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COMPETITION, PAYERS, AND HOSPITAL QUALITY

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ABSTRACT

The objective of this study is to estimate the effects of competition for both Medicare and HMO patients on the quality decisions of hospitals in Southern California. We use discharge data from the State of California for the period 1989-1993. The outcome variables are the risk-adjusted hospital mortality rates for pneumonia (estimated by the authors) and acute myocardial infarction (reported by the state of California). Measures of competition are constructed for each hospital and payer type. The competition measures are formulated to mitigate the possibility of endogeneity bias. The study finds that increases in the degree of competition for HMO patients decrease risk-adjusted hospital mortality rates. Conversely, increases in competition for Medicare enrollees are associated with increases in risk-adjusted mortality rates for hospitals. In conjunction with previous research, the estimates indicate that increasing competition for HMO patients appears to reduce prices and save lives and hence appears to improve welfare. However, increases in competition for Medicare appear to reduce quality and may reduce welfare. Increasing competition has little net effect on hospital quality for our sample.

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Introduction

Two types of insurers dominate the U.S. health care economy: the federal and state governments, through the Medicare and Medicaid programs, and privately purchased managed care or HMOs. These insurance systems reimburse health care providers differently, which gives providers different and potentially offsetting incentives to deliver quality care. Some argue that in a managed care environment competition will provide the appropriate incentives for health care insurers and providers to deliver the optimum level of care at prices that approach marginal cost (Enthoven (1993)). In contrast, hospitals will have different incentives to provide quality care to Medicare patients since they have little control over the reimbursement rates they receive from Medicare.[2] There is substantial evidence that since the rise of managed care, increasing competition in hospital markets has led to lower prices.[3] Insofar as hospital quality is determined by hospital investments, the incentives for hospitals to make these investments will depend, at least in part, on the return they receive for increasing hospital quality. That return will be a function of the competitive environment and the mechanisms of reimbursement. This line of reasoning suggests that competition for Medicare and HMO patients may have differing impacts on hospital quality, and any analysis of the impact of competition on hospital quality should attempt to account for this possibility.

In this paper we seek to estimate the effects of competition for both Medicare and HMO patients on the quality outcomes of hospitals in Southern California. We examine

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[2] See McClellan (1997) for a discussion of cost sharing under prospective payment and the ability of hospitals to affect the level of reimbursement for Medicare patients.

[3] For recent surveys of the relationship between hospital prices and competition see Gaynor and Vogt (2000) and Dranove and Satterthwaithe (2000).

two diagnoses, pneumonia and acute myocardial infarction (AMI), in order to verify the robustness of any findings. Our basic method of analysis is simple: we regress quality of care on levels of competition. However, we address a number of issues that complicate such an analysis. First, standard measures of competition are likely to be endogenous. This is because high unobserved quality for one hospital is likely to lead it to have a high market share and hence lead to a less competitive market. To address this issue, we develop measures of competition based on patient flows predicted using only exogenous characteristics.[4] Second, we account for competition for both HMO and Medicare patients by measuring quality as a function of the level of competition for each payer type multiplied by the predicted number of patients of that payer type. Third, hospital quality is notoriously difficult to measure. We address this issue separately for our two diagnoses. For pneumonia, we use quality measures that we developed in a previous work. As patient severity of illness is likely an important determinant of hospital mortality for pneumonia, our measures control for observed and unobserved severity of illness with an instrumental variables type of identification.[5] For AMI, where the urgency of care limits the choice of hospital and thus likely makes unobserved severity of illness quantitatively less important, we use publicly available quality measures that control for observed severity of illness.[6] For our estimation, we focus on a single geographic area, Los Angeles County, and pool data from a four-year period. Thus, the identification of our parameters will come from examining how variations in competition and patient types across different parts of the area are related to hospital quality.

[4] We follow Kessler and McClellan (2000) in using this technique.
[5] See Geweke, Gowrisankaran, and Town (2001).
[6] These measures are provided by Luft and Romano (1997).

In contrast to the large body of work on the pricing effects of competition, the literature on the effect of hospital competition on medical outcomes is relatively sparse. Shortell and Hughes (1988), Ho and Hamilton (2000), and Mukamel, Zwanziger, and Tomaszewski (2001) find no significant effect between hospital competition and quality. In contrast, Kessler and McClellan (2000) find that increases in competition increased patient mortality from 1986-1989, but decreased patient mortality from 1991-1994. Additionally, they find that competition unambiguously reduced mortality only in states with above-median HMO penetration. Propper, Burgess, and Green (2002) find that increased competition between hospitals in Britain's National Health Service reduced mortality rates for AMI. Our analysis is most similar to the Kessler and McClellan study. However, our work differs from theirs in several important ways as we examine the effects of competition for patients with different types of insurance, and over two very different diseases. Perhaps most importantly, our findings imply different relationships between competition and hospital quality.

Competition and Payers: Why Competition for Different Types of Patients May Impact Quality of Care

In this article we examine the relationship between competition for patients with differing insurance arrangements and hospital quality. It is reasonable to ask why competition over different payer classes may have a different impact on hospital quality. There are two key assumptions that, if met, will imply that competition for different payer types will impact the optimal, profit-maximizing hospital quality. The first assumption is that patients (or their agent physicians) directly or indirectly through their insurance choice select hospitals, at least in part, on the basis of perceived quality. The second assumption is that the hospital cannot choose to offer different quality levels to patients based on their insurance type. If these conditions hold and if increasing quality is costly, then hospitals will have an incentive to adjust their quality for all patients in response to changes in their competitive environments.

