The Determinants of HMOs' Contracting with Hospitals for Bypass Surgery

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Objective. Selective contracting with health care providers is one of the mechanisms HMOs (Health Maintenance Organizations) use to lower health care costs for their enrollees. However, are HMOs compromising quality to lower costs? To address this and other questions we identify factors that influence HMOs' selective contracting for coronary artery bypass surgery (CABG).

Study Design. Using a logistic regression analysis, we estimated the effects of hospitals' quality, costliness, and geographic convenience on HMOs' decision to contract with a hospital for CABG services. We also estimated the impact of HMO characteristics and market characteristics on HMOs' contracting decision.

Data Sources. A 1997 survey of a nationally representative sample of 50 HMOs that could have potentially contracted with 447 hospitals.

Principal Findings. About 44 percent of the HMO-hospital pairs had a contract. We found that the probability of an HMO contracting with a hospital increased as hospital quality increased and decreased as distance increased. Hospital costliness had a negative but borderline significant ($0.10 < p < 0.05$) effect on the probability of a contract across all types of HMOs. However, this effect was much larger for IPA (Independent Practice Association)-model HMOs than for either group/staff or network HMOs. An increase in HMO competition increased the probability of a contract while an increase in hospital competition decreased the probability of a contract. HMO penetration did not affect the probability of contracting. HMO characteristics also had significant effects on contracting decisions.

Conclusions. The results suggest that HMOs value quality, geographic convenience, and costliness, and that the importance of quality and costliness vary with HMO. Greater HMO competition encourages broader hospital networks whereas greater hospital competition leads to more restrictive networks.

Key Words. HMOs' contracting, managed care, coronary bypass surgery

Health maintenance organizations (HMOs) have transformed the market for health care services. Total HMO enrollment has increased from 33.3 million in 1990 to 80.9 million in 2000 (InterStudy 2001). Health maintenance organizations combine the insurance function of health plans, that is, the

financing of their enrollees' medical care, with the provider functions of coordinating and delivering of care (Weiner and de Lissovoy 1993). By employing selective contracting, limiting consumer choice of providers, and monitoring and regulating their enrollees' use of medical services, HMOs can potentially lower the cost of care, improve continuity of care, and raise the quality of care for their enrollees.

One potential benefit of HMOs is that they can improve their enrollees' provider choices because they may have access to better information on providers' practice patterns and quality (Pauly 1989). In principle, HMOs should be better able to assess the quality and prices of individual providers than can individual fee-for-service consumers. However, a key policy issue is whether in practice HMOs compromise the quality of care for their enrollees to lower costs. Prior research has provided little empirical evidence on this issue. While the theoretical advantages of managed care are compelling, the assessment of whether HMOs in the marketplace actually value higher quality as well as lower costs remains under debate.

One way to assess HMOs' actual decision making is by investigating how they select specialty care providers for their enrollees. Most HMOs organize their local provider networks by establishing contracts with selected physicians and hospitals in the plan's region. Studying the contracting process can provide information about the factors that influence HMOs' provider choice.

Only a few studies have analyzed HMOs' contracting strategies. Zwanziger and Meirowitz (1997) studied the hospital characteristics that influenced hospital selection for inclusion in managed care plans' provider networks

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through a survey of the major HMOs and PPOs (Preferred Provider Organizations) in 13 large MSAs (Metropolitan Statistical Areas) in 1993. They found that managed care plans were most likely to contract with nonprofit hospitals and least likely to contract with for-profit hospitals, with public hospitals in between. Hospitals' likelihood of being included in managed care plans' networks increased with their bed size. In addition, teaching hospitals, defined by Council of Teaching Hospitals (COTH) membership, had a lower probability of having a contract with managed care plans. Zwanziger and Meirowitz (1997) found an inverted U-shape relationship between hospital costliness and the probability of a contract, that is, the most expensive and least expensive hospitals were less likely to be included in managed care plans' hospital networks.

In a case study of three markets, Schulman et al. (1997) reported that HMOs select hospitals for tertiary care services on the basis of both price and quality. However, HMOs' assessment of quality is often subjective, based on hospital reputation. Only in the most mature HMO market did HMOs report using objective data to track outcomes to validate hospital quality. Escarce et al. (1999) found evidence that HMOs do not always improve the quality of hospital care their enrollees receive. In their study of the market for coronary artery bypass surgery in California and Florida, they found that commercially insured HMO patients in California used higher quality hospitals than commercially insured non-HMO patients, controlling for other factors. In contrast, commercially insured HMO and non-HMO patients in Florida were similarly distributed across hospitals of different quality levels, whereas Medicare HMO patients in Florida used lower quality hospitals than patients in the standard Medicare program.

In this study we analyze the contracting process between HMOs and hospitals for coronary artery bypass surgery (CABG). We identify the hospital, HMO, and market characteristics that influence whether an HMO contracts with a particular hospital. We emphasize the roles of hospital cost, quality, and convenience, and test whether each is a significant determinant of a contract being established.

