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MANAGED CARE DISCOUNTING: EVIDENCE FROM THE MARKETSCAN DATABASE

Avi Dor
Siran M. Koroukian
Michael Grossman

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ABSTRACT

The paper examines price discounting by health maintenance organizations and preferred provider organizations in markets for hospital services. Our empirical analysis focuses on transaction prices for angioplasty, which is a relatively common procedure, with well defined 'product' characteristics. After controlling for patient and procedure heterogeneity and market power we find that on average prices for PPOs are 8% lower than fee-for-service plans, followed by point-of-service HMOs who capture a 24% discount. Our results are in general agreement with earlier work that shows that managed care discounts are 'real', after accounting for process of care.

Avi Dor
Department of Economics
Case Western Reserve University
Peter B. Lewis Building
11119 Bellflower Road
Cleveland, OH 44128-7235
and NBER
avi.dor@weatherhead.case.edu

Siran M. Koroukian
Department of Epidemiology and Biostatistics
Case Western Reserve University
10900 Euclid Avenue
Cleveland, OH 44106-4945
smk@neo.cwru.edu

Michael Grossman
NBER
365 Fifth Avenue
5th Floor
New York, NY 10016-4309
and CUNY
mgrossman@gc.cuny.edu

Introduction

It is generally assumed that managed care has been successful at lowering prices, but the implications have been a matter of debate. Critics have argued that managed care organizations attain savings by reducing intensity of services, while others have argued that savings are 'real' and are a consequence of discounts per unit of care, rather than a consequence of reduced intensity. Examining treatment episodes for acute myocardial infarctions, i.e., heart attacks, Cutler, McClellan and Newhouse (2000) suggest that discounts are attained by managed care plans without sacrificing intensity. They pose the question, "does managed care achieve discounts through reduced intensity?" We rephrase the question as "does managed care achieve discounts even after accounting for product heterogeneity?" To address this we utilize a unique claims database that contains relatively rich detail on both sources of payment and on the process of care for hospital procedures. The specific procedure we focus on is angioplasty, which is suitable for empirical research because it is a well-defined and relatively common cardiac procedure.

Our study complements Cutler et al. in one other important dimension: their study examined differences between managed care options within a single large HMO, whereas we focus on differences between various insurers and employers. After accounting for market forces, casemix and product heterogeneity, we find a high degree of residual discounting by managed care. Thus, despite the different frameworks the results in the two studies are in general agreement.

Our data enable us to observe *transaction prices*, i.e., actual payments borne by the payer and received by the hospital, rather than charges, i.e. gross prices that do not reflect price caps or discounts applied differently to various payers. Previously Brooks, Dor, and Wong (1997) have shown that managed care has lead to discounts in the case of another procedure, appendectomy. While we do not wish to err on the side of picking a procedure that is too complex to be adequately controlled for in a regression, the example of appendectomy may be too narrowly defined for a model designed to show how price discounts can persist when accounting for

differences in the type of care delivered. Moreover, by using a more updated file, we are able to examine discounting by gradation of managed care, based on choices available in the self-insured firms that make up the data file. These choices, as defined in our data are, discussed in Section 2. Section 3 presents the analytical framework for estimating the price equation; Section 4 describes our main database and supplementary files; Section 5 presents descriptive information on price differences by gradations of managed care; Section 6 presents regression results and the degree of discounting achieved by managed care. Implications are given in the concluding section.

Forms of Managed Care

For at least two decades, managed care enrollment has been growing rapidly. While only one quarter of the privately insured population enrolled in some form of managed care, the majority of this population is enrolled in managed care today. However, even within managed care there are substantial differences between the major types of plans, and their relative market shares have been changing over time. Thus, the relative market share of more traditional 'closed-form' HMOs is beginning to level off, whereas the shares of 'open-form' HMOs, Preferred Provider Organizations (PPOs) and other forms of hybrid managed care and fee-for-service are rising. According to recent data from the Health Insurance Association of America (2002), between 1994 and 1997, the market share of fee-for-service plans for private insurance coverage fell from 32.8 percent to 21.2 percent, while the share of PPOs grew from 44.8 percent to 47.3 percent, and the share of most recent entrant to the managed care arena, namely point-of-service HMOs more than doubled, rising from 1.8 percent to a 4.8 percent market share. During the same period, traditional HMOs rose from 22.5 percent to 26.9 percent; however, these figures mask the fact that many of these HMOs were beginning to adopt open market incentives as well. Below, we briefly review the definitions of the major forms of insurance.