For example, consider two hospitals, A and B. Suppose hospital A faces substantial competition for Medicare patients, while hospital B does not. Hospitals, in general, cannot affect their Medicare payment level. If Medicare reimburses hospitals below some threshold at which it is undesirable for them to attract Medicare patients, the hospital will have an incentive to reduce overall quality to shed patients.[7] The ability of the hospital to shed patients will depend on the options these patients face. Because patients at hospital A have more choices, it will be easier for hospital A to shed patients by reducing quality than for hospital B. Thus, if Medicare marginal payments are below the threshold, then, all else being equal, A will have an incentive to have lower quality than B. Conversely, if Medicare pays above the threshold, then A will have an incentive to have higher quality than B.

Theoretically, the impact of competition on quality for patients enrolled in managed care plans is less clear. Different economic models yield differing predictions on the relationship between competition and price because they incorporate different underlying assumptions.[8] As it is very difficult to determine which assumptions are likely to be empirically correct, we have no clear guidance on the directional impact of increased hospital competition on hospital quality. Furthermore, the institutional differences between hospital competition for HMO patients and the generic economic model of

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[7] It is important to note that this threshold is not necessarily marginal cost. Ultimately, the threshold will depend on the nature of the entire cost relationship and elasticities of demand of the different payer groups.
[8] See Shaked and Sutton (1983), Motta (1993), Moorthy (1988), and Spence (1975).

oligopoly competition makes it difficult to map these theories into our analysis. The theoretical difficulty is that decreasing competition puts direct upward pressure on prices and direct downward pressure on quality. However, the direct price effect leads to an indirect quality impact that works in the opposite direction of the direct quality effect—the higher the margins are per patient the greater the incentive to increase quality. While the theoretical models provide little guidance, our view is that most economists would predict that increases in competition for HMO patients would likely increase hospital quality.

Importantly, the incentive to increase quality may also vary by diagnostic and procedure category. The margins on Medicare payments vary considerably across DRGs (McClellan 1997), and the profitability of treating a given diagnosis varies across payers (Chernew, Gowrisankaran, and Fendrick 2002). Hospital reputations differ across different disease or condition classes, which provides evidence that they can affect the quality of care in one specific area. Hospitals that are even modestly approaching profit-maximizing decisions for pricing and input choices must pay close attention to the net revenues for high revenue health conditions such as pneumonia and cardiac conditions. The span of the impact across different conditions of many of these investments is limited. For example, opening or expanding a cardiac catheterization lab may well impact the treatment of AMI but will not likely directly impact pneumonia care. Lastly, the elasticity of demand is likely to vary across different conditions–for instance, we would expect that AMI patients will have much less elastic demand than pneumonia patients due to the urgency of treatment–which implies that the same payment margin will have different effects across different conditions.

If a hospital were to face a change in competitive conditions (e.g., a change in Medicare payment policy) for a high revenue health condition the hospital could respond by making disease–specific investments. Those investments could include recruiting highly respected physicians, opening specialty treatment centers (e.g., catheterization labs, critical care units), and constructing information technology infrastructures (e.g., electronic medical records integrated with physician practice records systems).

In this paper we focus on the relationship between competition and hospital quality for two diagnoses: AMI and pneumonia. In general, pneumonia patients can have discretion over the hospital to which they are admitted. Differences of an hour in transportation time between hospitals will not likely directly impact the patient's prognosis. Thus, our measures of competition for pneumonia should map directly into capturing the competitive environment for this disease. However, this is not true for AMI. A delay of several minutes in treatment can have a substantial impact on the patient's outcome.

Since patients have less discretion in selecting their hospital when they suffer an AMI, it is reasonable to ask: What are the competitive forces at work that affect hospitals' incentives to provide quality care for AMI? We believe there are at least two forces at play. First, while hospitals may not compete directly for AMI patients, they do compete to be part of an HMO's network and, insofar as quality of care impacts the HMO's decision to include the hospital in the network, it will affect the hospital's incentive to provide quality care. Chernew, Scanlon, and Hayward (1998) find that HMO enrollees are more likely to be admitted to better hospitals for coronary artery bypass graft (CABG). Second, the quality of care for AMI is likely positively correlated with quality of care for other heart procedures and diagnoses, and for most of these diagnoses patients do have discretion over the choice of hospital. For example, the successful treatment of AMI requires mastery of a menu of procedures and treatments (e.g., CABG, angioplasty). These procedures are often performed without the presence of AMI when patients have the luxury of selecting a hospital based on characteristics other than their proximity to the institution.

Methodology

The purpose of this paper is to estimate the relationship between hospital quality and competition for different payer types. To do this, we need to formulate a measure of competition for each payer group. Besides controlling for payer groups, we have two other broad concerns in measuring the level of competition. Traditionally, measures of competition are formulated using a two-step method. The first step defines the extent of the geographic and product market. In studying hospital competition, this is generally done by defining the geographic markets (e.g., counties) in which hospitals compete. The product market usually is a set of inpatient services. The second step involves measuring market shares given the market definition.

Both steps may introduce significant biases to the competition measure. For example, the definition of the geographic market is usually based on geopolitical boundaries (e.g. counties or standardized metropolitan statistical areas (SMSAs)) instead of economic notions of markets and thus is often ad hoc. These ad hoc measures of market concentration could lead to substantial biases. It is also difficult to model the fact that hospitals are geographically dispersed within a given market with substitutability of hospitals varying substantially within the market.

