.18	0.84	13.4
39	**University of Utah Hospital,** Salt Lake City	37.9	2.3%	1.00	0.37	15	1.60	0.91	13.3
40	**University of Iowa Hospitals and Clinics,** Iowa City	37.8	1.0%	0.89	0.78	18	1.31	0.49	24.6
41	**University of California, San Diego Medical Center**	37.5	0.9%	0.89	0.27	17	2.66	0.91	18.7
42	**Presbyterian University Hospital,** Pittsburgh	37.4	0.5%	0.83	0.66	11	2.12	1.20	17.7

"Reputational score" is the percentage of doctors surveyed who named the hospital. "Mortality rate" is the ratio of actual to expected deaths (lower is better). "Residents to beds" is the ratio of interns and residents to beds. "Technology score" is an index from 0 to 19. "R.N.'s to beds" is the ratio of registered nurses to beds. "Board-certified M.D.'s to beds" is the ratio of doctors certified in a specialty to beds. "Inpatient operations to beds" is the ratio of annual inpatient operations to beds. NA = Not available.

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Table 1. Hospital Data By State, Year, and Specialty

State	Observations	Data Year	Observations	Specialty	Observations
Arizona	2	1994	29	Cancer	58
California	212	1995	16	Digestive	79
Colorado	8	1996	22	Gynocology	19
Connecticut	7	1997	36	Heart	67
Florida	1	1998	60	Neuro	70
Illinois	53	1999	64	Ortho	66
Iowa	30	2000	59	Respiratory	32
Maryland	47	2001	49	Urology	55
Massachussetts	26	2002	51		
New York	10	2003	30		
Pennsylvania	16	2004	30		
Virginia	1				
Washington	8				
Wisconsin	25				
Total	446		446		446

Notes: Data are from the NIS sample created by the HCUP and from the state of California's OSHPD office. Observations are at the hospital-specialty-year level. Observations are included for hospital-specialties that have a non-missing, overall rank (lagged).

Table 2. Summary Statistics - Hospital Data

	Mean	Standard Deviation	Minimum	Maximum
Total Medicare Patients Within a Specialty	342	308	26	1,942
Non-Emergency	120	104	10	1,334
Emergency	222	257	10	1,709
Total Medicare Patients By Specialty				
Cancer	122	53	26	342
Digestive	422	232	88	1,019
Gynocology	92	26	42	133
Heart	741	470	147	1,942
Neurology	321	134	69	671
Orthopedics	277	203	26	1,401
Respiratory	380	219	135	946
Urology	142	65	44	280
Observations	446	446	446	446

Notes: Observations are at the hospital-specialty-year level. The data represent patient counts for the first and second quarters of the observation years. Observations are included for hospital-specialties that have a non-missing, overall rank (lagged).

Table 3. Summary Statistics - College Data

	Mean	Standard Deviation	Minimum	Maximum	Observations
Undergraduate					
Research Schools					
Acceptance Rate	38.8	18.2	9	84	628
SAT Scores	1331.5	86.0	1105	1525	596
Liberal Arts Schools					
Acceptance Rate	42.7	13.5	18	78	560
SAT Scores	1305.8	66.2	1105	1470	546
Graduate					
Law Schools					
Acceptance Rate	24.2	9.0	5.6	55.9	563
LSAT Scores	163.3	3.6	155.5	173	590
Business Schools					
Acceptance Rate	28.9	11.8	6.6	74	548
GMAT Scores	652.4	29.9	570	730	592
Medical Schools					
Acceptance Rate	7.8	4.2	2.1	29.7	425
MCAT Scores	10.8	0.5	9.5	12.3	445
Engineering Schools					
Acceptance Rate	30.4	12.4	8.6	75.2	607
GRE Scores (Quant.)	754.0	15.8	678	791	426

Notes: Observations are at the college-year level. Observations are included for college-years that have a non-missing, overall rank (lagged). Acceptance rate and test score data are taken from US News and World Report's Best Colleges and Best Graduate Schools issues between 1990 and 2006.