The two forms of fee-for-service insurance are 'comprehensive' and Major Medical plans. Under comprehensive insurance, patients can opt for any provider of their choosing, with

the insurer essentially paying full cost up to some outlier limit. Major Medical insurance is based on the same payment methodology and consumer choice as comprehensive fee-for-service, but restricts benefits to major medical and surgical procedures. PPOs are essentially fee-for-service plans, but with discounted fees and some limitation on choices available to consumers. Choices are limited to listings of providers who make up the PPO's network. Consumers retain an option to go outside of the network, but incur higher copayments and deductibles in addition to higher fees if they opt to do so.

In closed-form HMOs, physicians can only serve patients who are enrolled in the plan. Physicians in closed form HMOs are either salaried contract employees of the HMO (staff model) or contract workers (group model). In open HMOs, also referred to as independent practice associations or network HMOs, physicians and hospitals may have contracts with several HMOs and may see private fee for service patients as well. For the most part, contractual arrangements with hospitals in closed HMOs mirror those of open HMOs, although the largest closed HMO, Kaiser Permanente does own hospitals outright in a few localities across the country. While both forms of HMOs differ in terms of how they contract with providers, both are predicated on the same consumer-insurer relationship, whereby premiums are essentially prepayment for any medical care needed with little or no cost sharing for patients, and no out-of-plan choice.

More recently, hybrid forms of managed care have emerged, combining features of HMOs with features of PPOs or fee-for service plans. The hybrid forms include Point of Service (POS) HMOs and Exclusive Provider Organizations (EPO). POS-HMOs resemble traditional HMOs as long as consumers stay within the network: cost-sharing by patients is minimal, but the ability to choose among providers is also minimal; in addition patients are assigned a 'gatekeeper', usually a family physician or nurse case manager, and are not able to access specialists directly without the gatekeeper's referral. However, like PPOs, POS-HMOs give their members the option of choosing physicians and hospitals outside the network, in exchange for higher out-of-pocket participation. Thus, while PPOs and POS-HMOs are different within-

network, they resemble each other when consumers opt to go outside of the network. Finally, like PPOS, EPOs negotiate discounted fees with network providers, but they provide no coverage for services rendered outside of the network. Prices for services provided by hospitals within PPO networks are typically set separately for every major procedure. For POS of service HMOs there are numerous permutations for price setting mechanisms, which may include pricing by procedure or by episode (Anders, 1996, Kongstvedt, 2002).

Analytical Framework

Transaction Prices for PTCA.

Angioplasty, named more fully Percutaneous Transluminal Coronary Angioplasty (PTCA) is a procedure intended to treat ischemic coronary artery disease. More than 530,000 PTCA procedures were performed in 1997 nationwide, with estimated charges exceeding $20 billion[1]. This procedure involves the introduction of a thin flexible, hollow catheter into an artery in the groin. The catheter is advanced through the blood vessel to the heart. A special balloon tip on the catheter allows the physician to open a diseased (occluded) coronary artery by inflating the balloon and dilating the diseased vessel. First introduced in 1977, the PTCA procedure evolved from balloon angioplasty to the insertion of stents, to avoid narrowing of the arteries after the patient. In the period observed (1995-1996) about 40 percent of all angioplasties were done in combination with stents (see Table 1).

The MareketScan database reports actual payments received by the hospital, as opposed to charges, which do not reflect discounts and caps negotiated by insurers. We label the payments received *transaction prices*. Another important dimension of price in our analysis is that it is reported for the "principal procedure" designation of angioplasty. The reason for reporting medical prices this way is summarized in the earlier study by Cutler et al:

"…what is the good we are pricing? There are literally thousands of individual services that a heart attack patient can receive –specific tests, units of blood, operating room time, etc., Disaggregating to the individual level does not seem the most appropriate way to proceed,

however. It seems more natural to think of the good as "bypass surgery and its related services" or "angioplasty and its related services", since this is the type of good which individuals or physicians acting as their agents decide to purchase…"

By focusing on angioplasty as the principal procedure, we adhere to their approach. However, we are also able to exploit the data further, and account for product heterogeneity. This is further described in the data section[2].