The second problem in formulating measures of competition is that one must construct measures of hospital size. Measures of competition that are based on actual patient flows will be endogenous: high quality hospitals may attract more patients from farther away. Thus, an exogenous increase in the quality of a hospital would cause it to appear to have more market power. This problem will be exacerbated with HMO patients because HMOs typically form hospital networks, where the networks typically include only a subset of the total set of hospitals. For example, consider a region with one HMO and two hospitals. If the HMO negotiates a favorable rate with one hospital and includes it in its network, a Hirschman-Herfindahl Index (HHI) measure of market concentration based on actual HMO patient flows will be extremely high and will underestimate the intensity of the actual hospital competition.

Following Kessler and McClellan (2000) and Town and Vistnes (2001), we compute a measure of competition that is based upon the results of a multinomial logit model of hospital choice. Our specification for the choice model explicitly accounts for geographic and product differentiation but is not based on endogenous hospital variables. This allows us to formulate hospital–specific measures of competition for the different insurance categories that satisfy both of our concerns. In the remainder of this section, we discuss our model of hospital choice and our construction of competition and quality measures.

<u>Model of Hospital Choice</u>

We now detail our exact choice model. We posit that the indirect utility that a patient with diagnosis s receives from being admitted to hospital $j \in J$, conditional on deciding to be admitted to a hospital, is given by

(1) $$u_{ij}^{s} = \lambda_1^s d_{ij} + \lambda_2^s beds_j + \lambda_3^s close_{ij} + \lambda_4^s d_{ij} \times emerg_i + \lambda_5^s close_{ij} \times emerg_i + e_{ij}^{s},$$

where d_{ij} is the distance from the center of the patient's zip code to the center of the hospital's home zip code, $beds_j$ is the number of beds at hospital j, $close_{ij}$ is an indicator variable taking the value of one if the hospital is the closest one to the patient's home zip code and zero otherwise, and $emerg_i$ is an indicator variable taking the value of one if the patient had an emergency admittance and zero otherwise. The error term, e_{ij}^{s}, is iid and captures the effects of unobservable attributes on patient choice. For example, it is possible that the patient's physician plays a role in selecting the hospital, and we do not have any information on the identity of a patient's physician. The error term is assumed to be distributed Type I extreme value. This is the standard conditional multinomial logit framework and the parameters from (1) are estimated via maximum likelihood.

A well-known drawback to the multinomial logit model with independent errors is that it imposes the rather restrictive assumption of independence of irrelevant alternatives (IIA). The IIA implication is particularly troublesome in combination with the assumption of a homogeneous population as it implies that substitution patterns between hospitals are proportional to market shares. Since we are using individual data and there is variation across individuals and hospitals in the explanatory variables and these variables explain a good deal of the actual hospital choices, in our case the unappealing consequences of the IIA assumption are mitigated.

We estimate the parameters of (1) using California patient discharge data. Ideally, the parameters of (1) should be estimated separately for every payer group. The discharge data, however, does not permit that approach. This is because the privately insured patients in our patient-level data are covered by different HMOs, each of which defines a different set of hospitals that its enrollees use. Without knowing the feasible choice set for each HMO patient in the data set, we cannot calculate unbiased estimates for (1). Instead, we estimate (1) using the hospital selection decisions of traditional Medicare enrollees. We use this population because, in general, the price they pay for inpatient services (essentially a small deductible) does not differ by hospital, and they are free to choose any hospital.[9] We then assume the parameter estimates of (1) hold for the HMO population. Previous work (Town and Vistnes (2001)) has tested this assumption by assessing how well this Medicare-based choice model describes hospital choices for a very different patient population, Medicaid enrollees. While Medicaid enrollees' preferences also likely differ from those of other patients, they find the Medicare-based choice model translates quite well to the younger Medicaid population.

Formulating Measures of Market Concentration and the Geographic Dispersion of Patients

We use the estimated parameters of (1) to formulate hospital–specific measures of competition for each type of payer category. For a given hospital choice set *J*, let $\hat{P}_{ij}^{s}$ be the estimated probability that individual *i* with diagnosis *s* will be admitted to hospital *j*. Under the logit assumption, $\hat{P}_{ij}^{s}$ is given by

$$(2) \qquad \hat{P}_{ij}^{s} = \frac{\exp(\hat{u}_{ij}^{s})}{\sum_{k \in J} \exp(\hat{u}_{ik}^{s})},$$

[9] As our data are from the early 1990s, the percentage of Medicare beneficiaries that is enrolled in HMOs is small. We include those patients that were admitted to a Kaiser hospital. However, we have performed the analysis excluding them and the results excluding the Kaiser patients are essentially quantitatively identical to the results throughout this paper.

where $\hat{u}_{ij}^{s}$ is the expected utility of being admitted to hospital j as implied by the parameter estimates of the logit model.

