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ABSTRACT: Almost all U.S. hospitals procure their equipment through group purchasing organizations ("GPOs"). Some hospitals subject the prices secured by GPOs to a second round of competition in an "aftermarket," in which vendors both on and off the GPO contract compete for the hospital's business. To measure the extent of the potential benefit to hospitals from another round of competition, we analyzed a database of approximately 8,100 aftermarket transactions for hospital capital equipment. The transactions data suggest that hospitals were able to achieve average savings of approximately 10 to 14 percent across the entire database (2001 through 2010) and a savings of 15 percent on average for 2010 data. These savings may be attributable to many factors, including the compensation structure of GPOs.

I. INTRODUCTION

Group purchasing organizations ("GPOs") were originally established by small hospitals to pool their purchasing power for more favorable contracts with medical suppliers.[1] By buying as a group, hospitals should achieve lower prices and greater discounts than they would if they bought individually, while also minimizing transaction costs involved in procuring supplies. Since their inception in the early twentieth century, GPOs have greatly expanded in size, number, and importance; in 2009 alone, GPOs negotiated contracts worth $200 to $300 billion,[2] and the vast majority of

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* *Editor's note: A 2010 unpublished study by the authors addressed the topic of group purchasing organizations ("GPOs") and their effect on healthcare costs. The following article presents new methodology and data to support the authors' views.*

1. S. PRAKASH SETHI, INT'L CTR. FOR CORP. ACCOUNTABILITY, GROUP PURCHASING ORGANIZATIONS: AN EVALUATION OF THEIR EFFECTIVENESS IN PROVIDING SERVICES TO HOSPITALS AND THEIR PATIENTS 6, 17 (2006).

2. *Id.* at 18. GPO-financed studies indicate that GPO contract-covered purchases were expected to be worth between $257 to $287 billion by 2009. Sethi independently estimates the market size to be $218 billion in 2005. *Id.* According to a report by Locus Systems, the estimated GPO purchasing volume for 2007 was between $246.3 billion and

hospitals, nursing homes, and other healthcare institutions rely upon them to make purchasing decisions.[3]

Ostensibly, GPOs seek the best products at the lowest prices through a committee deliberation process in which vendors are selected, based on a combination of price and quality factors, to supply an entire network of hospitals.[4] GPOs then negotiate contracts with the manufacturers, distributors, and other suppliers.[5] To cover their operating expenses, GPOs currently charge vendors "administrative" and other fees based on a percentage of the value of the purchases made by the hospitals through these contracts.[6] Indeed, the vast majority of a GPO's income is from vendors (in the form of administrative fees) and not from the GPO's hospital members (in the form of membership dues).[7]

$274.8 billion. *See also* LOCUS SYSTEMS, A 2008 UPDATE OF COST SAVINGS AND A MARKETPLACE ANALYSIS OF THE HEALTH CARE GROUP PURCHASING INDUSTRY 11 (2009).

3. SETHI, *supra* note 1, at 6.

4. *Frequently Asked Questions*, HEALTHCARE SUPPLY CHAIN ASS'N, http://www.supplychainassociation.org/?page=FAQ (last visited Dec. 15, 2011) (formerly Health Indus. Grp. Purchasing Ass'n).

> Most healthcare providers make group purchasing selections in a committee setting, usually comprised of healthcare professionals, such as doctors, nurses and other clinicians. These committees help determine which medical supplies are most appropriate from a clinical standpoint. Once a decision is made, GPOs work to negotiate contracts with healthcare manufacturers, distributors and other suppliers. *Id*.

5. *Id*.

6. U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-10-738, GPOs: SERVICES PROVIDED TO CUSTOMERS AND INITIATIVES REGARDING THEIR BUSINESS PRACTICES 4 (2010) ("GPOs' sources of revenue include contract administrative fees, other fees obtained from vendors, and fees resulting from direct charges to customers. According to a 2009 study, on average, GPO contracts account for about 73 percent of nonlabor purchases that hospitals make"). *Id*.