Model Specification

Because of the wide dispersion in prices, price equations were expressed in log-linear form (Brendt 1991). In previous work Brooks, Dor, Wong (1997) derived a specific functional form for the price equation in a similar insurer-provider setting. By assuming a Nash-Bargaining game, their specification imposes the restriction that products, i.e., medical procedures, are homogeneous[3]. While the homogeneity assumption is innocuous in their example of appendectomy, a fairly simple and uniform procedure, it is too restrictive for our current example of heart surgery. For this reason, we adopt the more flexible hedonic price approach in our empirical framework. Accordingly, an end product can be viewed as a summation of product attributes. Each of these attributes is valued and therefore adds it's own unique weight to the final price, which can be retrieved directly from a linear regression (Brendt 1991; Grossman and Goldman 1978). Thus we include various technical features of angioplasty in the price regressions. In addition we borrow from Brooks et al. by incorporating available measure of relative bargaining power for insurers and hospital markets, i.e. their respective market structures. The general specification of the pricing equation can be summarized as follows:

$$ln\text{Price} = f(\text{product heterogeneity; casemix; hospital characteristics; insurance characteristics; market structure})$$

The vector "product heterogeneity" refers to variations in the way angioplasty is done, which are observed at the patient level; casemix is a summary measure for the overall severity of patients in the hospital admitted for this procedure. The vector "insurance" refers to the type of insurance plan, as reported in our data; "hospital" refers to hospital characteristics that are related to a

hospital's bargaining position such as teaching status and form of ownership (for profit, non-profit); market structure measures are for the two principal industries, namely health insurance and hospitals, thereby reflecting relative bargaining power.

The measure of the hospital's casemix or severity (for angioplasty patients) will be based on its *expected mortality rate.* In an alternative specification we include the *standardized mortality ratio* (SMR), i.e. the ratio of the actual rate to the expected rate, which is taken as an adverse measure of the hospital's clinical performance. We generally expect the expected mortality rate to be positively associated with prices, since higher casemix hospitals require additional compensation, and we expect the standardized mortality rate to be negatively associated with prices, since hospitals with adverse outcomes are less able to bargain for higher prices.

Note that we are not interested in assessing the validity of such measures, which has been a matter of some debate (e.g., Thomas and Hopper 1999, McClellan and Staiger 1999a, 1999b). Rather, our interest lies in replicating or, at least, approximating information available to large purchasers during the period studied (1995-1996), and assessing the effect of this measure on the pricing decision. The algorithm most widely accepted during that period simply adjusts for age, gender, and the presence of major associated illnesses or comorbidities (Rosenthal 1997; Krakauer et al. 1992; HCFA 1993)[4]. Many localities, state data agencies, local hospital associations, business coalitions, and the like replicated this method for specific procedures such PTCA.[5] As a measure of the best available information, we reconstruct expected and standardized mortality rates using this specification. Further details are provided in the next section.

Data and Variables

***Overview*:**

The analysis of hospital pricing data for PTCA procedures in the MarketScan® database was performed using data elements from multiple sources. The final analysis aimed at assessing the association between participation in a managed care program and hospital pricing used a number of data elements originating from the MarketScan® database. The final analysis also incorporated hospital characteristics (teaching status; ownership data; and market share) from the American Hospital Association (AHA) database, as well as managed care penetration rates, as retrieved from the Area Resource File. Hospital-specific expected 30-day mortality for PTCA admissions were derived from Medicare Provider Analysis and Review files (MEDPAR).

Main Analysis File: MarketScan

The main analysis file we use is drawn from the MarketScan file, a claims database drawn from approximately 80 large self-insured employers. Maintaining their confidentiality was a precondition for contributing data to MarketScan. Therefore individual records were stripped of the identity of the employer.[6] For purposes of this research, we obtained data for all hospital admissions for which angioplasty was the primary procedure in 1995 and 1996. After excluding outliers (upper 99th and lower 1st percentiles of the hospital payments), this resulted in a combined raw sample size of 4,916 individual hospitalizations. Prior to 1995, the form of insurance plan was not reported in the data. As of 1995, detailed fields for managed care were added. These plans include comprehensive insurance, major medical, preferred provider organization (PPO), and three forms of Health Maintenance Organizations, namely staff/group model HMOs, point-of-service (POS) HMOs and exclusive provider organizations (EPOs). There were no cases of staff or group HMOs in the data, which is not surprising given that self-insured firms are not likely to provide medical services internally. There were only 18 cases of EPOs in the combined

analysis file; for purposes of analysis these were combined with their closest managed care kin, namely PPOs.