In this framework the Herfindahl index is:

(3) $$HHI_{iz}^{s} = \sum_{j \in J} \left(\hat{P}_{ij}^{s} \right)^2 .$$[10]

HHI_{iz}^{s} measures the degree of competition over each individual. The hospital should care not only about the amount of competition it faces for each payer group but also about the number of potential patients it may attract in each group. That is, we wish to weight HHI_{iz}^{s} by the number of potential patients. For a given patient, the "number of potential patients" is just the probability of admission $\hat{P}_{ij}^{s}$. Our measure of competition for hospital j for patients z and s, which we denote as H_{jz}^{s}, is just the sum of this measure over patients:

(4) $$H_{jz}^{s} = \sum_{i \in I_z^s} \hat{P}_{ij}^{s} \left(HHI_{iz}^{s} \right),$$

where I_z^s is the set of patients with diagnoses s with insurance z. H_{jz}^{s} is, in essence, the weighted sum of the estimated, patient-level HHI. Note that, H_{jz}^{s} will capture both the effects of competition and number of patients.

We formulate (4) for five different payer groups for each diagnosis. The five groups are Medicare enrollees (MED), HMO enrollees (HMO), self-pay and indigent patients (IND), traditional indemnity insurance enrollees (IDM), and enrollees in California's Medicaid program, MediCal (MCD). The effects of competition for these

[10] The actual HHI that we use is somewhat different as there is cross-ownership across hospitals. We calculate (3) for each separate hospital corporation, summing the probabilities across hospitals within the corporation to calculate the corporation probability. Likewise, the summation in (4) is over hospital corporations.

payer groups will depend on the generosity of the payments and the ultimate size of each group.

The measure of HHI in (4) is based solely on the parameter estimates of the hospital choice equation and the geographic distribution of patients and hospitals. The only hospital characteristic included in (4) besides a hospital's location is the number of beds. Importantly, this HHI measure does not account for hospital heterogeneity in facilities (e.g., presence of open heart surgery capabilities, cardiac catheterization labs) or reputation. Including other hospital characteristics in the hospital choice model may provide a better measure of market power. However, we choose not to include those characteristics in the market power measure implemented here as it puts the measure at increased risk for endogeneity. Hospitals that have unobservably higher quality may also invest more in the observable characteristics (e.g., cardiac catheterization labs), and, if true, this investment could lead to a biased coefficient on H_{jz}^{s}.

There are two sources of variation that identify the parameters on H_{jz}^{s}. First, there is significant variation across zip codes in the number of potential patients by insurance type. The coefficient of variation across zip codes on the number of AMI procedures is approximately 1.0 for all five payer groups. The across zip code correlation in the number of AMIs is 0.59 between the Medicare and HMO categories, 0.47 between the Medicare and Medicaid categories, and 0.35 between the HMO and Medicaid categories. The second source of variation is the result of hospitals facing different competitive environments. Town and Vistnes (2001) find significant differences in hospital bargaining power in the Los Angeles area.

Measures of Hospital Quality

Our focus in this paper is on the relationship between hospital quality and concentration. An obvious and nontrivial issue is: How do we measure hospital quality? There is a rather large literature in health services research devoted to answering that question. The literature has identified multiple measures of hospital quality that can be grouped into two categories: process–based or outcome–based. In essence, process–based measures of hospital quality count the amount and the quality of inputs that are used in treating patients. Outcome–based measures are what the name implies; they measure actual patient outcomes from treatment. The most common and oldest outcome–based measure of hospital quality is mortality and it is the one we focus on here.[11] Throughout this paper we will use the term "quality" to refer to the negative of a hospital's risk-adjusted mortality rate.

Hospitals that are of the same quality may have different mortality rates because they are treating patients with different risk profiles. Thus, it is important that hospital mortality rates are adjusted to reflect the risk characteristics of the patients they treat. Again, there is a large literature on the methods to adjust mortality rates for risk (see Iezzoni (1997) for an overview). Considerable care is exercised here to diminish the likelihood that severity differences across hospitals are contaminating our measures of hospital quality.

We use two different risk-adjusted hospital mortality rates: one for pneumonia and one for AMI. The pneumonia mortality rates come from Geweke, Gowrisankaran, and Town (2001) (hereafter, GGT). GGT estimate a Bayesian model of the 10-day in-hospital mortality that corrects for both observable and *unobservable* severity of illness of

[11] Florence Nightingale (1863) conducted the first study of the determinants of hospital mortality rates.

the patient. That is, if there are unobservable (to the econometrician) components of severity that influence a patient's choice of hospital (e.g., sick patients seek care at better hospitals, all else equal) standard risk adjustment techniques will yield biased estimates of the quality of care provided by the hospital. GGT correct for this bias using Bayesian techniques that are analogous to the classical econometric method of instrumental variables.[12] The identifying assumption is that a patient's mortality is not affected by how far that patient's residence is from alternative hospitals. Conceptually, the estimator would predict hospital A to be of higher quality than hospital B if patients residing near hospital A have lower mortality than patients residing near hospital B, after controlling for their medical and demographic characteristics.

The methodology generates estimates of the hospital-specific component of mortality that, given the underlying identifying assumptions, will eliminate both the observed and unobserved severity differentials from the risk-adjusted hospital mortality rates. In order to form our measure of hospital quality used here, we draw a random sample of patients and use the GGT estimates to calculate the likelihood of death for each patient at each hospital. The hospital mortality rate is then the mean estimated mortality rate across this sample of patients. GGT use data for the years 1989-1992. Because of the computational complexity of the estimation procedure, they limit the number of hospitals they include in their sample to those hospitals located in Los Angeles County (N=114).

