Buying Loyalty or Bargaining Power? Examining the Motivation for Vertical Integration between Physicians and Hospitals*

Haizhen Lin
Indiana University & NBER

Ian M. McCarthy
Emory University & NBER

Michael Richards
Vanderbilt University

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1 Introduction

Relationships between physicians and hospitals have dramatically changed in recent years. The nature of these relationships, however, is not well understood. At one extreme, physician practices or groups may be formally acquired by a hospital or hospital system. Recent years have seen a new wave of these relationships forming in the U.S., with the fraction of physicians working in practices owned by hospital systems increasing from 7% in 2009 to 25% in 2015 (Richards *et al.*, 2016). At the other extreme, physicians may remain fully independent but nonetheless choose to operate almost exclusively with a given hospital. We refer to the observed frequency with which physicians admit or refer patients to a given hospital as "physician loyalty," which may or may not be driven by a formal contractual relationship with a given hospital. This differs from the

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notion of vertical integration (VI) between physicians and hospitals, which we define as the formal ownership of a physician practice by the hospital or hospital system.[1]

Empirical evidence suggests that physician loyalty is far more prevalent than VI. For example, Baker *et al.* (2016) show that in less than 7% of hospital admissions is the admitting physician or practice owned by the hospital, while 60% of all admissions are to hospitals that do not own any physician practices. But when allowing for both formal and informal physician-hospital relationships reflected in observed patient flows, McCarthy (2017) finds that Medicare admissions are isolated to one hospital for 60% of physicians (i.e., 60% of physicians are 100% loyal to a single hospital based on the Medicare population).

In this study, we first examine the effect of VI on physician loyalty. Essentially, does vertical integration serve to increase physician loyalty, or do hospitals simply integrate with physician practices that are already loyal to that hospital? We answer this question by estimating the effects of VI on observed loyalty, the latter of which is measured as the share of a given physician's operations performed at a given hospital. This analysis is done at the physician-hospital level. Here, in addition to linear fixed effects estimates allowing for unobserved, time-invariant physician and hospital factors, we employ a two-stage least squares (2SLS) estimator in which our instruments for vertical integration include a set of plausibly exogenous, time-varying physician and hospital characteristics.

We then examine the effect of hospital-physician integration on quality of care and hospital prices, where we differentiate between two potential motivating factors for vertical integration. First, VI may be a tool to improve patient care (e.g., via improved care coordination). Second, VI can increase a hospital's bargaining position by facilitating a more credible threat in negotiations with insurers. While these motives are not mutually exclusive, we argue that integration pursued for purposes of patient care will intuitively generate some observed change in physician behaviors. Adopting physician loyalty as one such behavior, observed integration with little increase in loyalty relative to non-integrated physicians may suggest that integration was driven by a bargaining motive over care improvement.

Our analysis is based on a panel of all U.S. general medical and surgical hospitals from 2008 to 2015 and derives from various data sources. We employ the SK&A physician database to

[1] More generally, physician-hospital "alignment" typically refers to some underlying contractual relationship between physicians and hospitals (Cuellar & Gertler, 2006; Ciliberto & Dranove, 2006), of which formal VI serves as one possible relationship.

identify formal physician-hospital VI, and we quantify physician loyalty using observed patient flows from 100% of the Medicare fee-for-service inpatient claims over the same time period. We limit our claims data to planned and elective procedures so as to focus on hospital admissions for which physicians may have some influence on hospital selection. We measure quality using estimated hospital fixed effects from a regression of observed mortality at the inpatient level, and we measure hospital prices as the inpatient revenue per discharge for non-Medicare patients based on data from the Healthcare Cost Report Information System (HCRIS) (Dafny, 2009).

Our analysis of physician loyalty finds that VI has a significant effect on a physician's share of operations performed at a given hospital, with loyalty increasing by at least 17 percentage points among vertically integrated physicians relative to non-integrated physicians. These results are consistent with those of Baker *et al.* (2016), who examined the effect of hospital-physician VI on patient hospital choice and found that patients were significantly more likely to choose a given hospital if the admitting physician was part of a practice owned by that hospital. Turning to our analysis of hospital outcomes, preliminary results suggest that VI driven by a bargaining motive may increase prices and decrease quality. Conversely, when VI results in some observed change in physician behaviors, we estimate a small but significant improvement in quality and a reduction (albeit statistically insignificant) in price.