While hospital-based discharge data tend to report "charges" in lieu of payments, the MarketScan data, which are drawn from insurance-based claims reports only "net payments". Charges are akin to *list prices*, prior to any insurer discounting, and thus may not necessarily reflect what the insurer actually paid. Net payments are the amount the hospital actually got paid, and are thus the actual *transaction prices* of interest to us. However, we are also able to exploit the data further, and account for product heterogeneity. A number of variables are used. Among these are binary indicators for number of vessels and stents, thrombolytic infusion (an anti-clotting devise), and number of comorbidities. In addition we include a binary indicator that distinguishes between urgent and non-urgent (elective) procedures. In non-urgent cases there is some flexibility for patients and their physicians in terms of scheduling angioplasty, so we expect prices of urgent procedures to be higher.[7] Summary statistics are presented in Table 1.

Supplementary Data Sources

The data from MarketScan were augmented with variables describing market structure, at the level of the Metropolitan Statistical Area. The Herfindahl index for hospital markets was constructed from the American Hospital Association (AHA) Annual Surveys for 1995 and 1994, and merged with the MarketScan data with a one-year lag.[8] Hospital market shares that make up the main component of this index were calculated from the number of total admissions. Other hospital characteristics that might be related to bargaining position were also taken from the AHA files. These are teaching status, i.e., binary indicators for no teaching, minor teaching, or major teaching, and type of ownership, i.e., government, for-profit, and non-profit. In the MarketScan file a matching AHA ID was found missing for 530 cases, resulting in a final sample size of 4,386 for the price regressions. These mapped out to 452 hospitals and 146 metropolitan statistical areas. [9] Compared with all AHA hospitals with some capacity to perform angioplasties and/or cardiac catheterizations, MarketScan hospitals in our analysis file were somewhat more tilted

towards non-profit status, but virtually identical to AHA hospitals in their distribution by teaching status. [10]

The insurance industry is relatively fragmented, and to date, detailed data on market share by type of insurance have not been compiled. The Area Resource File provided a measure of market segmentation, namely HMO penetration, or the percent of the adult population enrolled in HMOs aggregated to the MSA. This variable also entered the sample with a one-year lag.

Expected mortality rates and standardized mortality rates for the aggregate hospital were taken from the Medicare Provider Analysis and Review (MEDPAR) files, using the HCFA risk-adjustment method. We applied this method to two logistic regression panels centered on 1991 and 1992, thereby obtaining expected mortality rates for 30-day post-admission associated with angioplasty.[11] Expected and standardized mortality rates were merged, with equal lags, into the 1995 and 1996 MarketScan records by provider i.d. number. The observed and predicted hospital-level mortality rates are approximately 5 percent.

Descriptive Results

Mean transaction prices by type of insurance are reported in Table 2, along with standard errors in parentheses, and sample sizes within each cell. There are two major categories, and four subcategories, namely fee for service: which includes major medical and comprehensive insurance, and managed care, which includes PPOs and point of service HMOs. The managed care options were previously described. Major Medical insurance provides coverage for major illnesses requiring large financial outlays, while excluding a variety of small procedures covered by comprehensive plans.

From these descriptive results, a number of interesting observations can be made: Between 1995 and 1996 there was a sharp decline in the number of cases with fee-for-service coverage, and a sharp increase in managed care in our data Apparently, many employers switched from fee-for-service to managed care during this period observed. Thus in 1995 the

combined managed care options accounted for 25 % of all cases, in 1996 their share rose to 46%. Within the fee-for-service and managed care sectors, comprehensive coverage and PPO are dominant. Major Medical in particular is disappearing from the marketplace, accounting for about 8% of all cases in 1995 but only 3% of cases in 1996.