Our other mortality measure is the AMI mortality rates that come from Luft and Romano (1997) (hereafter, LR). They estimate the 30-day risk-adjusted mortality rates for AMI for most hospitals in California. LR link the hospital discharge records to death

[12] See Gowrisankaran and Town (1999) for a classical instrumental variables estimation procedure that uses the same identification method.

certificates and thus are able to measure accurately whether a patient died within the 30-day outcome window. In addition to controlling for patient demographics, LR carefully control for comorbidities by linking up the AMI discharge records with other possible past admissions to California hospitals. LR formulate a risk-adjusted measure that is unlikely to contain systematic biases due to unobservable severity. We believe this for two reasons. First, LR's study carefully controlled for potential observed severity differences across patients. Second, AMI patients have less discretion over their choice of hospital since time until treatment is rendered is a critical determinant of mortality for heart attacks; thus, the need to control for unobservable severity, which is important for pneumonia, is less acute for AMI.

We focus our attention on the Los Angeles region. We limit ourselves to this geographic area for three reasons. First, GGT limit their study of hospital quality for pneumonia to Los Angeles County. Their econometric methods are rather computationally intensive and do not allow for a wider geographic scope. Thus, our estimates of hospital quality for pneumonia are limited to Los Angeles County. Second, in previous work Town and Vistnes (2001) have analyzed the pricing behavior of hospitals in this region over this time period. They found that the price a hospital charges an HMO decreases in the ability of the HMO to drop or replace the hospital from its network. Thus, we can link our measures of concentration and quality to the pricing behavior of these hospitals. Finally, by limiting our geographic focus, our results likely will not be driven by geographic variation in unobservable characteristics that may affect mortality but are unrelated to hospital competition.

Our empirical strategy is straightforward. Once the measures of market concentration have been formulated and the measures of hospital performance have been collected, we regress the risk-adjusted mortality rate on the relevant measure of competition for the different payer groups using OLS, controlling for hospital for-profit status, teaching status, and size.

Data

Our principal data comes from the State of California Office of Statewide Health Planning and Development (OSHPD) patient discharge database, which records information for every individual who was discharged from an acute care facility in the state. As discussed above, the risk-adjusted mortality rates were obtained from LR and GGT for AMI and pneumonia, respectively. Both LR and GGT use OSHPD data to formulate their risk-adjusted mortality rates. LR estimate each hospital's average AMI mortality rate for 1991-1993. Similarly, GGT formulate each hospital's relative contribution to patient mortality for 1989-1992. Thus, there is substantial overlap in the time frames used by both studies in formulating their measures of hospital mortality rates.

The parameters from (1), the hospital choice problem, are also estimated using the Version B patient discharge data from OSHPD. For this purpose, the data provide patient-level information on zip code of residence, DRG, race, sex, age (by classes), hospital that the patient was admitted to, source of admittance (emergency room, etc.), and disposition (normal discharge, death, etc.). From this data we kept those patients who were admitted to a hospital in Los Angeles, Orange, Riverside, San Bernardino, and Santa Barbara counties and who were coded as Medicare enrollees. We removed from the data set any patient whose source of admission was other than the emergency room or routine[13] and any patient with missing zip code information. All of the hospitals for which we have mortality data are located in Los Angeles County. We include patients and hospitals from the surrounding counties in this sample to avoid biases that may occur for those hospitals located near the county border.

We estimate the parameters of (1) for two different types of conditions: AMI and pneumonia. We use the recorded primary DRG as the basis for determining which patients were treated for pneumonia and which were treated for AMI.[14]

In addition to the patient level data, OSHPD is the source of our hospital-level data on size and for-profit status. We measure hospital size by the number of staffed beds. We construct three dummy variables based on staffed beds (151-200, 201-300, greater than 300—the omitted category 150 or fewer beds) that we use as independent variables. We use categorical variables in order to allow for nonlinear relationships between hospital size and mortality.[15] We also use a hospital's teaching status as a regressor. We define a hospital to be a teaching hospital if it is a member of the Council of Teaching Hospitals, as listed in the American Hospital Association (AHA) Annual Report of Hospitals database. Our data also include the longitude and latitude for the center of each zip code, which we obtained from the TIGER database.[16] This longitude/latitude data allows us to calculate straight-line distances using the great circle

[13] This serves to eliminate patients admitted from nursing homes and other care facilities who may have very different choice sets.
[14] The DRG codes for pneumonia are 89 and 90, while the DRG codes for AMI are 121, 122, and 123.
[15] Our results are unaffected if we include just the size of the hospital as a regressor.
[16] Center-of-zip code longitudes and latitudes can be off when zip codes are very large. By restricting our study to hospitals in the Los Angeles/Orange County metropolitan area, where most zip codes are relatively small, we largely avoid this problem.

formula between hospitals' and patients' home zip codes.[17] Lastly, there is significant cross–ownership of hospitals in Los Angeles County. We use OSHPD data to track hospital ownership in our calculations of concentration for the different diagnoses.

Table 1 presents summary statistics for the different data sets used in the analysis. The top half of the table presents the summary statistics for the Medicare discharge data for the AMI and pneumonia diagnoses. The typical AMI patient is younger (75 versus 76.5 years), travels slightly further to her chosen hospital (7.7 versus 7.5 km), and is more likely to be admitted via the emergency room (63% versus 20%) than her pneumonia counterpart. Over a third of both AMI and pneumonia patients are admitted to the closest hospital.