7. *Id*. at 6 ("This fee is designed, in part, to cover a GPO's operating expenses and serves as its main source of revenue."). *Id*. Some have questioned whether the GPO compensation system creates inherent conflicts of interest. Given its dependency on vendors for financing, a GPO (the "agent") might have an incentive to prioritize the interests of preferred vendors over the interests of its member hospitals (its "principals"). For example, Professor Einer Elhauge of Harvard Law School has explained how GPOs

If a GPO is receiving an administrative fee equal to a percentage of the proceeds, the GPO's incentive to seek out the lowest prices for hospitals is weakened.[8] Moreover, in the presence of administrative fees, medical suppliers might be induced to bid less aggressively on price, as some of their resources are shifted towards competing for the largest administrative fee.[9] The resulting diminution of competition might raise net costs for hospitals and government—which reimburses hospital expenses through Medicare, Medicaid, and other programs[10]—despite the savings in transaction costs and consolidation of purchasing power made possible by GPOs.

Over the past decade, the government and the media have begun to scrutinize GPO practices, particularly in the midst of the economic turmoil and heightened concern over healthcare costs of the last two years. Following a 2002 *New York Times* investigation that highlighted GPOs'

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have brokered contracts with exclusionary provisions that, in effect, reduce competition in the supply of medical products. *See Hospital Group Purchasing: Lowering Costs at the Expense of Patient Health and Medical Innovations? Hearing before the Subcomm. on Antitrust, Business Rights, and Competition of the S. Comm. Of the Judiciary*, 107th Cong. 107-899 (2002) (statement of Einer Elhauge submitted for the record); EINER ELHAUGE, THE EXCLUSION OF COMPETITION FOR HOSPITAL SALES THROUGH GROUP PURCHASING ORGANIZATIONS, REPORT TO U.S. SENATE 20-21 (2002), http://www.law.harvard.edu/faculty/elhauge/pdf/gpo_report_june_02.pdf. *See also* MICHAEL E. PORTER & ELIZABETH OLMSTEAD TEISBERG, REDEFINING HEALTH CARE: CREATING VALUE-BASED COMPETITION ON RESULTS 361-362 (2006) ("buying groups may serve the interests of the suppliers that provide their funding, not providers, thereby undermining value-based competition . . . [t]here is no valid reason for buying groups to accept financing or any payments from suppliers."). *Id*.

8. Another potential incentive problem is that soliciting sales quotes from device manufacturers and reviewing specifications likely requires effort on the part of the GPO, and given their compensation scheme, the GPOs internalize all of those costs. This aspect of the principal-agent problem is similar to the one faced by real estate agents, who are compensated with a percentage of the sale price. *See* Steven D. Levitt & Chad Syverson, *Market Distortions when Agents are Better Informed: The Value of Information in Real Estate Transactions* 1-2 (Nat'l Bureau of Econ. Research, Working Paper No. W11053, 2005).

9. *See generally* Y. NARAHARI ET AL., GAME THEORETIC PROBLEMS IN NETWORK ECONOMICS AND MECHANISM DESIGN SOLUTIONS 266 (2009) (for a primer on bidding in procurement auctions).

10. SETHI, *supra* note 1, at 53.

potential conflicts of interest,[11] Congress initiated a series of hearings to determine whether further legislation on GPOs was needed.[12] In 2005, in response to this public attention, a collection of GPOs launched the Healthcare Group Purchasing Industry Initiative ("HGPII").[13] The HGPII set forth a set of principles meant to serve as a code of conduct and self-governance for the GPO industry.[14] Still, some worried that HGPII lacked sufficient specificity, enforcement, and monitoring, to address the public's concerns.[15] Not satisfied with the self-regulation of GPOs, a group of three U.S. Senators, Herb Kohl of Wisconsin, Charles E. Grassley of Iowa, and Bill Nelson of Florida, sent letters in 2009 to the seven largest GPOs.[16] They requested information on their business practices and copies of contracts.[17] In September 2010, Senator Grassley's office issued a report titled *Empirical Data Lacking to Support Claims of Savings With Group Purchasing Organizations*, noting that "[b]ased on GAO's findings and the study constraints identified in the available literature, there is limited data on the actual savings that may or may not be achieved through GPOs."[18]

The debate over GPO effectiveness has given rise to numerous studies. For example, a 2002 Government Accountability Office ("GAO") study asked whether hospitals paid lower prices on their own or through a GPO when buying the same model of safety syringe.[19] The GAO found that

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11. Walt Bogdanich, *Medicine's Middlemen; Questions Raised of Conflicts at 2 Hospital Buying Groups*, N.Y. TIMES, Mar. 4, 2002, at A18.