Table 4. The Effect of USNWR Hospital Rankings on Patient Volume

	Dependent Variable: Log Number of Medicare Discharges by Type							
	Non-Emergency Patients				Emergency Patients			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Overall Rank (Lagged)	0.0088		0.0084	0.0101	-0.0034		-0.0029	-0.0024
	(.0027)***		(.0029)***	(.0034)***	(.0036)		(.0036)	(.0036)
Cont. Quality Score		0.144	0.054			-0.106	-0.075	
		(.100)	(.102)			(.114)	(.108)	
Cont. Quality Score (Cubic)				X				X
Hospital-Specialty F.E.	X	X	X	X	X	X	X	X
Year F.E.	X	X	X	X	X	X	X	X
R-Squared	0.895	0.891	0.894	0.894	0.950	0.950	0.950	0.950
Observations	446	446	446	446	446	446	446	446

Notes: Observations are at the hospital-specialty-year level. The dependent variable is the log number of non-emergency Medicare patients (Columns (1)-(4)) or emergency patients (Columns (5)-(8)) that were admitted between Jan. and Jun. of the observation year. Overall Rank (Lagged) represents the rank that the hospital-specialty received the July or August before the Jan. - Jun. data. Hospital-specialty and year fixed effects are included. The overall rank variable was inverted such that an increase in overall rank by one should be interpreted as an improvement in rank (e.g. 8^{th} to 7^{th}).

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5. The Effect of USNWR Hospital Rankings on Total Revenue

	Dependent Variable: Log Total Revenue Generated from Medicare Patients by Type							
	Non-Emergency Patients				Emergency Patients			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Overall Rank (Lagged)	0.0105		0.0100	0.0120	0.0015		0.0024	0.0030
	(.0031)***		(.0032)***	(.0036)***	(.0035)		(.0035)	(.0037)
Cont. Quality Score		0.177	0.069			-0.103	-0.129	
		(.106)*	(.107)			(.125)	(.126)	
Cont. Quality Score (Cubic)				X				X
Hospital-Specialty F.E.	X	X	X	X	X	X	X	X
Year F.E.	X	X	X	X	X	X	X	X
R-Squared	0.940	0.937	0.940	0.940	0.954	0.955	0.955	0.954
Observations	446	446	446	446	446	446	446	446

Notes: Observations are at the hospital-specialty-year level. The dependent variable is the log total revenue generated from non-emergency Medicare patients (Columns (1)-(4)) or emergency patients (Columns (5)-(8)) that were admitted between Jan. and Jun. of the observation year. Overall Rank (Lagged) represents the rank that the hospital-specialty received the July or August before the Jan. - Jun. data. Hospital-specialty and year fixed effects are included. The overall rank variable was inverted such that an increase in overall rank by one should be interpreted as an improvement in rank (e.g. 8^{th} to 7^{th}).
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6. The Effect of USNWR Hospital Rankings on Non-emergency Medicare Patient Discharges - by Specialty

	Dependent Variable: Log Number of Non-emergency Medicare Patient Discharges by Specialty						
	Cancer	**Digestive**	**Heart**	**Neurology**	**Orthopedics**	**Respiratory**	**Urology**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Overall Rank (Lagged)	0.0121	0.0040	0.0020	0.0091	0.0095	-0.0196	0.0157
	(.0072)	(.0077)	(.0133)	(.0045)*	(.0101)	(.0278)	(.0123)
Cont. Quality Score (Cubic)	X	X	X	X	X	X	X
Hospital_Specialty F.E.	X	X	X	X	X	X	X
Year F.E.	X	X	X	X	X	X	X
R-Squared	0.704	0.888	0.898	0.971	0.940	0.966	0.708
Observations	58	79	67	70	66	32	55