Conceptual Framework

The Demand for and Supply of Contracts

Like any market, the market for contracts for CABG operations is characterized by demand and supply factors. We postulate that HMOs' behavior can be

described by a demand for contracts with hospitals, and that hospitals' behavior reflects their willingness to supply or provide such contracts. We first describe a very simple model that focuses primarily on the determinants of whether a contract will be established. We then describe an informal extension of this framework to consider more complex variations that we observe in the market: (1) HMOs establish contracts with hospitals that they do not actually use for CABG patients, and (2) contracts may be either CABG-specific or general, covering all inpatient care.

HMOs' demand for contracts is a derived demand based upon the desires of employers and others who buy insurance coverage from HMOs. To attract and maintain enrollment, HMOs must assemble provider networks that satisfy purchasers' desires for high quality, convenient, and reasonably priced medical care. We assume that HMO i has a demand (or reservation) price, p_{ih}^{D}, for each hospital h in its market area, that is, a maximum price that the HMO is willing to pay for a CABG contract with each hospital that offers the particular service (or services) it seeks. The HMO's demand price for a particular hospital is expected to be influenced by the attractiveness of the hospital to purchasers (Melnick et al. 1992). If purchasers value quality and convenience, HMOs are expected to have higher demand prices for hospitals that offer higher quality of care and are more conveniently located. HMOs' demand prices also may vary with hospital characteristics, such as size, ownership, and teaching status, which serve as indirect measures of cost and/or quality. For instance, public hospitals may be perceived as providing lower quality and fewer amenities, for-profit hospitals as less costly, or teaching hospitals as higher quality. Including large hospitals in the network may be attractive to many purchasers (Melnick et al. 1992).

HMOs' demand prices may also be affected by organizational features of the HMOs. For example, nonprofit HMOs' objective functions may include prestige, size of enrollment, scope of services, and physician and staff satisfaction, subject to a break-even constraint. By contrast, for-profit HMOs' objectives may emphasize earnings and profits. Consequently, nonprofit HMOs generally would be expected to have higher demand prices than for-profit HMOs. Similarly, IPA (Independent Practice Association) and network model HMOs are likely to have higher demand prices than group or staff model HMOs. IPA and network model HMOs contract directly with individual physicians or physician groups, which are primarily independent practices. The IPA model HMOs are predominantly organized around solo and single-specialty practices while network model HMOs contain few solo practices and are predominantly organized around group practices. The

typically broad geographic distribution of these practices leads such HMOs to demand more hospital contracts. Feldman et al. (Feldman, Chan, et al. 1990; Feldman, Kralewski, et al. 1990) found that IPA model HMOs have larger hospital networks and less elastic demand curves for hospital services than group or staff model HMOs. Large HMOs are also likely to have higher demand prices than small HMOs, because they require larger hospital networks to accommodate their enrollees. Further, due to scale economies, large HMOs may have lower costs of negotiating contracts and monitoring hospital performance. Finally, HMOs' demand price may be sensitive to the structure of the hospital market. Health maintenance organizations are expected to have lower demand prices in more competitive hospital markets, because the HMO has more potential suppliers to choose from (Staten et al. 1988).[1]

We also assume that each hospital h has a supply price, p^S_{ih}, for each HMO i in its market, that is, a minimum price that the hospital is willing to accept from the HMO. Hospitals with higher costs or input prices are expected to have higher supply prices, since the price must cover the marginal cost of services. Thus, for example, teaching hospitals are likely to have higher supply prices because they have higher costs. Similarly, for-profit hospitals may have higher supply prices than nonprofit or public hospitals if maximizing profits is their sole objective. Hospital size also may affect supply prices owing to scale effects on hospitals' cost structure (e.g., Grannemann et al. 1986; Frech and Mobley 1995).

Hospitals' supply prices are also expected to be influenced by the structure of the HMO market (Staten et al. 1987; Pauly 1988). Therefore, hospitals are expected to have higher supply prices in competitive HMO markets, because they have more HMOs to choose from in developing contracts, and in markets where HMO penetration is low, because they can fill their beds with patients who have other types of insurance. In addition, high HMO penetration may reduce the overall demand for CABG surgery because HMOs may be less likely to encourage expensive diagnostic testing or may have higher thresholds for recommending surgery. If this creates excess CABG surgery capacity, hospitals may lower their supply price in order to cover their marginal costs. However, hospitals are expected to have lower supply prices for large HMOs, since large HMOs can channel more patients to or away from hospitals (Pauly 1988).

A contract between HMO i and hospital h will exist whenever the HMO's demand price equals or exceeds the hospital's supply price. Therefore, we can express the probability of a contract as:

$$\Pr(\text{contract}) = \Pr(\_p^*_{ih} = p^D_{ih} - p^S_{ih}) > 0.^2$$

In the empirical analysis, we estimate a reduced-form version of equation 1 by replacing the demand and supply prices with their exogenous determinants. Therefore, factors that increase the HMO's demand price or decrease the hospital's supply price make it more likely that a contract will exist, whereas factors that decrease the HMO's demand price or increase the hospital's supply price make it less likely that a contract will exist.

This framework considers only the dichotomous outcome of whether a contract exists. We next discuss two informal extensions of this basic model. One extension gives HMOs three possible contracting outcomes with hospitals: a contract and actual use; a contract without any use of the hospital; and no contract. (There is also a fourth possibility: no contract but observed use. However, as we will show below, this option is infrequent.) The second extension considers whether the contract is CABG-specific or a general contract for all inpatient care.