12. Mary Williams Walsh, *Senators Investigate Hospital Purchasing*, N.Y. TIMES, Aug. 14, 2009, at B1.

13. SETHI, *supra* note 1, at 9.

14. *Id*. at 10.

15. *Id*.

16. Walsh, *supra* note 12, at B1.

17. *Id*.

18. S. COMM. ON FINANCE, 111TH CONG., EMPIRICAL DATA LACKING TO SUPPORT CLAIMS OF SAVINGS WITH GROUP PURCHASING ORGANIZATIONS 6 (2010) (Sen. Charles E. Grassley), http://grassley.senate.gov/about/upload/2010-09-24-GPO-Report.pdf.

19. *See* U.S. GOV'T ACCOUNTABILITY OFFICE, GA-02-690T, GROUP PURCHASING ORGANIZATIONS—PILOT STUDY SUGGESTS LARGE BUYING GROUPS DO NOT ALWAYS OFFER HOSPITALS LOWER PRICES 2 (2002) [hereinafter 2002 GAO GPO Study]; *Hearing*

median prices were higher by one to five percent through GPOs than outside them for all safety syringe models and for most pacemaker models.[20] According to an investigation by the *Los Angeles Times*, the prices that Novation, the largest GPO, charges the University of California on its drug purchasing contract have been undercut by hundreds of thousands of dollars by a group of oncologists at UCLA who decided to contract with suppliers themselves.[21]

Other recent studies have supported the cost-saving claims of GPOs, concluding that they do indeed generate savings for member hospitals relative to a world without GPOs. In 2008, Burns and Lee surveyed hospital executives in charge of materials management to gauge satisfaction with GPO utilization, services, and performance.[22] While the study concludes that GPOs are effective at lowering product prices and reducing the transaction costs of negotiating contracts, the authors of the study note that these findings are based on the imperfect knowledge of survey respondents rather than on empirical cost savings data.[23] Similarly, Schneller found that GPOs save hospitals as much as $36 billion a year based on surveys of hospital administrators.[24] Additionally, Goldenberg and King calculated that, in 2008, GPOs saved the U.S. government up to $64 billion—including $16 to $36 billion in savings to public health care programs—based on hospital-reported savings of 10 to 18 percent on purchases made through GPOs.[25] Most recently, researchers at Purdue University demonstrated,

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Before the S. Subcomm. on Antitrust, Competition, and Business and Consumer Rights of the Comm. On the Judiciary, 107th Cong. (2002) (statement of William J. Scanlon, Dir. Healthcare Issues).

20. *Id*. at 11.

21. Michael Hiltzik, *Supply Middlemen May Leave Hospitals Ailing*, L.A. TIMES, Apr. 14, 2005, at B1.

22. Lawton R. Burns & J. Andrew Lee, *Hospital Purchasing Alliances: Utilization, Services, and Performance,* 33 HEALTH CARE MGMT. REV. 203, 213 (2008).

23. *Id*.

24. EUGENE S. SCHNELLER, THE VALUE OF GROUP PURCHASING-2009: MEETING THE NEEDS FOR STRATEGIC SAVINGS 4 (2009), http://www.novationco.com/pressroom/industry_info/value_of_gpo_2009.pdf.

25. LOCUS SYSTEMS, *supra* note 2, at i (noting that both the Schneller (2009) and Goldberg and King (2009) studies were commissioned by the Health Indus. Grp. Purchasing Ass'n (HIGPA)).

using theoretical models, that the presence of a GPO lowers *total* purchasing costs for hospitals; however, hospitals face higher *unit* prices than they would if they were to negotiate directly with vendors.[26]

Prior studies on the GPO procurement process focused on the savings realized by a particular hospital or a particular type of medical device. In contrast, this study provides an empirical analysis of aftermarket transactions for medical equipment across many types of devices and several hospitals. To our knowledge, it is the only study of its kind to use actual hospital transactions as source data. It is also the first paper to examine the incremental effect of GPO *financing*. The counterfactual world in prior GPO studies has been a world without GPOs. In contrast, this study takes for granted the efficacy (and existence) of GPOs and focuses narrowly on the price effects relating to GPO financing. It does so by comparing (a) the price secured by an aftermarket broker whose compensation is not tied to the auction proceeds with (b) the price of the *same* device originally secured by a GPO. We obtained a database from MEMdata—a firm that brokers capital equipment purchases for hundreds of medical facilities—of over 8,100 aftermarket auctions for medical equipment from GPO contracts. Unlike most GPOs, MEMdata's compensation is based on a hospital's *savings* relative to some benchmark (typically the GPO contract price).[27]