Notes: Observations are at the hospital-specialty-year level. The dependent variable is the log number of non-emergency Medicare patients that were admitted between Jan. and Jun. of the observation year. Overall Rank (Lagged) represents the rank that the hospital-specialty received the July or August before the Jan. - Jun. data. Hospital-specialty and year fixed effects are included. The overall rank variable was inverted such that an increase in overall rank by one should be interpreted as an improvement in rank (e.g. 8^{th} to 7^{th}).
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7. Conditional and Mixed Logit Estimates of Hospital Choice

	Conditional Logit	Mixed Logit		Conditional Logit
		Mean	Stand. Dev.	Stand. Dev.
	(1)	(2)	(3)	(4)
Overall Rank (Lagged)	0.0125	0.0118	0.0054	0.0028
	(.0063)**	(.0068)*	(.0041)	(.0064)
Overall Rank X (Less Than 10 Miles)				.0303
				(.0032)***
Distance				
Less Than 3 Miles	12.339	12.620	2.097	12.384
	(.088)***	(.097)***	(.090)***	(.089)***
3 to 6 Miles	11.337	11.491	1.417	11.382
	(.088)***	(.092)***	(.065)***	(.088)***
6 to 10 Miles	10.057	10.209	0.707	10.104
	(.088)***	(.091)***	(.076)***	(.088)***
10 to 20 Miles	8.4715	8.596	0.222	8.495
	(.086)***	(.088)***	(.075)***	(.086)***
20 to 50 Miles	6.4685	6.483	0.635	6.492
	(.084)***	(.085)***	(.079)***	(.084)***
50 to 100 Miles	3.4834	3.479	0.244	3.503
	(.075)***	(.077)***	(.131)*	(.075)***
Cont. Quality Score (Cubic)	X	X	X	X
Alternative-Specific Constants	X	X	X	X
Log Likelihood	-58,967	-58,732	-58,732	-58,921
# of Individuals	28,647	28,647	28,647	28,647
# of Observations	4,698,108	4,698,108	4,698,108	4,698,108

Notes: Each observation represents a unique patient-hospital pair. The observations represent all patient-hospital pairs from a 25% random sample of all Medicare, non-emergency, heart patients admitted between January and June between 1998 and 2004 to hospitals that treated at least 10 non-emergency patients. Columns (1) and (4) present results from a conditional logit model and Columns (2) and (3) present results from a mixed-logit model. The dependent variable is an indicator that equals 1 if the patient chose the hospital represented in that patient-hospital pair. Overall Rank (Lagged) represents the rank that the hospital-specialty received the July or August before the Jan. - Jun. data. The base group for the distance indicators is the hospital being located more than 100 miles from the individual's home. An alternative-specific constant was included for each hospital. The overall rank variable was inverted such that an increase in overall rank by one should be interpreted as an improvement in rank (e.g. 8^{th} to 7^{th}).
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 8. The Effect of USNWR College Rankings on Admission Outcomes - Without Continuous Quality Controls

	Undergrad-Research		Undergrad-Liberal		Law		Business		Medicine		Engineering	
	Acceptance	SAT	Acceptance	SAT	Acceptance	LSAT	Acceptance	GMAT	Acceptance	MCAT	Acceptance	GRE (Quant)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log Overall Rank (Lagged)	-3.09	8.66	-1.39	9.74	-2.66	1.18	-2.54	5.62	-0.40	0.26	1.36	-4.87
	(.84)***	(2.73)***	(.82)*	(3.74)***	(.84)***	(.24)***	(1.05)**	(2.34)*	(.51)	(.06)***	(1.39)	(2.58)*
College F.E.	X	X	X	X	X	X	X	X	X	X	X	X
Year F.E.	X	X	X	X	X	X	X	X	X	X	X	X
R-Squared	0.924	0.970	0.883	0.937	0.889	0.952	0.814	0.922	0.799	0.867	0.738	0.669
Observations	628	596	560	546	563	590	548	592	425	445	607	426