Contingent Contracts

Why should an HMO want to contract with a hospital it does not expect to use? One possible reason is that the HMO may not know with certainty that it can limit its members' CABG care only to hospitals it prefers. For example, a member may have a sudden heart attack and be taken to the nearest hospital, regardless of whether that hospital has a contract. To allow for such contingencies, the HMO may prefer to have a contract at a price in excess of its true demand price, instead of being expected to pay the hospital's full charges if it has no contract. (Ex-post price negotiation is another possibility, but there is no guarantee that the HMO can obtain a price below its contract price level.) A second possible rationale for contracting with a hospital the HMO does not expect to use is that including the hospital in the HMO's network may have marketing value. For example, a contract with a costly teaching hospital may signal potential members that the HMO values high quality care.

Allowing for the possibility of contingent/marketing contracts suggests that the HMO may have two reservation prices, since it should be more willing to accept a higher contract price at a hospital it does not expect to use. In other words, we would expect price, and possibly quality, to be less important in determining the establishment of a contingent/marketing contract relative to a contract with a hospital the HMO actually uses. Rather, proximity to the HMO should be a primary determinant of a contingent (i.e., no use) contract, since

the likelihood of an HMO enrollee being admitted for an emergency CABG procedure should diminish with the distance between the hospital and the HMO. Because the infrastructure of the network and IPA model HMOs tend to be spread out geographically compared to staff and group model HMOs, network and IPAs should be less likely to have contingent/marketing contracts. Similarly, in applying this framework to a reduced-form model in which we do not observe the actual contract price, factors that increase hospitals' supply prices or decrease HMOs' demand prices, such as underlying cost and quality, should be less relevant in determining the existence of a contingent/marketing contract relative to a contract/use outcome.

Generally, hospitals do not have much motivation to enter into contingent/marketing contracts. Contract negotiations are not a costless exercise. Hospitals do not use HMO contracts as marketing tools. Therefore, without a reasonable expectation of actually receiving patients, hospitals should not be interested in negotiating such contracts. If hospital officials know beforehand that the HMO will only use their facility in the event of emergency, they are better off not having a contract and charging list prices for the CABG services. So under what market conditions can HMOs encourage hospitals to accept contingent/marketing contracts? Possibly when HMO markets are concentrated, HMOs can get hospitals to accept contingent/marketing contracts, because hospitals have fewer options. Perhaps, in markets with low HMO penetration, HMOs may find it easier to obtain contingent/marketing contracts because hospitals are not dependent upon HMOs for their patient census. In addition in low penetration markets, HMOs can explain their lack of use on their small number of patients relative to the market size. Conversely in high penetration markets, hospitals are concerned about patient census and therefore insist that there is a reasonable probability that the HMO will use them during the fiscal year.

CABG-specific versus General Inpatient Contracts

We expect that HMO and hospital size will influence whether a contract is general or CABG-specific. Larger HMOs and hospitals are more likely to have both the administrative staffs necessary to negotiate service-specific contracts, and the patient volumes necessary to set CABG-specific contract terms. The extent of competition in the HMO and hospital-CABG markets may also influence contract structure. Health maintenance organizations may be more able to ''pick and choose'' among particular services where there are many competing CABG hospitals. Conversely, hospitals in markets with high HMO

competition may seek to establish ''all or nothing'' contracts that do not give HMOs any special considerations for particular services.

The effects of cost and quality on the type of contract are less clear a priori, especially given the limitations of the measures available. We would still expect either type of contract to be less likely in high-cost hospitals and more likely in high-quality hospitals, but it is unclear as to whether these effects should differ by contract type. However, we would expect that distance should be less important in establishing a CABG-specific contract. To the extent that HMOs seek to develop and hospitals seek to become regional centers for CABG procedures, then CABG-specific contracts should be more likely between relatively distant hospitals and HMOs compared to general contracts.

DATA

Survey of HMOs' Tertiary Care Contracting

The analysis is based on a 1997 survey of 50 HMOs conducted by Georgetown University Medical Center and fielded by Mathematica Policy Research (MPR). The unit of observation was an HMO operating in an MSA; thus an HMO operating in multiple MSAs was treated as multiple observations. (To reduce respondent burden, an HMO plan could be selected only once.) For HMOs operating in consolidated MSAs, we selected the primary MSA where the HMO's headquarters were located. A stratified random sample was drawn from the universe of 925 HMO-MSA combinations, with strata defined by HMO type (group/staff, network/mixed, or IPA), and three market characteristics: HMO penetration (high or low), HMO competition (high or low), and hospital competition (high or low). Two of the 24 strata were empty.[3]

The final sample of 50 HMOs represents a response rate of 84.7 percent of eligible HMOs contacted. Eight HMOs either refused to participate or did not respond to MPR's attempts to contact them, and one HMO was excluded from the analysis because the only hospital it reported having a contract with did not offer coronary bypass surgery (CABG).[4] The characteristics of HMOs in our sample differ from the national distribution (Table 1) because we purposely over-sampled group/staff model HMOs, small HMOs, and nonprofit HMOs to obtain more reliable estimates of their contracting behavior. However, the sample is fairly representative of HMOs by census division and MSA size (Table 2). The West South Central census division is the only region not represented in the sample while the East North Central and the Pacific regions have the most HMOs in the sample. Table 2 compares the distribution

of the sample HMOs to the national distribution of HMOs as reported by InterStudy (1997).[5]