In 1995 mean prices in the major medical, fee-for-service, PPO, and the HMO categories were virtually identical to each other, nearly $13,000, or about 8% below the fee-for-service price. Between 1995 and 1996 there was a slight increase in the mean PPO price and a slight decrease in the mean comprehensive fee-for-service price and HMO prices and an increase in PPO prices. However the relative rankings remained the same in 1996, with comprehensive prices highest, and HMO prices lowest, with a persistent differential of 8%, on average. Prices for Major Medical insurance increased sharply between 1995 and 1996, but this may have been an artifact of the small number of cases in the cell. Because prices in this group showed a wide variation we decided not lump it with the comprehensive fee-for-service category. The regression analysis below allows us to determine whether such price differentials persist after prices are adjusting for various characteristics.

It is also interesting to observe mean unadjusted prices by major classifications of the procedure. As expected, prices for urgent procedures are substantially higher than prices for non-urgent procedures in all classes of insurance. With the exception of the HMO category, prices for the one vessel/with stent variation of the procedure are higher than prices for one vessel/no stent, and prices for multiple-vessels/with stent are higher than prices for multiple-vessels/no stent procedures.

Regression Results:

Log-price regressions are presented in Table 3. Three variants of the specification are reported in the table as models 1, 2, and 3. The variables are identical, except for the hospital outcome measure used (expected PTCA mortality, standardized PTCA mortality). For the most

part all other variables have similar effects across the specifications. Clinical descriptors of angioplasty tend to have statistically significant effects on price, indicating that the more complex the procedure, the higher the price. Stents are a more important determinant of price than number of vessels (stent combinations add anywhere from 24 to 28 percent to price, whereas multiple vessels alone add only 10%). Thrombolytic infusion adds about 35-37 percent to price depending on the specification.[12] Prices for urgent procedures are about 15-16 percent higher compared with non-urgent procedures. The number of comorbidities, a measure of the underlying complexity of the particular case, also adds to price significantly.

The coefficients of hospital characteristics indicate teaching status was not significant. This may be due to angioplasty having become a relatively routine procedure, making the reputation of teaching hospitals carry less weight. Compared with prices in public hospitals, prices at non-profit hospitals are significantly lower by about 13-14 percent; prices at for-profit hospitals tend to be higher by about 13-15 percent, with moderately significant coefficients [13]. Variables that capture the structure of health care markets are generally significant with signs in the expected direction. Thus the lagged Herfindahl index has a positive effect on price while the lagged HMO penetration rate is negative. There was no statistical difference in prices between 1995 and 1996.

The variables of main interest pertain to the form of insurance and managed care. All of the related results were highly significant. Compared with fee-for-service, prices for PPOs were lower by about 8 %, and prices for POS-HMOs were lower by about 24%. Prices for major medical plans fell in between PPO and HMO discounted prices, but pertain to a relatively small number of cases (see table 1), and are more likely to be the result of capping benefits rather than discounting through negotiations with providers in a plan. Interestingly, discounts for managed care are even larger after adjusting for the process of care than would appear from the unadjusted means. Adding expected or standardized mortality rate to the model (specification 2 and 3) had a negligible effect on all other coefficients. Although these variables have the expected sign

(positive for expected rate and negative for the standardized rate) the results were not statistically significant. These results are at least suggestive of the notion that information on hospital performance is not fully reflected in the determination of the market price. However these results should be interpreted with caution since the validity of these measures has been called into question and purchasers may deliberately discount such information (McClellan and Staiger 1999b).

Discussion and Implications

Anecdotes abound that managed care organizations attempt to lower their costs internally by providing lower payments to providers. Our analysis suggests that these payments represent discounts that persist even after adjusting for the underlying patient severity and the characteristics of the medical procedure in a given case, for managed care plans offered by employers. We further find that greater market concentration in hospitals tends to increase prices; HMO penetration tends to reduce prices. Together these results are consistent with the predictions of the bargaining model

Our study complements an earlier related study by Cutler, McClellan and Newhouse (2000) that focused on payments for heart attacks by type of insurance. Their analysis was centered on one large firm that offered a menu of managed care and indemnity choices to its employees. Our analysis incorporates a cross-section of many firms offering similar insurance plans but with choices not known within the firm. Cutler et al. found that HMOs made lower payments, after accounting for intensity of services as measured in terms of length of stay and ancillary services provided. They were able to conclude that these payments were due to real discounts on a per unit basis as high as 20 percent. Rather than focusing on the entire episode of care, our analysis focused on transaction prices for a specific procedure. Thus, we were able to rely on detailed information on variants of the procedure to obtain a price that is adjusted for patient severity and intensity of service delivered. While there may have been residual difference

in resources used between plans in our data, the price discounts we calculated tend to pertain to a relatively homogeneous 'product'. Even with different approaches to measurement, we find strong agreement between our analysis and that of Cutler et al., namely that managed care insurers are able to capture substantial discounts for a given level of service. Interestingly, adjusting for service characteristics results in even greater managed care discounts than would appear from the unadjusted means in the descriptive analysis.