In Part II, we summarize the database of aftermarket transactions, and we test whether the hospitals in the transactions database are representative of the population of U.S. hospitals. In Part III, we analyze the price improvements afforded to hospitals in the aftermarket. When medical device purchases are brokered by an intermediary whose compensation is not tied to auction proceeds, hospitals enjoy an average price reduction of 10 percent (relative to the GPO price) from 2001 through 2010, and an average

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26. Total purchasing costs remain the same, according to the authors, because the higher unit prices are offset by the lower contracting costs associated with GPOs. Qiaohai (Joice) Hu et al., *The Impact of Group Purchasing Organizations on Healthcare-Product Supply Chains, Manufacturing & Service Operations Management* KRANNERT SCH. OF MGMT., PURDUE UNIV. (forthcoming 2011).

27. *See* MEMDATA PROGRAMS & SERVICES, http://www.memdata.com/services.php (follow "Performer" hyperlink) (last visited Nov. 30, 2011).

> MEMdata's eRFP service is a procurement auction process in which all sources of equipment are identified at the lowest prices through full, fair and free competitive bidding. You forward all capital proposals for eRFP processing and simply choose your preferred vendor. MEMdata's fee for Performer is a percentage of your hard dollar savings. If there are no savings, there is no fee. *Id*.

price reduction of 15 percent in 2010. Using regression analysis, we identify the factors that explain the variation in savings across the auctions. In Part IV, we review the policy implications of our findings and consider the limitations of our analysis.

II. THE DATABASE OF AFTERMARKET TRANSACTIONS

We obtained a database of approximately 8,100 aftermarket medical device transactions between 2001 and 2010 from MEMdata,[28] a firm that conducts procurement auctions for GPO-member hospitals seeking to improve upon the prices offered by the incumbent suppliers on the GPO contract.[29] As noted above, unlike most GPOs, whose compensation is tied to contract *revenues*, MEMdata is compensated according to the *savings* realized by the hospital. Before availing themselves of aftermarket options with MEMdata, many hospitals undertake significant additional negotiation efforts (for example, taking advantage of promotions and clearances), thereby limiting the potential for savings. MEMdata's procurement auction process is delivered from an online platform called electronic Request For Proposal ("eRFP"). Vendor proposals are processed electronically and archived in a proprietary database.

The database contains competitive bids for a range of capital equipment—defined as medical supplies expected to last for more than twelve months. Competitive bids are those from suppliers not on the GPO contract.[30] The "awarded price" (that is, the winning bid) in the transaction database ranges from $29.95 (for an oximeter thermometer) to $2.8 million (for an Intensity Modulated Radiation Therapy system). The categories of capital equipment in the database include: biomedical, dietary, imaging, information technologies, laboratory, laundry, monitoring, oncology, physical therapy,

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28. The mere participation in an aftermarket transaction does not affect a member hospital's eligibility to remain in the GPO; rather, purchasing some supplies off the GPO contract typically results in pricing penalties on remaining items purchased on the GPO contract. *See infra* Part IV.

29. In supplying the transaction data, MEMdata required strict non-disclosure rules be followed and that no pricing associated with any vendor, GPO, hospital, or equipment models be disclosed.

30. While hospitals often incur penalties from buying off the GPO contract (for example, hospitals typically pay higher prices for not meeting share-based requirements or for not complying with a bundled rebate, and are sometime forced to return prior rebates), most GPO contracts do not explicitly bar them from doing so. All of the hospitals in our transactions database belong to GPOs.

plant, storage, surgery, telecom, and vehicles. Although these categories span a diverse range of equipment, most categories account for a very small percentage of transactions in our database, as illustrated in Table 1 below. When a product can be categorized, the most common categories are biomedical, surgery, and imaging equipment.