The survey collected information about factors related to how HMOs select providers for their members who required CABG services. The HMOs were asked to identify hospitals they contracted with and the hospitals they used for CABG services in the last fiscal year for their enrollees in a particular MSA. Health maintenance organization plan and market characteristics were obtained from InterStudy (1997). Measures of hospital characteristics and

Table 1: Distribution of HMO Characteristics

	Sample	*National*[1]
Group	45.4	14.9
IPA	28.4	43.4
Network/Mixed	26.2	41.7
For Profit	55.9	62.7
Size (75,000 or more)	44.5	74.0

[1]*Source:* InterStudy *Competitive Edge 7.1* (Minneapolis, MN, 1997). The data reported in this column is for July 1, 1996.
[2]There is one major difference between the InterStudy data and our survey data. InterStudy data sometimes treats an HMO operating in two neighboring MSAs or MSAs in the state as one HMO. We always treat each HMO–MSA pair as a separate observation.

Table 2: Distribution of Sample of HMOs by Census Division and MSA Population

	MSA Population			
Census Division	*Less Than 1 Million*	*Greater Than 1 Million*	*All*	*Total Number of HMOs*[1]
New England	2	0	2	39
Mid-Atlantic	3	3	6	77
South Atlantic	2	3	5	114
East South Central	2	1	3	42
West South Central	2	3	5	64
East North Central	12	3	15	126
West South Central	0	0	0	51
Mountain	2	1	3	56
Pacific	7	4	11	67
Total	32	18	50	636

[1]*Source:* InterStudy *Competitive Edge 7.1* (Minneapolis, MN, 1997). The data reported in this column is for July 1, 1996.
[2]There is one major difference between the InterStudy data and our survey data. InterStudy data sometimes treats an HMO operating in two neighboring MSAs or MSAs in the state as one HMO. We always treat each HMO–MSA pair as a separate observation.

market structure were constructed from the 1996 AHA Annual Survey of Hospitals (AHA 1996).

Empirical Application

Identifying Hospitals in Each HMO's Market

Using the 1997 public use file of the America Hospital Association's Annual Survey of Hospitals, we identified as ''CABG hospitals'' those institutions that performed open-heart surgery. During the survey HMOs were given a list of CABG hospitals in their MSAs and asked whether they contracted with or used any of these hospitals for CABG services. The HMOs were also asked to identify any other hospitals outside the MSA that they contracted with or used for CABG services for enrollees residing in the MSA.

For the analyses, each HMO's choice set of hospitals was defined based on the following criteria: For HMOs in MSAs with a population greater than one million we included all of the CABG hospitals in the MSA. For HMOs in MSAs with a population fewer than one million we included all the CABG hospitals within the MSA, plus all other CABG hospitals within a given radius of the MSA's population centroid, based on the approximate distance to the farthest hospital the HMO indicated it either contracted with or used. This radius ranged from 50 to 125 miles. A total of 447 hospitals were identified as belonging in the choice sets of the HMOs in the study sample.

Variable Specification

1. *Hospital Cost, Quality, and Convenience* The key hospital variables were measures of costliness, geographic convenience, and quality. We used average salary per full-time-equivalent employee, adjusted for input price differences using the HCFA (Health Care Financing Administration) hospital wage index to represent underlying hospital costs. Higher underlying costs should increase the supply price and, therefore, have a negative effect on the probability of a contract.

Geographic convenience was measured as the straight-line distance between the population centroid of the hospital's zip code and the population centroid of the MSA, weighted to account for the distribution of HMO enrollees across the counties in the MSA. Greater distance should reduce the likelihood of a contract, since it should lower HMOs' demand price.

To measure quality, we calculated for each hospital a mortality Z-score based on its number of CABG patients and the difference between its predicted and actual number of CAGB patient deaths. Using the 1995 Medicare Provider Analysis and Review (MedPAR) data we estimated a logistic regression model to predict the likelihood of a CABG patient dying in the hospital as a function of patient characteristics, including age, gender, source of admission, and comorbidities (Escarce et al. 1999).[6] We used a residual approach to adjust for hospitals' case mix. This measure does not penalize hospitals that have high death rates because they serve a relatively unhealthy patient population nor does it reward hospitals that have low death rates because they serve a healthy patient population.

Of the 447 hospitals in our sample, 59 did not have MedPAR data. Using data from the 1996 AHA Annual Survey of Hospitals we imputed values for quality for those hospitals. Specifically, we regressed quality on hospital ownership, resident-to-adjusted admission ratio, hospital beds, and expenses per adjusted admission. These models were then used to impute values of quality for the 59 hospitals with missing data. Analyses with and without these 59 hospitals found that the results were not sensitive to the imputation.