These results were not affected by the inclusion of hospital level performance measures such as the HCFA (now CMS) expected mortality rate. These results are at least suggestive of the notion that information on hospital performance is not fully reflected in the determination of the market price; Indeed, during the mid 1990's access to the CMS and other reporting systems was relatively limited. However these results should be interpreted with caution since the validity of these measures has been called into question, leading purchasers to deliberately discount such information; Moreover, there have been calls for the Federal government to improve the measurement and dissemination of quality information for hospital care on a national basis (Corrigan, Eden, and Smith 2002). Future research should track the impact of new reporting systems on pricing as they enter the market and become more diffused. As the structure of the managed care industry has changed since the mid 1990's future research should also examine whether discounts by MCOs persist.

Notes

[1] (http://hcup.ahrq.gov/HCUPnet.asp, accessed December 15, 2003.

[2] Other studies focused on an "average" price for the aggregate hospital, calculated from total revenue divided by the number of inpatient days or stays. For instance, Melnick et al. (1992) used the average per diem rate for medical/surgical services. Melnick et al. (2000) calculate price for each payer by dividing total revenues by adjusted discharges, given as the sum of actual inpatient cases and weighted outpatient visits. A similar approach is used by Manheim et al. (1994). Keeler et al. (1999) calculate net revenue per discharge by multiplying each patient's total charge by the average discount factor for private patients at their hospital. Dranove and Ludwick, (1999) caution that these methods provide approximations of actual prices, and are subject to measurement error due to unobservable service mix differences. Transaction prices avoid this pitfall, yet negotiations between hospitals and insurers often involve bundled prices, not necessarily individual procedures. However, there is ample anecdotal evidence that hospitals have been willing to grant procedure-specific discounts to HMOs in exchange for guaranteed referrals (Hilzenrath, 1994). Other accounts cite examples of carve-out arrangements and price negotiations between hospitals and insurers that pertain strictly to cardiac procedures such as CABG and PTCA (Anders, 1996, Hilzenrath, 1994). We consider results from the different approaches complimentary. Melnick et al. (1992) find similar effects of managed care discounting in California.

[3] Under the Nash bargaining model, two agents (such as the hospital and the insurer in our example) maximize some measure of their respective payoffs jointly. How the pie ends up being split depends on their relative bargaining power. For a brief review of the properties of this model in a health care setting see Dor and Watson, 1995.

[4] HCFA Risk adjusters for PTCA include age, gender, diabetes, and diagnosis groupings (based on ICD9 codes) of heart attack, congestive heart failure, cerebrovascular cancer, COPD, and organ failure. Many state reporting systems also replicated this method for specific procedures such as PTCA and heart surgeries. The Centers for Medicare & Medicaid Services (CMS) no longer maintains hospital rankings based on mortality rates.

[5] Examples include the Health Quality Choice project in Northeast Ohio, the Pennsylvania Cost Containment Commission Reports, and Greater NY Hospital Association ranking (see Aron et al., 1998, Heller et al., 2001, for instance). The Quality Indicators assembled by the federal Agency for HealthCare Quality and Research were made available for only one year, 1997, i.e., after our study period, and for only 19 states, and thus did not apply to our sample.

[6] Health benefits in the U.S. remain heavily employer-based with about 60 percent of all insured individuals being enrolled through employer-sponsored plans. Self-insurance by firms occurs more frequently than is commonly perceived. In 1993, 40 percent of all employees who receive employer-sponsored health insurance benefits were enrolled in self-insured plans. In large firms of 500 or more employees the proportion of insured employees in a self-insured plan was even higher, at 63 percent (Acs et al. 1996). By 1997, these self-insurance rates declined, but remained fairly high at 33 percent and 55 percent respectively (Marquis and Long 1999).