The hospital data is presented in the bottom half of Table 1. Both AMI and pneumonia carry a significant likelihood of death, with the AMI mortality rate being higher than the pneumonia mortality rate (14.9% versus 9.5%). The relatively high likelihood of death for these conditions suggests that mortality is an appropriate measure of hospital quality. There is also significant variation in the mortality rates for both diagnoses across hospitals. The standard deviation is 3.9% and 2.3% for AMI and pneumonia, respectively. The average hospital has 242 staffed beds. The hospitals are roughly split between for-profit and not-for-profit hospitals (49% versus 44%) and 4% of the hospitals are members of the Council of Teaching Hospitals.

[17] Using data from upstate New York, Phibbs and Luft (1995) show a strong correlation between travel times and straight-line distances. We assume the same correlation holds for the metropolitan Los Angeles region.

Results

Hospital Choice and Estimates of $\underline{H_{jz}^{d}}$

Table 2 presents the results of estimating equation (1) for the Medicare population, with both AMI and the pneumonia diagnoses. The coefficient estimates are roughly as expected. The coefficient on the impact of distance on hospital choice is negative and significantly different from zero for both diagnoses. Larger hospitals are more attractive for both conditions—the coefficient on number of beds is significant and positive. AMI patients appear to be more sensitive to size than pneumonia patients. Patients are inclined to go to the closest hospitals for the treatment of both AMI and pneumonia. This coefficient is significantly different from zero. AMI patients who are admitted via the emergency room are more likely to go to hospitals that are closest to their home. The coefficient on $Emergency \times Distance$ is significantly negative in both samples. The coefficient on $Emergency \times Distance$ in the AMI sample is larger than the one in the pneumonia sample. As time until treatment is a key determinant of AMI survival it is not surprising that patients who experience a heart attack reduce the distance they are willing to travel when they are aware that their condition needs immediate treatment. The coefficient on $Emergency \times Close$ is not significantly different from zero at traditional confidence levels for either diagnosis.

Using the coefficient estimates in Table 2, we formulate our measures of competition for the five payer groups for both medical conditions. Table 3 presents the summary statistics of the measures of competition, *H*, by diagnosis for each payer group. There is significant variation across hospitals in these measures. In general, the standard deviations are larger than the means and the maximum value for each measure is over ten times the mean value for each measure. In Table 3 we present the hospitals that correspond to the maximum and minimum below their respective values. The hospitals with the maximum and minimum appear sensible. The hospitals with the minimum values are small hospitals or are located near other large hospitals (e.g., Charter Community Hospital; Beds = 140), while hospitals with the maximum values are large (LA County/USC; Beds = 1,879) or are geographically isolated (Westlake Medical Center; Beds =115) institutions. Also, the measures of market power for well-known hospitals imply that these facilities have relatively more market power and that seems reasonable. For example, Cedars Sinai and UCLA Medical Center have H_{MED}^{AMI} values that are at the 95 and 85 percentiles of the distribution, respectively.

The measures of *H* are highly but imperfectly correlated. OLS regressions of H for one payer group on H for *all* other payer groups for the same diagnoses yield an average R^2 of 0.90. Within diagnoses, differences in H are going to be solely due to differences in the geographic distribution of patients. This suggests that even in an urban area such as greater Los Angeles, hospitals will face differences in patient mix and competition for patients from different payer groups.

<u>Hospital Competition and Hospital Quality</u>

Next we examine the multivariate relationship between the measures of hospital quality and hospital concentration for AMI and pneumonia diagnoses. We control for similar hospital-specific characteristics as in (1) to avoid any endogeneity of the competition measures. Table 4 reports regressions that examine the relationship between measures of competition and mortality for AMI and pneumonia separately. We transform all continuous variables by the natural logarithm in these regressions.

The main findings of this paper are captured in these regressions results. Hospital quality is correlated with the weighted measure of competition that differs across payer groups. All else equal, increased competition for Medicare enrollees decreases hospital quality. This is true for both diagnoses. The coefficient on H_{MED} is negative and significantly different from zero at traditional levels of confidence in all three regressions. Increases in H_{MED} across hospitals correspond to the hospitals facing an increase in the number of Medicare enrollees nearby and/or a decrease in competition for those enrollees. Recall that our measures of hospital quality are risk adjusted so it is unlikely that this finding is driven by differentials in risk patient profiles that may be correlated with differentials in H_{MED}. The magnitudes of the coefficients imply that a 10% increase in H_{MED} is associated with a decrease in hospital mortality of 3.5% for AMI and 3.4% for pneumonia. That is, increasing H_{MED} from the median level to the top quartile decreases expected mortality by about 22% for AMI and 17% for pneumonia. The estimated effect of competition on hospitals in markets where there is administrative pricing is consistent with the findings of Propper, Burgess, and Green (2002) for Britain's National Health Service.

McClellan (1997) finds that reimbursements for pneumonia are relatively more generous than for AMI. Insofar as our results imply that the mortality rate for AMI is more sensitive to changes in the competitive environment for Medicare patients than pneumonia mortality, they are consistent with McClellan's estimates.

The finding that vigorous competition for Medicare patients is associated with high mortality rates suggests that Medicare margins are small. This finding is consistent with the work of Chernew, Gowrisankaran, and Fendrick (2002). Small (or negative)

Medicare margins are sufficient to account for our results, but there are other possibilities. For example, this result may also be due to non profit-maximizing behavior on the part of hospitals. If not-for-profit hospitals are maximizing revenues subject to a break-even constraint, then even relatively generous Medicare margins may cause competition to result in a decrease in quality.