2. *HMO Characteristics* We obtained information on HMO characteristics from the HMO Directory published by InterStudy (Interstudy 1997). The variables in the model represent HMO type (network or IPA, relative to groups/staff HMOs), ownership status (for-profit relative to nonprofit) and size (more than 75,000 enrollees) for each HMO.

3. *Hospital Characteristics* Hospital characteristics are included in the model as indirect proxies for quality and cost. We include dummy variables for hospital ownership (public or for-profit, relative to private nonprofit) and teaching status (member of COTH, the Council of Teaching Hospitals), and hospital size measured as the number of beds.

4. *Market Structure* InterStudy (1998) was also our source of data on HMO penetration rate and level HMO competition (one minus the Herfindahl index) for each MSA represented in the study. The penetration rate was measured as a dummy variable that equaled one if it exceeded the median in the sample, 28 percent. We used a dichotomous measure because preliminary analyses suggested that HMO penetration has a threshold effect. The hospital competition variable was constructed using data from the Annual Survey of Hospitals. For each hospital in the data set, we calculated its hospital-specific level of competition (as one minus the Herfindahl index) based on the distribution of beds for all CABG hospitals within 30 miles of the particular

hospital. These measures of competition imply that a higher value of the variable is associated with a greater level of competition.

METHODOLOGY

We seek to estimate the effects of exogenous factors on: (1) whether a HMO-hospital contract exists, (2) whether the HMO uses a particular hospital, and (3) whether the contract is general or CABG-specific. In the first set of models, the dependent variable is a dichotomous variable that equals one if the HMO-hospital pair had a contract for CABG services. We estimate two versions of this model: one in which all effects are main effects[7] and a second specification that includes interactions of HMO type with the measures of cost, quality, and distance. The latter specification allows us to test whether the contracting decisions of different types of HMOs are differentially affected by these factors. These models are estimated using binomial logistic regression.

The second and third models extend the basic framework. Our second model estimates the effects of the exogenous factors on the existence of a contingent/marketing contract. The dependent variable is a categorical variable with three possible outcomes: the HMO did not have a contract nor used the hospital, the HMO had a contract but did not use the hospital, and the HMO had a contract and used the hospital for CABG services. By doing so, we implicitly assume that HMOs and hospitals jointly recognize that a contract may be a contingent/marketing contract, even if this feature is not explicit.[8,9] The third model explores the determinants of the type of contract, that is, general versus CABG-specific. We estimate the effects of the exogenous factors on contract type by creating a single categorical dependent variable with three possible outcomes: no contract, a general contract, or a CABG-specific contract. This model assumes that the general versus CABG-specific structure of the contract is negotiated at the same time. We estimated the second and third models using multinomial logistic regression. An implicit assumption of the multinomial logistic regression is the independence of irrelevant alternatives. This assumption implies for example that the odds of an HMO having a general contract with a hospital relative to not having a contract are the same regardless of whether the HMO has the option of negotiating for a CABG-specific contract. We used the test prescribed by Hausman and McFadden (1984) on the various combinations of constrained and unconstrained models and failed to reject the null hypothesis that the difference in coefficients is not systematic. The p-values were greater than 0.9 and the chi–squared statistics were sometimes negative.

Because the HMOs were randomly drawn from a stratified sample, we weighted each HMO by the inverse of the probability of its selection, that is, the number of HMOs in the strata divided by the number of HMOs selected from the strata. Standard errors were adjusted for the use of sampling weights.

RESULTS

Contract Frequency

On average HMOs contracted with about 40 percent of the CABG hospitals in their markets and used about 30 percent of the CABG hospitals in their markets for this service (Table 3). The average HMO in the sample had 8.94 CABG hospitals in its market, contracted with 3.56 hospitals, and used 2.64 hospitals. Almost three out of every four hospitals with a contract were used by the HMO for CABG services. HMOs rarely obtained CABG services from any of the hospitals with which they did not contract. Nearly seventy percent of HMO contracts were general (Table 4). General contracts were used about 60 percent

Table 3: Distribution of Hospitals by HMO Contract Status and Use ($N = 447$)

	Number of Hospitals	*Percent*
No Contract, Not Used by HMO	257	57.5
No Contract, Used by HMO	12	2.7
Has a Contract, Not Used by HMO	44	9.8
Has a Contract, Used by HMO	134	30.0

Table 4: Distribution of Hospitals with HMO Contract Status by Type of Contract and Use ($N = 439$)

	Number of Hospitals	*Percent*
No Contract	269	61.28
General Contracts—Not Used	34	7.74
General Contract—Used	84	19.13
Specific Contract—Not Used	8	4.5
Specific Contract—Used	44	10.02

Note: For eight contracts the respondent did not specify the terms. Of those contracts two were used and six were not used.

of the time compared to CABG-specific contracts that were used almost 85 percent of the time.