TABLE 1: COUNT OF OBSERVATIONS BY CATEGORY

Device Category	Count Obs.	Percent of Obs.
No Category	4,722	58%
Biomedical	707	9%
Surgery	565	7%
Imaging	514	6%
Information Technologies	347	4%
Laboratory	297	4%
Monitoring	265	3%
Physical Therapy	202	2%
Dietary	140	2%
Plant	127	2%
Storage	121	1%
Telecom	46	1%
Laundry	15	0%
Vehicles	14	0%
Oncology	13	0%
Stress Test Systems	8	0%
Patient Assistance Device	4	0%
Cardio Fitness Equipment	1	0%
Compression	1	0%
Patient Positioning	1	0%
(All)	8,110	100%

An observation in the database of aftermarket transactions includes the auction number and date; hospital name, size, and zip code; type and quantity of devices required by the hospital; original GPO price from the incumbent supplier by device type; the bids of rival device companies by device type; and the savings achieved by the hospital. As each observation is a separate auction, hospitals may be repeated across multiple observations. For example, if a hospital procures ten different items in the aftermarket, the hospital appears ten times in the database (no many how many units of each

item was purchased). Supplemental data on the hospitals, including the type of facility and total patient revenue, were obtained from the American Hospital Directory ("AHD"). Table 2 shows the summary statistics of the variables in the combined database.

TABLE 2: SUMMARY STATISTICS OF KEY VARIABLES

Variable	Obs.	Sample Mean	Sample Std. Dev.	Minimum	Maximum
Hospital staffed beds	7,294	134	149	4	799
Number of competitive bids	8,110	2.7	1.9	1	31
Hospital patient revenues	7,294	$294 million	$563 million	0	$3.38 billion
Hospital net income	7,294	$503,034	$18.3 million	-$120 million	$148 million
GPO price	8,110	$81,436	$249,080	$1	$4.81 million
Awarded price	8,110	$73,990	$227,041	$0	$5.29 million

Notes: We were able to match a hospital in the transactions database to the AHD database in 7,294 auctions or approximately 90 percent of all auctions in the transactions database (280 out of 341 hospitals). In cases where the "awarded price" field was blank (about 40 percent of the records), we populated it with the lowest competing non-incumbent bid.

As Table 2 shows, the average hospital in the transactions database had 134 beds, $503,034 in annual net income, and $294 million in annual patient revenues. The average incumbent price was $81,436, and the average awarded price was $73,990. On average, the aftermarket auction induced 2.7 competitive bids.

To determine whether the sample of hospitals in the aftermarket transaction data was representative of the larger population of U.S. hospitals, we compared the means of the hospitals' characteristics in the transactions database with the same characteristics in the AHD database of 6,971 U.S. hospitals in Table 3.

TABLE 3: COMPARISON OF MEAN OF HOSPITALS FROM TRANSACTIONS SAMPLE WITH U.S. POPULATION OF HOSPITALS

	Staffed Beds	Total Patient Revenues	Net Income
Mean value from the AHD database (μ)	135	$277 million	-$126,127
Standard deviation from the AHD database (σ)	267	$553 million	$73.6million
Mean value from the transactions database (M)	127	$254 million	$2.4million
Sample observations (n)	280	280	280
Standard error of the mean $SE = \sigma / \sqrt{n}$	15.96	$33 million	$4.4 million
z statistic $z = (M - \mu) / SE$	-0.501	-0.697	0.574

As Table 3 illustrates, the means of the sample and the population of U.S. hospitals are fairly similar. The mean number of hospital beds from the sample of transaction data is 127, which is 0.501 standard error units from the population mean of 135.[31] One cannot reject the null hypothesis that the hospitals in the transactions database are comparable to a simple random sample from the population of U.S. hospitals. The same conclusion is true for total patient revenues and net income.[32] Accordingly, we conclude that our sample is not significantly different from the entire population of hospitals in terms of these characteristics. It is also worth noting that the hospitals in the transaction database are located in 41 distinct U.S. states, which suggests that most regions of the country are represented.

To determine whether the GPOs in the transactions database were representative of the population of GPOs, we compared the identity of GPOs in the transactions database with a list of GPOs by market share. According to the GAO, the top seven GPOs control 85 percent of the market share.[33]

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31. Using the z-score, a measure of the distance in standard deviations of a sample from the mean, we find that the probability of observing a standard normal value below -0.501 is approximately 0.309. The two-sided p-value is approximately 0.618 (twice the one-sided p-value). Accordingly, with probability 1 – 0.618 = 0.382, a simple random sample of 280 hospitals would have a mean test score within 8 (equal to 127 - 135) units of the population mean.