Notes: Observations are at the college-year level. The dependent variable is either the acceptance rate (%) or the average test score of incoming students. Overall Rank (Lagged) represents the rank that the hospital-specialty received the year prior to the data. College and year fixed effects are included. The overall rank variable was inverted such that an increase in overall rank by one should be interpreted as an improvement in rank (e.g. 8^{th} to 7^{th}).
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 9. The Effect of USNWR College Rankings on Admission Outcomes - With Continuous Quality Controls

	Undergrad-Research		Undergrad-Liberal		Law		Business		Medicine		Engineering	
	Acceptance	SAT	Acceptance	SAT	Acceptance	LSAT	Acceptance	GMAT	Acceptance	MCAT	Acceptance	GRE (Quant)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log Overall Rank (Lagged)	-3.57	10.66	-2.65	8.76	-3.20	1.33	-1.62	4.70	0.01	0.13	0.03	-3.48
	(.84)***	(2.80)***	(1.15)**	(4.57)*	(.946)***	(.297)***	(.988)	(2.53)*	(.54)	(.07)*	(1.34)	(2.68)
College F.E.	X	X	X	X	X	X	X	X	X	X	X	X
Year F.E.	X	X	X	X	X	X	X	X	X	X	X	X
Cont. Quality Score (Cubic)	X	X	X	X	X	X	X	X	X	X	X	X
R-Squared	0.925	0.970	0.884	0.938	0.895	0.953	0.817	0.924	0.801	0.874	0.753	0.671
Observations	628	596	560	546	563	590	548	592	425	445	607	426

Notes: Observations are at the college-year level. The dependent variable is either the acceptance rate (%) or the average test score of incoming students. Overall Rank (Lagged) represents the rank that the hospital-specialty received the year prior to the data. College and year fixed effects are included. The overall rank variable was inverted such that an increase in overall rank by one should be interpreted as an improvement in rank (e.g. 8^{th} to 7^{th}).
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 10. Estimating the Components of the Continuous Quality Score - Hospitals

	Dependent Variable: Continuous Quality Score (%)		
	(1)	(2)	(3)
Reputation (%)	1.17	1.16	
	(.01)***	(.01)***	
Risk-Adjusted Mortality Rate	-6.10		2.64
	(.81)***		(3.93)
R-Squared	0.959	0.952	0.001
Observations	350	350	350

Notes: Observations are at the hospital-specialty level. The dependent variable is the continuous quality score (%) reported in the US News and World Report's Best Hospitals issue in 2000. Data for reputation and risk-adjusted mortality rates were also taken from the magazine issue.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 11. Estimating the Components of the Continuous Quality Score - Undgraduate Research Universities

	Dependent Variable: Continuous Quality Score (%)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Reputation (%)	0.951	1.605							
	(.123)***	(.158)***							
Freshman Retention (%)	0.261		1.712						
	(.187)		(.211)***						
5-Year Graduation Rate (%)	0.306			.858					
	(.084)***			(.090)***					
Student-Faculty Ratio	-0.228				-1.26				
	(.124)*				(.248)***				
Classes Under 20 Students (%)	0.171					.412			
	(.037)***					(.089)***			
Classes Over 50 Students (%)	0						-.299		
	(.082)						(.202)		
Average SAT	-0.002							.081	
	(.008)							(.008)***	
Alumni-Giving Rate (%)	0.035								.425
	(.042)								(.087)***
R-Squared	0.953	0.695	0.593	0.67	0.365	0.324	0.047	0.698	0.347
Observations	47	47	47	47	47	47	47	47	47

Notes: Observations are at the college level. The dependent variable is the continuous quality score (%) reported in the US News and World Report's Best Colleges issue in 2000. Data for reputation and other ranking factors were also taken from the magazine issue.
* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix Table 1. The Effect of USNWR Hospital Rankings on Patient Volume and Total Revenue - Alternative Specifications