Binomial Logistic Analysis of Contract Existence

In Table 6, we report the results of the basic contracting model, both with and without interactions. (Table 5 presents the means and standard deviation of variables used in the multivariate analysis.) The model without interactions indicates that the probability of a contract increased with hospital quality and decreased with distance and hospital costliness. Quality and distance were both highly significant ($p = 0.01$), while costliness was borderline significant ($p = 0.10$). Allowing for interactions with HMO type suggests that different types of HMOs valued cost and quality differently in their contract negotiations. Only IPAs were significantly affected by hospital costliness. They were about twice as sensitive to costliness as network and group/staff HMOs. Network HMOs were more sensitive to changes in hospital quality than group/staff HMOs and IPAs. Conversely, group/staff HMOs, which may tend to rely primarily on a close relationship with a single hospital, were not affected by either hospital cost or quality, and were least sensitive to the distance between the HMO and hospitals. Network HMOs were more sensitive to changes in hospital quality than group/staff HMOs and IPAs. Conversely, group/staff HMOs, which may tend to rely primarily on a close relationship with a single hospital, were not affected by either hospital cost or quality, and were least sensitive to the distance between their enrollees and hospitals.

Table 5: Mean and Standard Deviations of Independent Variables

Independent Variable	*Mean*	*Standard Deviation*
Hospital Salary per FTE (000s)	45.469	10.758
Hospital Quality (Mortality Z-Score)	−0.026	0.162
Distance	35.115	41.370
For-profit HMO	0.559	0.497
Large HMO	0.445	0.498
IPA	0.284	0.451
Network	0.262	0.440
HMO Competition	0.691	0.186
Hospital Competition	0.800	0.205
High HMO Penetration	0.597	0.491
Public Hospital	0.103	0.304
For-profit Hospital	0.103	0.304
Council of Teaching Hospital (COTH)	0.320	0.467
Hospital Beds	403.9	229

Table 6: Logistic Model: Contract with This Hospital?

	Coefficient	*Standard Error*	*Coefficient*	*Standard Error*
Hospital Salary per FTE	−0.392*	0.235	−0.491	−0.378
Hospital Quality	2.677**	1.067	0.644	1.364
Distance	−0.043**	0.009	−0.028**	−0.008
HMO Competition	2.652**	1.091	2.206*	1.189
Hospital Competition	−2.093**	1.061	−2.412**	1.014
High HMO Penetration	−0.202	0.368	−0.423	0.399
For-profit HMO	1.094**	0.529	1.774**	0.632
Large HMO	1.058**	0.381	1.167**	0.401
IPA	0.423	0.499	6.767**	1.714
Network	1.044*	0.567	2.316	2.150
Public Hospital	0.281	0.500	0.323	0.470
For-profit Hospital	−0.575	0.630	−0.589	0.597
Hospital Beds	0.00026	0.00080	0.00067	0.00081
COTH	0.193	0.548	0.422	0.530
Network*Cost	–	–	−0.318	0.462
IPA*Cost	–	–	−1.330**	0.368
Network*Quality	–	–	4.495*	2.307
IPA*Quality	–	–	3.153	2.261
Network*Distance	–	–	−0.002	0.020
IPA*Distance	–	–	−0.025	0.018
Constant	0.992	1.111	0.992	−1.111
Pseudo R2	0.267	–	0.309	
N	447	–	447	

*$p < .10$.
**$p < .05$.

Health maintenance organization competition increased the likelihood of a contract while hospital competition reduced the likelihood that a particular hospital had a contract. Operating in a high HMO penetration MSA did not have a significant effect on the probability of a contract. For-profit and large HMOs were more likely to have a contract with a particular hospital than nonprofit and small HMOs, respectively. There is some evidence that network/mixed-model HMOs (from the model without interactions) and IPAs (from the model with interactions) were more likely to have a contract with a particular hospital than staff/group model HMOs. After accounting for costliness, quality, and geographic convenience, other hospital characteristics, such as ownership, size, and teaching status, did not affect the probability of a contract.

Multinomial Logistic Analysis of Contract Use

1. Distance, Cost, and Quality Table 7 reports the multinomial logistic results from the analysis of contract use. Hospital costliness, quality, and distance are highly significant predictors of contracts with actual use. Increases

Table 7: Multinominal Logit Analysis of Contract Use: No Contract–No Use is the Reference Group

	Contingent/Marketing Contract (Contract–No Use)		*Used Contract*	
	Coefficients	*Std Errors*	*Coefficients*	*Std Errors*
Hospital Salary per FTE	−0.117	0.409	−4.97**	0.190
Hospital Quality	0.344	1.182	3.634**	1.044
Distance	−0.083**	0.028	−0.039**	0.007
HMO Competition	−4.420**	2.062	3.579**	1.127
Hospital Competition	1.303	2.207	−2.312**	1.082
High HMO Penetration	−2.335**	0.807	0.016	0.354
For-profit HMO	0.847	0.806	1.465**	0.338
Large HMO	2.650**	0.671	0.820**	0.369
IPA	−1.904**	0.871	0.783**	0.393
Network	−2.630**	1.134	1.776**	0.468
Public Hospital	0.447	0.771	0.053	0.457
For-profit Hospital	0.363	0.648	−0.801**	0.377
Hospital Beds	0.00045	0.00116	0.00045	0.00052
COTH	−0.519	0.640	0.398	0.376
Constant	2.528	1.769	−0.068	1.181

Pseudo R2 = 0.3249
$N = 435$
*$p < .10$.
**$p < .05$.

in costliness and distance decreased the odds of contract use while quality increased the odds of contract use. The existence of a contingent/marketing contract was very sensitive to distance but not costliness or quality. The odds of a contingent/marketing contract were twice as sensitive to changes in distance than the odds of a used contract.