32. The corresponding z-scores are -0.697 and 0.574, respectively.

33. U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-03-998T, USE OF CONTRACTING PROCESSES AND STRATEGIES TO AWARD CONTRACTS FOR MEDICAL-SURGICAL PRODUCTS 4 (2003).

Based on an annual survey of GPOs conducted by *Modern Healthcare*, S. Prakash Sethi computed the relative share of 16 survey respondents (plus Consorta), which collectively comprise 98 percent of all purchases made through GPOs.[34] This analysis reveals that the top two GPOs (Premier and Novation) accounted for slightly over 50 percent of purchases in 2005; the top four GPOs (Premier, Novation, MedAssets, and Broadlane) accounted for slightly less than 75 percent; and the top ten (Premier, Novation, MedAssets, Broadlane, Amerinet, Health Trust, Consorta, HealthCare Purchasing Partners, GNYHA, and Innovatix) accounted for approximately 98 percent.[35] Table 4 shows the GPOs that are represented in the transactions database.

TABLE 4: GPOS REPRESENTED IN THE TRANSACTIONS DATABASE

GPO Name (Rank)	Represented?	GPO Name (Rank)	Represented?
Premier (1)	Yes	GNYHA (9)	Yes
Novation (2)	Yes	Innovatix (10)	Unknown
MedAssets (3)	Yes	AllHealth (11)	Unknown
Broadlane (4)	Yes	Hospital Purchasing Service (12)	Unknown
Amerinet (5)	Yes	Yankee Alliance (13)	Unknown
Health Trust (6)	Yes	Resource Optimization (14)	Yes
Consorta (7)	Yes	Child Health Corp. (15)	Yes
HealthCare Purchasing Partners (8)	Yes	National Capital Area Shared Services (16)	Unknown
		Services Healthcare (17)	Yes

As Table 4 shows, 12 of the top 17 GPOs are represented in the transactions database. Accordingly, the population of U.S. GPOs appears to be well represented in the transactions database. MEMdata did not keep an electronic record of the identity of the GPO for each aftermarket transaction, which prevents us from testing the hypothesis that some GPOs are better at securing lower prices than others.

III. EMPIRICAL ANALYSIS OF THE AFTERMARKET DATA

We now turn to estimating the savings (relative to the GPO-negotiated price) realized by hospitals on capital equipment purchases when the broker's compensation is not tied to auction proceeds. We also explain the variation in the savings across the auctions in the database. Before identifying explanatory variables, we first summarize the savings achieved

34. SETHI, *supra* note 1, at 26 (citing Cinda Becker, *Of Two Minds*, MODERN HEALTHCARE, Aug. 15, 2005, at S1-S5).

35. *Id.* at 23 (Exhibit 2).

by hospitals in the transactions database in Table 5. These savings are calculated by comparing the lowest GPO incumbent price to the awarded price (or, when awarded price field is blank, the lowest competing non-incumbent bid) for each auction. Each savings computation corresponds to a single transaction in the database, and is thus a one-time savings and not ongoing. To be as conservative as possible, we included all observations for the purpose of making these savings calculations. In a handful of observations (1.4 percent), the percent savings were negative—that is, the hospital ended up spending more on the device than the GPO-negotiated price, 21.7 percent of auctions provided no savings, and 76.9 percent provided positive savings.[36] Positive savings amounts indicate that the awarded price was less than the GPO-negotiated price. Including cases where the aftermarket auction did not produce *any* price improvement for the hospital tends to bias our average savings estimate downward.

Table 5 contains average savings amounts as well as percentages across all years from 2001 to 2010. It includes both our conservative estimates, which include negative and zero percent savings observations, as well as averages across observations with positive savings only. We include this second set of numbers because negative savings almost always indicate data anomalies or instances where the hospital chose to spend more money on a higher quality item; similarly, zero savings might mask a potential increase in utility to the hospital that is not quantifiable through price data. For example, an incumbent may have issued a revised bid for the same price, but with the addition of free shipping or installation. Competitive bids such as this would produce zero price savings according to the transactions database, even though actual savings were achieved.