	Dependent Variable: Log Patient Volume or Total Revenue Generated from Non-Emergency Medicare Patients by Type									
	Log Patient Volume					Log Total Revenue				
	Medicare	Medicare	Medicare	Insurance	Medicaid	Medicare	Medicare	Medicare	Insurance	Medicaid
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Overall Rank (Lagged)	0.0095	0.0097		0.0044	0.0062	0.0109	0.0131		0.0054	0.0071
	[.0030]***	[.0032]***		[.0037]	[.0042]	[.0033]***	[.0039]***		[.0050]	[.0061]
State Rank (Lagged)		0.024					0.002			
		[.032]					[.037]			
Log(Overall Rank) (Lagged)			0.228					0.292		
			[.071]***					[.092]***		
Cont. Quality Score (Cubic)	X	X	X	X	X	X	X	X	X	X
Including 3rd Quarter	X					X				
Hospital-Specialty F.E.	X	X	X	X	X	X	X	X	X	X
Year F.E.	X	X	X	X	X	X	X	X	X	X
R-Squared	0.909	0.896	0.895	0.948	0.875	0.947	0.941	0.941	0.954	0.902
Observations	446	446	446	446	444	446	446	446	446	444

Notes: Observations are at the hospital-specialty-year level. The dependent variable is the log number of non-emergency patients (Columns (1)-(5)) or the log total revenue generated from non-emergency patients (Columns (6)-(10)) that were admitted between Jan. and Jun. of the observation year. Columns (1)-(3) and (6)-(8) use data from only Medicare patients. Columns (4) and (9) use data from patients with private insurance. Columns (5) and (10) use data from patients on Medicaid. Overall Rank (Lagged) represents the rank that the hospital-specialty received the July or August before the Jan. - Jun. data. Columns (1) and (6) include data from for each year between Jan. and Sept. of each year. Hospital-specialty and year fixed effects are included. The overall rank, log(overall rank), and state rank variables were inverted such that an increase in the rank by one should be interpreted as an improvement in rank (e.g. 8^{th} to 7^{th}).
* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix Table 2. The Effect of USNWR Hospital Rankings on Patient Volume and Total Revenue with More Detailed Controls for the Continuous Quality Scores

	Dependent Variable: Log Patient Volume or Total Revenue Generated from Non-Emergency Medicare Patients									
	Log Patient Volume					Log Total Revenue				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Overall Rank (Lagged)	0.0110	0.0271	0.0062	0.0061	0.0194	0.0141	0.0140	0.0078	0.0038	0.0127
	(.0035)***	(.0172)	(.0041)	(.0051)	(.0192)	(.0037)***	(.0188)	(.0044)*	(.0054)	(.0214)
Cont. Quality Score (Cubic) X Specialties	X					X				
Cont. Quality Score (Cubic) X Specialties X Years		X					X			
Stand. Dev. Score (Cubic)			X					X		
Stand. Dev. Score (Cubic) X Specialties				X					X	
Stand. Dev. Score (Cubic) X Specialties X Years					X					X
Hospital-Specialty F.E.	X	X	X	X	X	X	X	X	X	X
Year F.E.	X	X	X	X	X	X	X	X	X	X
R-Squared	0.897	0.933	0.894	0.896	0.921	0.941	0.960	0.940	0.943	0.952
Observations	446	446	446	446	446	446	446	446	446	446

Notes: Observations are at the hospital-specialty-year level. The dependent variable is the log number of non-emergency Medicare patients (Columns (1)-(5) or the log total revenue generated from non-emergency Medicare patients (Columns (6)-(10)) that were admitted between Jan. and Jun. of the observation year. Overall Rank (Lagged) represents the rank that the hospital-specialty received the July or August before the Jan. - Jun. data. Hospital-specialty and year fixed effects are included. For Columns (1) and (6) the cubic of the continuous quality score was included separately for each specialty. For Columns (1) and (6) the cubic of the continuous quality score was included separately for each specialty-year. For Columns (3)-(5) and (8)-(10), the continuous quality score for each school was converted into a score representing its standard deviation from the mean. A cubic of this score (also included separately for each specialty and specialty-year) was controlled for in these regressions. The overall rank variable was inverted such that an increase in overall rank by one should be interpreted as an improvement in rank (e.g. 8^{th} to 7^{th}).

* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix Table 3. The Effect of USNWR College Rankings on Admissions Outcomes - With Standard Deviation Continuous Quality Score Controls

	Undergrad-Research		Undergrad-Liberal		Law		Business		Medicine		Engineering	
	Acceptance	SAT	Acceptance	SAT	Acceptance	LSAT	Acceptance	GMAT	Acceptance	MCAT	Acceptance	GRE (Quant)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log Overall Rank (Lagged)	0.02	2.25	-2.65	8.62	-1.57	1.18	0.52	3.45	-0.42	0.18	5.21	-9.01
	(1.26)	(4.00)	(1.19)**	(5.61)	(1.16)	(.35)***	(1.25)	(3.16)	(.63)	(.09)*	(2.00)***	(4.16)**
College F.E.	X	X	X	X	X	X	X	X	X	X	X	X
Year F.E.	X	X	X	X	X	X	X	X	X	X	X	X
Cont. Quality Score (Cubic) - Standard Deviation	X	X	X	X	X	X	X	X	X	X	X	X
R-Squared	0.926	0.971	0.884	0.938	0.897	0.952	0.818	0.923	0.801	0.869	0.746	0.672
Observations	628	596	560	546	563	590	548	592	425	445	607	426

Notes: Observations are at the college-year level. The dependent variable is either the acceptance rate (%) or the average test score of incoming students. Overall Rank (Lagged) represents the rank that the hospital-specialty received the year prior to the data. College and year fixed effects are included. The continuous quality score for each school was converted into a score representing its standard deviation from the mean. A cubic of this score was controlled for in the regressions. Te overall rank variable was inverted such that an increase in overall rank by one should be interpreted as an improvement in rank (e.g. 8^{th} to 7^{th}).

* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix Table 4. The Effect of USNWR College Rankings on Admissions Outcomes - With Year X Continuous Quality Score Controls

	Undergrad-Research		Undergrad-Liberal		Law		Business		Medicine		Engineering	
	Acceptance	SAT	Acceptance	SAT	Acceptance	LSAT	Acceptance	GMAT	Acceptance	MCAT	Acceptance	GRE (Quant)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log Overall Rank (Lagged)	-0.64	7.07	-1.89	5.35	-0.88	0.46	1.45	-2.87	2.16	0.02	-1.26	-2.38
	(1.42)	(5.00)	(1.36)	(6.83)	(1.38)	(.48)	(1.37)	(4.03)	(1.15)*	(.15)	(2.45)	(5.92)
College F.E.	X	X	X	X	X	X	X	X	X	X	X	X
Year F.E.	X	X	X	X	X	X	X	X	X	X	X	X
Cont. Quality Score (Cubic) X Year	X	X	X	X	X	X	X	X	X	X	X	X
R-Squared	0.931	0.974	0.899	0.946	0.914	0.956	0.832	0.931	0.824	0.891	0.770	0.688
Observations	628	596	560	546	563	590	548	592	425	445	607	426

Notes: Observations are at the college-year level. The dependent variable is either the acceptance rate (%) or the average test score of incoming students. Overall Rank (Lagged) represents the rank that the hospital-specialty received the year prior to the data. College and year fixed effects are included. The cubic of the continuous quality score was included separately for each year in the regressions. The overall rank variable was inverted such that an increase in overall rank by one should be interpreted as an improvement in rank (e.g. 8^{th} to 7^{th}).
* significant at 10%; ** significant at 5%; *** significant at 1%