2. Market Forces Health maintenance organization competition increased the odds of using a contract hospital, while hospital competition reduced the odds of using a contract hospital. Similar to the basic model, HMO penetration did not affect the existence of a contract with use. Health maintenance organization competition reduced the odds of contingent/marketing contracts while hospital competition did not have a statistically significant effect. Health maintenance organization penetration reduced the likelihood of a contingent/marketing contract.

3. HMO and Hospital Characteristics For-profit and large HMOs were more likely to have contracts with use than nonprofit and small HMOs. Large HMOs were also more likely to have contingent/marketing contracts than small HMOs. The IPAs and network HMOs were more likely to have contracts

with use than staff/group model HMOs. However, IPAs and network HMOs were less likely to have contingent/marketing contracts. Similar to the basic model, hospital characteristics did not generally affect the existence of contracts with use or contingent/marketing contracts, except for-profit hospital ownership, which lowered the odds of a contract with use.

Multinomial Logistic Analysis of Contract Type

1. Distance, Cost, and Quality The effects of distance, cost, and quality did vary by type of contract (Table 8). The odds of a general contract increased with hospital quality and decreased with hospital distance. Hospital costliness did not affect the odds of a general contract. The odds of a CABG-specific contract were inversely related to hospital costliness and distance. However, hospital quality did not affect the odds of a CABG-specific contract.

2. Market Effects, HMO and Hospital Characteristics Health maintenance organization and hospital competition had opposite effects, as in the basic contracting model, but only for the odds of a general contract. These market forces did not have a significant effect on CABG-specific contracts. Similar to the basic contracting model, high HMO penetration had no effect on either

Table 8: Multinomial Logit: Type of Contract Model

	General Contract		*CABG-specific Contract*	
	Coefficients	*Std Errors*	*Coefficients*	*Std Errors*
Hospital Salary per FTE	−0.246	0.188	−0.818**	0.259
Hospital Quality	2.588**	0.941	1.391	1.186
Distance	−0.053**	0.009	−0.021**	0.010
HMO Competition	2.990**	1.210	−0.029	1.329
Hospital Competition	−3.132**	1.118	0.254	1.648
High HMO Penetration	−0.300	0.393	−0.640	0.448
For-profit HMO	1.546**	0.353	−0.054	0.485
Large HMO	1.231**	0.362	2.076**	0.507
IPA	0.049	0.393	0.677	0.543
Network	0.654	0.457	0.672	0.642
Public Hospital	−0.270	0.498	0.581	0.550
For-profit Hospital	−0.922**	0.402	0.236	0.529
Hospital Beds	−0.00056	0.00061	0.00227**	0.00063
COTH	0.462	0.389	0.171	0.456
Constant	0.891	1.151	0.310	1.530

Pseudo R2 = 0.2656
$N = 439$
*$p < .10$.
**$p < .05$.

contract type. For-profit HMOs were more likely to have general contracts. Large HMOs were more likely to have both types of contracts compared to smaller HMOs, although the effect on CABG-specific contracts was greater. For-profit hospitals were less likely to have general contracts compared to nonprofit hospitals. Large hospitals were more likely to have CABG-specific contracts.

DISCUSSION

The empirical evidence suggests that HMOs value geographic convenience, hospital quality, and hospital costliness in deciding which hospitals to contract with, the type of contract, and whether to use the hospital for CABG services. The directions of the effects are consistent with the underlying characterization of a market for contracts. However, the predicted percent change in the likelihood of a contract associated with changes in distance, quality, and costliness are relatively small (Table 9).

Health maintenance organizations may contract with hospitals that are geographically convenient as a mechanism for attracting enrollees. Empirical studies in the hospital choice literature have consistently identified distance as an important factor in patients' hospital selection (Porell and Adams 1995). The HMOs appear to reflect this patient preference.

Quality, as measured by CABG mortality Z-score, is also valued by HMOs, though possibly to a lesser degree than convenience. The HMOs' demand appears to be responsive to a reduction in the mortality Z-score. A change of 0.1 in the mortality Z-score, which is equivalent to moving from the fiftieth to the fifty-fourth percentile of the distribution, increased the probability of a contract by 0.18 percent. However, our estimate of the magnitude of this effect may be

Table 9: The Percent Change in the Probability of a Contract Associated with Changes in Hospital Costliness, Quality, and Distance

	Change in Hospital Salary per FTE of $10,000	*Change in Hospital Quality Z-score of 0.1*	*Change in Distance by 10 Miles*
Any Contract	−0.263*	0.180**	−0.287**
Continency/Marketing Contract	−0.090	0.117	−0.664**
Used Contract	−0.290**	0.212**	−0.219**
General Contract	−0.100	0.178**	−0.378**
CABG-specific Contract	−0.673**	0.058	−0.049**

biased by our measure of quality, which is based only on Medicare CABG mortality. Hannan et al. (1997) suggest that in assessing hospital quality for CABG surgery, it is preferable to use an administrative database that includes all patients rather than one limited to Medicare patients. Although, Medicare data is probably the only national data HMOs could use to evaluate hospital CABG mortality. Also, our measure does not consider other indicators of hospital quality such as complication rates, infection rates, and amenities.