[7] Urgent cases are defined as cases associated with a diagnosis of heart attack. We are grateful to Kent Kwoh MD at the University of Pennsylvania and David Baker MD at the Northwestern

University School of Medicine for providing and validating ICD-9 codes for conditions such as Myocardial Infarction (AMI), i.e., heart attacks.

[8] The Herfindahl index is defined as the sum of squared shares of admissions in the MSA. The AHA survey has a code flagging hospitals able to perform angioplasty and/or cardiac catheterization, but does not report number of admissions undergoing these procedures. For this reason we opted to report the results based on the overall index. Using *all* admissions within a hospital, the Herfindahl index for angioplasty hospitals increases from 0.14 to 0.25; In alternate price regressions, both indices yielded qualitatively similar results, but the coefficients of the procedure-based index were not statistically significant. The full set of results is available from the authors upon request.

[9] The authors are grateful to Douglas Wholey for providing a mapping of ARF counties to MSAs for purposes of the analysis. Also see Wholey et al., 1995.

[10] In the 1995, 1091 hospitals were flagged as having capacity to perform angioplasty and catheterization. Of these, about 54.8% had major teaching status, while 24.8% were major teaching hospitals. The distribution by ownership was 19.1% for public hospitals, 13% percent for for-profit hospitals, and 67.9% for non-profit hospitals. See similar MarketScan distributions in Table 1.

[11]Three-year panels were used to minimize estimation error in the calculation due to single year fluctuations (Luft and Romano, 1993). While our intention was to adhere to the most widely known and accepted methodology, we made this concession to methodology on the assumption that purchasers would be able to infer random fluctuations in hospitals in their localities. In practice, using annual expected rates or three-year moving average made little difference in the price regressions. Results from the auxiliary mortality regressions are available from the authors upon request.

[12] To obtain accurate percent changes in the semi-log specification, coefficients of binary variables are converted using the transformation $e^{\beta}-1$

[13] We also experimented with interaction terms between each hospital characteristic and type of insurance. The corresponding coefficients were not statistically significant. Therefore we opted to report the more parsimonious specification in this paper.

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Table 1: Variable Definitions and Summary Statistics.

Variable	Data Source/Period	Mean	S.D
Dependent variable			
Hospital price	MarketScan, 1995-1996	13403.5	8590.2
Patient-level severity			
Age	MarketScan, 1995-1996		
Female	Same as above, binary	0.216	0.412
One vessel/no stent	Same as above, binary	0.842	0.365
One vessel/with stent	Same as above, binary	0.022	0.147
Multiple vessels/no stent	Same as above, binary	0.108	0.310
Multiple vessels/with stents	Same as above, binary	0.019	0.137
Thrombolytic infusion	Same as above, binary	0.010	0.094
Urgent procedure	Same as above, binary	0.296	0.456
No. Comorbidities	Same as above, (1-14)	3.270	2.011
Hospital-level outcomes (PTCA admissions)			
Expected mortality rate	MEDPAR (HCFA risk-adjustment, 30-day post-admission) 1991, 1992. For all patients undergoing PTCA.	0.028	0.006
Standardized mortality rate (observed mortality rate / expected mortality rate).	Same as above	0.946	0.366
Insurer and hospital characteristics			
Major Medical	MarketScan, 1995-1996	0.052	0.222
PPO	Same as above, binary	0.297	0.457
Point of service HMO	Same as above, binary	0.061	0.239
Non-teaching hospital	AHA-MarketScan crosswalk, binary	0.238	0.245
Minor teaching hospital	Same as above, binary	0.526	0.499
Major teaching hospital	Same as above, binary	0.236	0.424
Public hospital (N=4386)	Same as above, binary	0.069	0.254
For-profit (N=4386)	Same as above, binary	0.024	0.154
Non-profit (N=4386)	Same as above, binary	0.906	0.292
Market Structure			
Herfindahl index	AHA, 1994-1995 1 year lag	0.138	0.134
HMO penetration at MSA level	Area Resource File, 1 year lag	0.171	0.100