TABLE 5: SUMMARY OF AVERAGE SAVINGS, 2001-2010

Conservative Average Savings Amount	Conservative Average Percent Savings	Average Savings Amount (Positives Only)	Average Percent Savings (Positives Only)
$7,446	10%	$10,039	14%

According to these results, the aftermarket transactions afforded hospitals in the database an average savings of 10 percent by conservative estimates, and 14 percent if we exclude negative and zero savings observations, off the GPO-negotiated price.

36. If a hospital seeks out an intermediary to achieve a savings, but if that intermediary is not successful in generating a lower bid, then the hospital most likely would remain with the incumbent supplier.

Next, we identify through regression analysis the factors that determine the magnitude of these savings for a given auction. Our model includes hospital fixed effects, as hospitals are repeated across multiple observations in the dataset, as well as indicators for year and device type. The model further illustrates whether there were multiple incumbent suppliers on the GPO contract (that is, the entrant had to improve on the lowest of two GPO prices), whether the incumbent(s) lowered its initial bid, and total number of rival bids and total number of rival bids squared.[37] The fixed-effects can be used to determine whether any hospital enjoys savings significantly above or below the average savings enjoyed by all hospitals in the database, controlling for all other factors. To filter out data anomalies and possible errors, we excluded auctions containing outliers in terms of total rival bids and percent savings from our regression analyses. Outliers were defined as observations that are either less than the first quartile minus 1.5 times the interquartile range, or above the third quartile plus 1.5 times the interquartile range.[38] The results are presented in Table 6.

TABLE 6: REGRESSION RESULTS
(DEPENDENT VARIABLE = PERCENT SAVINGS)

Explanatory Variable	Coefficient	Std. Err.	*t* statistic
Total Rival Bids	0.0200***	0.0027	7.3
Total Rival Bids Squared	-0.0013***	0.0004	-3.44
Single Incumbent	0.0403***	0.0056	7.25
Incumbent Lowered Bid	0.0160***	0.0026	6.18
Year 2002	0.0065	0.0186	0.35
Year 2003	0.0086	0.02	0.43
Year 2004	-0.0233	0.0196	-1.19
Year 2005	-0.0203	0.0198	-1.02
Year 2006	-0.0233	0.0193	-1.21
Year 2007	-0.0211	0.0192	-1.1
Year 2008	-0.0169	0.0195	-0.87

37. We observed that the incremental effect of an additional bid was not constant—that is, the first few rival bids are more powerful than the last.

38. Outliers are identified using definitions found in standard statistics textbooks. *See*, *e.g.*, RAND R. WILCOX, FUNDAMENTALS OF MODERN STATISTICAL METHODS: SUBSTANTIALLY IMPROVING POWER AND ACCURACY 32-34 (2d ed. 2010).

Explanatory Variable	Coefficient	Std. Err.	*t* statistic
Year 2009	-0.0232	0.0195	-1.19
Year 2010	0.0013	0.0201	0.07
Category Biomedical	-0.0091	0.0063	-1.44
Category Cardio Fitness Equipment	-0.0961***	0.0069	-13.97
Category Compression	-0.0169**	0.006	-2.82
Category Dietary	0.0131	0.0105	1.24
Category Imaging	0.003	0.0061	0.49
Category Information Technologies	-0.0099	0.008	-1.24
Category Laboratory	-0.0012	0.0065	-0.18
Category Laundry	0.0179	0.0245	0.73
Category Monitoring	0.0057	0.0078	0.73
Category Oncology	0.0321**	0.0107	3.01
Category Patient Assistance Device	-0.0196	0.0337	-0.58
Category Patient Positioning	-0.0379***	0.0072	-5.22
Category Physical Therapy	-0.0012	0.0106	-0.11
Category Plant	0.0123	0.0131	0.94
Category Storage	0.0128	0.0128	1
Category Stress Test Systems	0.0347	0.039	0.89
Category Surgery	0.0001	0.007	0.01
Category Telecom	0.0119	0.0163	0.73
Category Vehicles	-0.023	0.0121	-1.9
constant	0.0147	0.0213	0.69

Notes: Hospital indicators are not shown above (significant for 281 out of 338 hospitals). Reference groups for years and categories are 2001 and 'No Category,' respectively. Outliers for total rival bids and percent savings have been dropped. R-squared equal to 0.16. Number of observations equal to 7,314. Asterisks are used to indicate significance of coefficients: * for p<.05, ** for p<.01, and *** for p<.001.