The existing studies of hospital-physician VI focus almost exclusively on the average treatment effect of VI on prices or expenditures. For example, Cuellar & Gertler (2006) found that integration led to higher prices and no efficiency gains, while Ciliberto & Dranove (2006) found no effect of vertical integration on hospital prices. Baker *et al.* (2014) similarly found that an increase in market share for more vertically integrated systems was associated with higher prices and increased spending.[2] Missing from this literature is the underlying motivation for integration and how such motivation may ultimately influence our understanding of the effects of VI in healthcare. Our study addresses this latter issue, with two specific contributions. First, our physician-level analysis provides an examination of which types of physicians and hospitals are likely to align as well as the effects of integration at the physician level. Second, we differentiate the effects of VI at the hospital-level according to the underlying motivation for VI. Examining the distinction

[2] In related studies, Afendulis & Kessler (2007) found that overall Medicare expenditures increased when patients with coronary artery disease were treated with a physician as part of an integrated network relative to a nonintegrated physician. Lammers (2013) investigated the effect of physician-hospital integration on technology adoption. Using state variation in corporate practice of medicine laws as an instrument for physician-hospital alignment, the author found that vertical integration has a significant positive effect on hospital adoption of electronic medical records and computerized provider order entry.

between integration for purposes of additional referrals/admissions (as measured by physician loyalty) versus bargaining is the central contribution of our study. From a policy perspective, differential effects on hospital outcomes due to these two motivating factors may help to identify which vertically integrated relationships merit further scrutiny versus which relationships are more likely to improve patient outcomes and efficiency.

The remainder of the paper is organized as follows: In Section 2, we briefly discuss the theoretical arguments for vertical integration (or, more generally, increased physician-hospital alignment); Section 3 discusses our overall empirical framework and dataset construction; Section 4 examines the effect of VI on physician loyalty; Section 5 discusses the effects of VI on hospital outcomes, including our differentiation between effects that appear to be driven by a bargaining motive versus effects more likely driven by an efficiency motive; and Section 6 concludes.

2 Vertical Integration versus Loyalty

The literature tends to define physician-hospital "alignment" as some formalized relationship between physicians and hospitals. This often means that the hospital or hospital system owns the physician practice, although other relationships may include an independent practice association, a group practice without walls, an open physician-hospital organization, a closed physician-hospital organization, or a management service organization.[3] Unfortunately, these different types of "alignment" many not reflect any contractual requirements on behalf of physicians or physician practices with regard to general practice patterns. Data on these other forms of alignment are also limited in that they are only available at the hospital level. We therefore focus on the effects of vertical integration between physicians and hospitals, defined as the acquisition of a physician practice by a hospital or hospital system.

The distinction between VI and physician loyalty is important for two central reasons. First, loyalty can exist without formal (contractual) integration. Even in the traditional hospital-physician arrangement (i.e., private practice physicians with admitting privileges at one or many local hospitals), physicians may choose to operate or refer patients almost exclusively to a given hospital or hospital system. The converse is also true – that integration can occur without an effect on loyalty. Second, a hospital can more easily translate integration into increased bargaining power

[3]The AHA identifies all such arrangements as "integrated healthcare delivery...implementing physician compensation and incentive systems for managed care services."

if the hospital and physician practice are formally integrated. In this sense, integration provides a formal mechanism with which to change physician behaviors or maintain credible threats in a bargaining context.

We argue that this distinction between loyalty and integration allows us to empirically separate the effects of vertical integration on hospital outcomes between effects more likely to be driven by a bargaining motive versus effects possibly driven by improvements in patient care. Specifically, we hypothesize that vertical integration is more likely pursued for bargaining purposes if physician loyalty is largely unchanged following vertical integration, while integration leading to large increases in loyalty may plausibly (though not necessarily) be motivated by goals other than increased bargaining power. We further outline our identification strategy in Section 3, with specific details in Sections 4 and 5.

3 Empirical Framework

Our empirical analysis proceeds in two related steps. Here, we discuss our broad estimation strategy and underlying identification assumptions in both steps. We then discuss details of our dataset construction.

3.1 Estimation Strategy

First, we estimate the effect of integration on loyalty based on data at the physician-hospital level. We measure alignment using the observed share of a physician's operations going to a given hospital, and we measure integration based on a hospital's ownership of a physician practice as captured in the SK&A data. This analysis is similar in spirit to Baker *et al.* (2016), where they estimate the effect of a physician practice being owned by a hospital on the probability of the physicians' patients being admitted to that hospital. The results of this analysis allow us to estimate the change in the share of each physician's operations going to a given hospital due to vertical integration, which acts as a generated instrument in our second-stage analysis.

Second, we aggregate the observed shares from the physician-hospital data up to the hospital level and form two measures of physician loyalty: one among vertically integrated physicians and one among all other physicians that operate at a given hospital. We measure the extent to which vertical integration drives physician loyalty by taking the difference between these measures.

For example, denote by s_h^1 the average share of physicians' operations going to hospital h among physicians that are vertically integrated with the hospital. Similarly denote by s_h^0 the average share of physicians' operations going to hospital h among physicians that are not vertically integrated with the hospital.[4] The difference between these measures, $\triangle s_h = s_h^1 - s_h^0$, then captures the degree to which vertical integration facilitated an increase in physician loyalty. We instrument for $\triangle s_h$ using the predicted difference in average shares from our first-stage analysis at the physician-hospital level.