Table 2: Transaction Prices for Angioplasty*, **

	Fee-For-Service		Managed-Care	
	Major Medical	Comprehensive	PPO	HMO (point-of-service)
Urgent	$14,203	$16,192	$15,926	$13,678
	(8,646)	(10,331)	(10,043)	(9,298)
N	79	798	472	104
Non-urgent	$11,066	$12,794	$11,857	$11,945
	(6,458)	(7,252)	(7,191)	(12,970)
N	177	2,103	988	195
One vessel / no stent	$11,415	$13,377	$12,800	$12,521
	(6,549)	(8,007)	(8,118)	(12,091)
N	221	2,490	1170	257
One Vessel / no stent	$18,664	$21,865	$17,410	$11,683
	(10,429)	(11,824)	(9,630)	(7,456)
N	3	42	51	13
Multiple vessels	$14,774	$14,568	$13,382	$12,810
	(9,919)	(9,321)	(8,477)	(12,030)
N	28	301	181	21
Multiple stents	18119	$17,282	$16,693	$14,882
	(.)	(9,277)	(12,189)	(14,726)
N	1	38	51	4
Thrombolytic infusion	$23,413	$18,643	$13,326	$13,386
	(16,546)	(10,582)	(3,529)	(4,753)
N	4	30	7	4
All, 1995	$11,336	$13,808	$12,975	$12,947
	(6,464)	(8,413)	(8,069)	(14,722)
N	178	1585	446	132
All, 1996	$13,626	$13,634	$13,259	$12,232
	(8,850)	(8,281)	(8,595)	(8,955)
N	78	1,316	1,014	167

* Standard errors in parentheses; **Numbers reported prior to exclusion of data due to other missing Variables.

Table 3: Regressions on log(Transaction Price) for Angioplasty [1,2]

Variable	Model 1	Model 2	Model 3
Patient Demographics			
Age	-0.001 (0.001)***	-0.001 (0.001)	-0.001 (0.001)
Male (ref)	----	----	----
Female	0.007 (0.018)	0.007 (0.018)	0.008 (0.018)
Patient-Level Severity			
1 Vessel, no stent (ref)	----	----	----
1 Vessel, with stent	0.217 (0.059)***	0.214 (0.059)***	0.216 (0.059)***
Multiple vessels, no stent	0.096 (0.024)***	0.097 (0.024)***	0.097 (0.024)***
Multiple vessels with stent	0.247 (0.068)***	0.245 (0.068)***	0.247 (0.069)***
Thrombolytic infusion	0.312 (0.078)***	0.303 (0.078)***	0.312 (0.077)***
Non-Urgent (ref)	----	----	----
Urgent	0.144 (0.019)***	0.143 (0.019)***	0.145 (0.019)***
No. Comorbidities	0.043 (0.005)***	0.043 (0.005)***	0.044 (0.005)***
Insurance Type			
Fee-for-service (ref)	----	----	----
Major medical insurance	-0.139 (0.033)***	-0.141 (0.033)***	-0.137 (0.033)***
PPO	-0.085 (0.017)***	-0.088 (0.018)***	-0.082 (0.017)***
HMO	-0.274 (0.043)***	-0.277 (0.043)***	-0.274 (0.043)***
Hospital Characteristics			
Minor Teaching	-0.013 (0.019)	-0.014 (0.019)	-0.011 (0.019)
Major Teaching	-0.023 (0.023)	-0.028 (0.024)	-0.014 (0.024)
Public (ref)	----	----	----
Private for-profit	0.128 (0.069)*	0.120 (0.069)*	0.144 (0.070)**
Private non-profit	-0.146 (0.146)***	-0.148 (0.031)***	-0.143 (0.031)***
Expected PTCA mortality	----	1.613 (1.347)	
Standardized PTCA mortality			-0.040 (0.025)
Market Structure			
Herfindahl Index	0.417 (0.055)***	0.400 (0.058)***	0.426 (0.055)***
HMO penetration	-0.288 (0.082)***	-0.296 (0.083)***	-0.320 (0.084)***
Year procedure was performed			
1995 (ref)	----	----	-----
1996	-0.016 (0.016)	-0.016 (0.016)	0.016 (0.016)
Intercept	9.377 (0.066)***	9.344 (0.069)***	9.412 (0.069)***
R-Square	0.1237	0.1240	0.1244

[1] Huber-White standard errors are used to correct for heteroscedasticity due to hospital clusters.

[2] Note: * $0.05 < p < 0.1$ ** $0.01 < p < 0.05$ *** $p < 0.01$ (All other statistics is not significant at $p > 0.1$)