As Table 6 shows, rival bids exert downward pressure on the awarded price (and thus increase the percent savings) at a decreasing rate, increasing percent savings by an average of 1.7 percentage points (equal to $2\% + 2 \times -0.13\% \times 1$) for the first competitive bid and by an additional 1.5 percentage points (equal to $2\% + 2 \times -0.13\% \times 2$) for the second competitive bid and so on. Similarly, if an auction involves a single incumbent—that is, there was only one incumbent price to beat—then savings increase by four percentage points on average. Presumably, this

effect occurs because lone incumbents are more insulated from competition; therefore, their original prices will be higher than those offered when the hospital has another readily available option. Because higher starting prices leave more room for savings through solicitation of rival bids, the coefficient is positive. The coefficient on *incumbent lowered bid*, which indicates whether the incumbent on the GPO contract was induced to submit a revised bid that improved upon its initial offer, is also positive and significant at the five percent level.

IV. POLICY IMPLICATIONS

GPOs play an important role in brokering transactions between hospitals and medical device suppliers. Our empirical findings suggest that hospitals can achieve significant savings relative to the GPO-negotiated price through participation in medical-device aftermarkets. To the extent that the savings relative to the GPO-negotiated price are attributable to the broker's compensation—and not to some other factor that we failed to control for—our findings could lend support for reforming the way in which GPOs are financed. According to economic theory, the current GPO compensation system could induce GPOs to preserve some degree of pricing power for their preferred vendors. A more competitively priced fixed administrative fee means less compensation for GPOs. If GPOs were prevented from receiving administrative fees from medical suppliers, which could be achieved by removing the safe harbor from the anti-kickback statute, then GPOs would likely structure their procurement process in a way that elicited more competitive bidding, resulting in lower prices and greater competition. Importantly, as our preferred approach would merely alter the financing of GPOs, any efficiencies that GPOs currently offer, including reduced transactions costs or consolidated buying power, would be preserved.

Despite both the economic and statistical significance of our results, there are a few remaining validity concerns and caveats. First, the observed savings might be driven in part by sample selection—that is, hospitals that seek out savings in the aftermarket, and thereby appearing in this database, are more likely to achieve lower prices than hospitals that do not seek out savings in the aftermarket. Schneller mentions that hospitals may "utilize GPO pricing as benchmarking and utilize GPO contract pricing to achieve custom contracting for their organizations."[39] However, a selection hypothesis would require that hospitals *know* when they are not getting the best prices; in the absence of any available benchmark for comparison, this alternative explanation seems unlikely. The selection hypothesis is further strained by our finding that over 20 percent of auctions in the transactions

39. SCHNELLER, *supra* note 24, at 15.

database generated no savings relative to the GPO price, suggesting that hospitals do not know when they are not getting the best price.

Second, it is also important to note that price is not the only factor that differentiates one contract from another. Hospitals must also consider service agreements, clauses regarding product guarantees and return policies, service level agreements, possible rebates, and other add-ons not captured by price.[40] To the extent that these non-price factors are not controlled for in our regressions (and are correlated with the awarded price), our estimated savings could be upwardly biased. That said, these terms may be just as negotiable as price and similarly improved upon in the aftermarket setting. Thus, it is unclear whether and in which direction these unobserved factors could bias our results.

A third, and final, limitation of this analysis is its focus on the procurement of capital equipment. Although GPOs are intimately involved in the procurement of capital equipment, they broker other types of materials, particularly commodities and pharmaceuticals,[41] which we were not able to analyze due to lack of data. It is uncertain to what extent our findings would be valid across these other types of purchases. A future path of research would be to obtain a comparable database of aftermarket transactions for other types of medical devices.

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40. DEP'T OF JUSTICE AND FED. TRADE COMM'N, IMPROVING HEALTH CARE: A DOSE OF COMPETITION 3 (2004), http://www.ftc.gov/reports/healthcare/040723healthcarerpt.pdf ("Although CMS uses an administered pricing system for Medicare, hospitals engage in non-price competition to attract Medicare and Medicaid beneficiaries, and engage in price and non-price competition for private payors and patients. As detailed below, competition in the market for hospital inpatient services has enhanced quality and lowered prices."). *Id*.

41. SCHNELLER, *supra* note 24, at 24. *See also* Burns & Lee, *supra* note 22, at 211.