Increases in the degree of competition for HMO patients (a decline in *H*) are correlated with increases in hospital quality. In the AMI regression the coefficient on H_{HMO} is positive and significant at the 1% level. In the pneumonia regression the coefficient is positive but insignificant at traditional levels — the p-value is 0.33. Deaths from pneumonia are a relatively rare event for patients under age 65 compared to AMI. Pneumonia is the tenth leading cause of death for those 25 to 64 years of age, while heart disease is the second leading cause of death for those 25 to 64 years of age (National Center for Health Statistics).[18] The magnitudes of the coefficients imply that a 10% increase in H_{HMO} is associated with an increase in hospital mortality of 3.4% for AMI and 1.0% for pneumonia. That is, increasing H_{HMO} from the median level to the top quartile increases expected mortality by about 22% for AMI and 7.4% for pneumonia. Given that pneumonia is a relatively infrequent occurrence for the population that is likely to enroll in HMOs, it is not surprising that the relationship between HMO competition and pneumonia mortality is weaker than for AMI mortality.

For AMI patients, the coefficient estimates indicate that the effect of changes in the competitive environment (e.g., from a merger) on hospital quality will depend upon the relative impact of the change on the opposing forces of competition for HMO patients

[18] Source: Minino and Smith (2001). For the 65 and over population, heart disease is the leading cause of death while pneumonia is the fifth leading cause of death.

and competition for Medicare patients. Thus, the impact on hospital quality will depend on the geographic distribution of patients by payer type. For pneumonia, our results indicate that increases in competition will reduce hospital quality. These observations imply that the underlying forces that affect hospital quality are complex and that the impact of changes in the competitive environment on mortality will vary by diagnoses, the geographic distribution of patients by payer type, and Medicare payment policies.

As an illustration of the opposing forces of Medicare and HMO competition, we compare the implied impact of a change in competition for AMI on hospital mortality with those of Kessler and McClellan (2000). Kessler and McClellan find that a decrease in competition of moving from the 2nd quartile to the 1st quartile of the HHI distribution in high HMO penetration states is expected to increase mortality by 1.60 percentage points. We perform a similar hypothetical experiment with our data by estimating the net impact of moving all hospitals in the 2nd quartile to the median of the 1st quartile for both H_{MED} and H_{HMO} for AMI. In contrast to Kessler and McClellan, our results indicate that an increase in measured market power from the 2nd to the 1st quartile of the distribution will leave expected mortality essentially unchanged. In this experiment, the Medicare and HMO effects exactly offset one another.

The coefficients on the other payer group *H*'s are all insignificant at traditional levels of confidence. The coefficients on the hospital characteristics are insignificant in the AMI regression. In the pneumonia regression, the coefficient on 151-200 beds is positive (relative to the excluded category of 150 or less beds), while all the included ownership categories are negative (relative to the excluded category of public hospitals).

For both diagnoses, there is no significant difference in the quality of not-for-profit and for-profit hospitals, conditioning on other variables.

Discussion

Using data from the same geographic region over the same time frame, Town and Vistnes (2001) found that the bargaining power of an HMO with a hospital increases with the ability of the HMO to replace or remove a hospital from its network of hospitals. Thus, our findings in conjunction with the work of Town and Vistnes imply that from the perspective of an HMO enrollee, increased hospital competition leads to lower hospital prices paid by the HMO and to higher hospital quality. These results run contrary to the popular press characterization of the effect of HMOs upon the provision of the quality of care, in which the HMOs are viewed as severe cost cutters, sacrificing the quality of care in order to increase profits. However, competition among hospitals for patients whose costs are controlled by the government – as through Medicare – reduces hospital quality. Our estimates indicate that the net effect of changes in the competitive environment on hospital quality will depend on the distribution of patients by type of payer. In our sample, increases in competition are expected to reduce hospital quality for both AMI and pneumonia.

Our results contrast with and clarify the findings of Kessler and McClellan (2000). They find that competition unambiguously improved welfare for AMI patients only in the post-1990 period. Our findings indicate that the story of hospital competition is not that simple. Interpreting their conclusions using our results, the reason for the change in the effect of competition may be the large increase in the percent of HMO patients during the late 1980s and early 1990s.

Moreover, Kessler and McClellan (2000) report that increases in hospital competition significantly improved hospital quality for Medicare patients in those states with above median HMO enrollment, while in states in which the HMO penetration was below the median, the effect of competition on mortality was not significant. That is, they find an HMO penetration / hospital competition interaction spillover effect for Medicare enrollees. Our results indicate the mechanism behind these spillovers: an increase in the competition for HMO patients directly leads to improved hospital mortality rates. Furthermore, the effects of competition depend upon the type of payer and the generosity of those payments.

Our results are also consistent with the works of Chernew, Scanlon, and Hayward (1998) and Escarce, *et al.* (1999). They find that HMO patients in California are more likely to be admitted to higher quality hospitals for coronary artery bypass graft surgery than non-HMO patients. The results of these papers along with our findings suggest that HMOs have preferences for higher quality hospitals, at least with respect to heart conditions. Thus, increased competition for HMO patients places more pressure on hospitals to improve their quality. Our results also hint that HMOs are less concerned about the quality of care for pneumonia, as increased competition for HMO patients does not have an estimated large or significant effect on pneumonia mortality.