Although we did not find a consistent statistically significant negative cost effect, we do believe the results provide sufficient evidence to conclude that HMOs purchase CABGs on the basis of price. The actual price HMOs pay for CABGs is correlated with the cost structure of hospitals. However, hospitals' costliness may be a poor proxy for hospitals' offer prices to HMOs, explaining why our estimated elasticities are small. An ideal study would include the actual rate negotiated between HMOs and hospitals in the models. Unfortunately, HMOs declined to give us information on the actual rates they paid for CABG services.

Market structure is also an important determinant of hospital contracts and use. Greater HMO competition leads to broader hospital networks. This suggests that HMOs may compete on the basis of network size. The HMOs in competitive markets may appeal to consumers' desire for provider choice to attract and maintain enrollment. Greater hospital competition allows HMOs to be more selective, thus reducing the likelihood of any particular hospital contract or use. Surprisingly, HMO penetration did not have any direct effect on the contracting process, except in the existence of contingent/marketing contracts.

The primary limitation of the analysis is that we are unable to observe actual transaction prices and therefore cannot measure the price–quality tradeoff directly. Additionally, our measure of hospital quality may be endogenous. The CABG mortality declines as patient volumes increase (e.g., Luft et al. 1979; Hannan et al. 1989; Hannan et al. 1991). Therefore, a hospital could potentially improve its mortality rate by increasing its volume by winning a lot of HMO CABG contracts. Unfortunately, we could not find good instruments for CABG mortality to treat it as endogenous in our analysis. In particular, hospital size, ownership, and teaching status were not good predictors of CABG mortality. We tried to address this problem by using lagged values of CABG mortality based on 1995 MEDPAR data.

Another limitation is our conceptualization of the contingent/marketing contract. We hypothesize that HMOs make the contracting and hospital use decisions jointly. A plausible alternate hypothesis is that hospital use decision is

nested within the contracting decision. Unfortunately, we could not test the validity of this alternate theory because we cannot distinguish the contracting equation from the hospital use equation. Another drawback is we assume that by observing a contract at a hospital that was not used, that we have observed a contingent/market contract. However, the demand for CABGs is uncertain and we may be actually observing contracts that the HMOs intend to use, but have not because demand for CABGs was low during the fiscal year.

Our study documents the importance of geographic convenience, hospital quality and costliness, HMO characteristics, and market structure on HMO–hospital contracting and use. Although limited to only one tertiary care service, it suggests that HMOs value both hospital quality and convenience, in addition to price. The effects that we estimate are national averages and the impact of these factors may vary within specific markets (Schulman et al. 1997). It is clear that more work needs to be done, focusing on other tertiary care services, and using data on actual transaction prices.

NOTES

1. Put another way, when there is more competition in the hospital market, the firm demand curve for hospital services is more price elastic.
2. Some hospitals may have no interest in contracting with certain HMOs, and may never even enter into negatiations (Staten et al. 1988). This behavior can be accommodated within the conceptual framework by assuming that such hospitals' supply prices are infinte.
3. There were no group/staff and network/mixed-model plans in high HMO penetration, low HMO competition, and high hospital competition areas.
4. We believe this was due to an error in our data collection in that we could not match the hospital the HMO named with the correct American Hospital Association identifier.
5. The InterStudy data treat an HMO operating in two neighboring MSAs or multiple MSAs in the state as one HMO. We treat each HMO–MSA pair as a separate observation, which is why we had 925 HMO–MSA combinations in our sample frame compared to 636 HMOs in the InterStudy data.
6. The comorbidities are acute myocardial infarction, ischemic heart disease, cancer, HIV infection, chronic obstructive pulmonary disease, vascular disease, liver disease, renal disease, nutritional disease, coagulation defects, functional impairment, renal dialysis, dementia, congestive heart failure, aneurysm, and aortic value disease. We also controlled for whether the patient received vascular and abdominal procedures.
7. This specification implicitly allows an HMO to have no contracts with any hospitals in its market, for example, if all hospitals are too costly or too low quality. In preliminary analysis, we estimated an alternative specification that measured cost, quality, and

distance as deviations from a benchmark hospital, that is the lowest cost, highest quality, or nearest hospital in each HMO's choice set. The results were qualitatively similar, although differential cost and quality were not statistically significant. We do not report this model, however, since all HMOs in our sample did, in fact, have at least one contract with a hospital in their market. In other words, the theoretical possibility of no contract existing is not empirically relevant in our data. Also, this alternative specification precludes the possibility of HMOs contracting with more than one hospital because it is in a low-cost market, or contracting with only one hospital because it is in a high-cost market.

8. We also explored a Heckman selection model, in which the first-stage selects whether a contract exists and the second stage equation estimates the likelihood of usage, given a contract. This approach was not successful, however, because of the inability to specify factors that influence contract existence but not hospital use.
9. In preliminary analysis, we estimated a separate model for hospital use that allowed for a fourth possible outcome, no contract with hospital use. However, this event was very infrequent and essentially random, in the sense that it was not significantly related to any of the variables in the model. We therefore exclude these observations from the contract use analysis.

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