Our results suggest that the incentives for hospitals to reduce mortality rates differ according to the method of reimbursement. This, in turn, implies that both antitrust and Medicare policies will play a role in determining hospital quality. Increases in market concentration, as would occur following a merger, can lead to either increases or decreases in hospital mortality and the net effect will depend upon the geographic distribution of the Medicare and managed care populations about the hospitals. Also, the impact of the merger may vary across different types of medical conditions with different Medicare margins. This conclusion differs somewhat from Kessler and McClellan (1999) whose results imply that hospital mergers can only reduce hospital quality.

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Table 1

Summary Statistics
Means and Standard Deviations
(standard deviations in parentheses)

Medicare Patient Discharge Data		
	AMI sample	Pneumonia Sample
Age (in years)	75.0 (6.9)	76.5 (6.9)
Percent admitted to closest hospital	37%	36%
Distance to chosen hospital	7.74 km (11.9)	7.46 km (10.8)
Percent emergency admit	63%	20%
Number of observations	4,153	6,750

Hospital Summary Statistics			
	Mean (Standard Deviation)	Min	Max
AMI mortality rate	14.9% (3.91)	5.2	26.5
Pneumonia mortality rate	9.5% (1.6%)	5.6	15.5
Staffed bed size	242.0 (222.8)	14	1,879
Percent private, not-for-profit	43.5%	0	1
Percent for-profit	48.7%	0	1
Percent teaching hospital	4%	0	1

Table 2

Parameter Estimates from Multinomial Logit Hospital Choice Model
(standard errors in parenthesis)

Variable	AMI Coefficients	Pneumonia Coefficients
Distance/10	-1.96*** (0.079)	-2.09*** (0.043)
Beds/100	0.11*** (0.0045)	0.083*** (0.0036)
Closest hospital	0.53*** (0.12)	0.55*** (0.062)
Emergency × (Distance/10)	-0.79*** (0.092)	-0.56*** (0.063)
Emergency × close	0.0025 (0.12)	-0.10 (0.076)
N	4,153	6,750
Log-Likelihood	-11,785	-20,202

***Significant at the 1% level.

Table 3

Summary Statistics of Concentration by Payer-Group and Condition

Variable	Means (Standard Deviations)	Min	Max
AMI Estimates			
H^{AMI}_{MED}	5.91 (6.91)	1.83 (Pacific Alliance)	64.0 (Westlake Medical Center)
H^{AMI}_{HMO}	1.95 (3.03)	0.38 (Verdugo Hills Hospital)	12.8 (Westlake Medical Center)
H^{AMI}_{IND}	0.63 (0.74)	0.18 (Bay Harbor Hospital)	6.73 (Westlake Medical Center)
H^{AMI}_{IDM}	1.31 (2.16)	0.30 (Linda Vista Hospital)	20.9 (Westlake Medical Center)
H^{AMI}_{MCD}	2.18 (3.14)	0.56 (Charter Community Hospital)	24.7 (LA County/USC)
Pneumonia Estimates			
H^{P}_{MED}	8.31 (8.86)	2.92 (Pacific Hospital)	73.2 (Westlake Medical Center)
H^{P}_{HMO}	1.95 (3.16)	0.43 (Burbank Community Hospital)	30.4 (Westlake Medical Center)
H^{P}_{IND}	0.96 (1.36)	0.31 (Norwalk Community Hospital)	11.0 (Palmdale Hospital)
H^{P}_{IDM}	1.72 (2.73)	0.37 (Linda Vista Hospital)	20.4 (Palmdale Hospital)
H^{P}_{MCD}	1.92 (2.41)	0.53 (Charter Community Hospital)	16.2 (Palmdale Hospital)

Note: The superscript "P" denotes pneumonia. The subscripts "MED" denotes Medicare enrollees, "HMO" denotes HMO enrollees, "IND" denotes the self-paying or indigent population, "IDM" denotes those covered by traditional indemnity insurance and "MCD" denotes Medicaid. The hospitals corresponding to the minimum and maximum are listed below the reported figure.

Table 4

OLS Regressions of Hospital Mortality on Hospital Characteristics
(robust standard errors in parentheses)

Variable		Dependent Variable	
		Log of AMI Mortality	Log of Pneumonia Mortality
Log of H_{MED}		-0.35*** (0.10)	-0.34** (0.14)
Log of H_{HMO}		0.27*** (0.11)	0.10 (0.10)
Log of H_{IND}		-0.10 (0.092)	0.073 (0.13)
Log of H_{IDM}		0.10 (0.11)	0.13 (0.11)
Log of H_{MCD}		0.021 (0.061)	-0.024 (0.13)
Not-for-profit		0.052 (0.10)	-0.46*** (0.10)
For-profit		0.0077 (0.11)	-0.48*** (0.12)
Teaching Hospital		0.070 (0.14)	-0.42*** (0.12)
Size Dummies	151 – 200 Beds	0.10 (0.10)	0.23*** (0.073)
	201 – 300 Beds	-0.047 (0.12)	0.13 (0.074)
	Greater than 300 Beds	-0.020 (0.13)	0.032 (0.090)
Log of AMI Quantity		0.025 (0.045)	—
Constant		2.88*** (0.27)	3.22*** (0.29)
R^2		0.19	0.22
N		107	114

Note: Standard errors are robust standard errors. In pooled regression, the continuous independent variables are transformed by the logarithm. The measures of competition are diagnoses specific.
***Significant at the 1% level.
**Significant at the 5% level.
*Significant at the 10% level.