Our analysis ultimately attempts to measure a hospital's underlying motivation for observed vertical integration. Specifically, if a hospital acquires a physician practice with no subsequent increase in loyalty, then we take this as evidence that the acquisition was motivated more for bargaining purposes. If instead a hospital purchases a physician practice and sees large increases in loyalty from those physicians, then it is possible that some motivating factors other than bargaining power may have been at play. Therefore, in the context of the literature on vertical integration between physicians and hospitals, the central identifying assumption in our analysis is that integration driven by a bargaining motive will have smaller effects on loyalty than integration motivated by some other factors. If this assumption does not hold, it will tend to bias our estimates toward zero.

3.2 Description of Data

Our analysis is based on Medicare claims data from 2008 through 2015, where we have 100% of the inpatient and (institutional) outpatient claims along with the universe of physician office (i.e., carrier) claims for a 20% sample of Medicare beneficiaries. We focus on planned inpatient operations in which we observe the National Provider Identifier (NPI) of the operating physician, where we define a planned admission as an "elective" admission type that is initiated by a physician, clinic, or HMO referral. This excludes, for example, transfers from other hospitals or inpatient stays initiated through the emergency department, urgent care center, or trauma center. From the claims data, we construct a dataset of all observed physician-hospital pairs for each year from 2008 through 2015. The physician-hospital data include the share of a given physician's operations at each hospital in a given year; hospital characteristics including zip code, NPI, total

[4] In addition to the average shares, we also measure alignment using a concentration index calculated as the sum of squared shares across physicians for each hospital.

admissions, total charges, total reimbursements from Medicare, and total diagnosis related group (DRG) weights; and physician characteristics including office zip code, NPI, primary specialty, practice tax ID, and total operations across all hospitals.

We then merge to these data several additional datasets. First, we obtain data on hospital ownership of physician practices from SK&A, a commercial research firm that regularly surveys the ambulatory physician practice landscape. The SK&A database approximates a near-universe of U.S. office-based physician practices and provides detailed information regarding practice ownership affiliations (including the health system name for those vertically integrated), practice specialty, practice size, and practice location. The SK&A data also includes each physician's NPI, which we use to merge to the claims data.

We incorporate additional hospital-level data from the provider of service (POS) files and the American Hospital Association (AHA) annual surveys, again merged based on Medicare provider number. These data include the number of staffed hospital beds and indicators for hospital teaching status, membership in a larger hospital system, and for-profit/not-for-profit ownership. We then merge hospital financial information and data on total discharges from the Healthcare Cost Report Information System (HCRIS) based on the Medicare provider number. Finally, we incorporate local demographic and other county-level controls from the American Community Survey (ACS), merged based on county FIPS codes observed in the AHA data.

The resulting unit of observation is a physician-hospital-year. We focus on a balanced panel of physicians from 2008 through 2015 with offices located in the contiguous United States. We also drop physicians that ever operate at a hospital more than 120 miles from their primary office or who are not matched in the SK&A data. The resulting analytic data consists of 317,271 physician-hospital observations over the entire time period. Descriptive statistics of our physician-hospital variables are provided in Table 1. These data show that physicians perform an average of between 24 and 25 operations (on between 23 and 24 unique patients) at a given hospital in a given year. These numbers are very consistent over time, with a small decrease in the number of a physician's operations per hospital from 25.16 in 2008 to 24.32 in 2015. We also see that physician practices are located relatively close to the hospitals at which the physician operates, with an overall average distance of 6.2 miles over the entire time frame. Interestingly, this distance has increased persistently over time (albeit of a small magnitude) from 5.7 miles in 2008 to just under 7 miles in 2015.

Table 1

The "Hospital Share" variable in Table 1 reflects the average share of each physician's operations performed at a given hospital. This serves as our measure of physician loyalty. Consistent with increasing integration of physician practices with hospitals (Richards *et al.*, 2016; Baker *et al.*, 2014), we see that the average share of a physician's operations going to a given hospital has increased from 61% in 2008 to 68% in 2015. Relatedly, we see a large increase in the percentage of physician-hospital pairs for which the physician practice is owned by the hospital or hospital system, with just 11% of all such pairs in 2008 up to 29% in 2015. These summary statistics in Table 1 also suggest a large degree of physician loyalty even in the absence of formal vertical integration. In particular, the percentage of physician-hospital pairs that are vertically integrated nearly tripled from 2008 to 2015, while the degree of loyalty (as measured by hospital share) increased just 10%.

Tables 2 - 4 present descriptive statistics for individual physicians, hospitals, and counties, respectively. From Table 2, the average physician performed 41 operations (39 unique patients) in 2008 compared to 36 operations (34 unique patients) in 2015. Recall that these counts reflect planned and elective surgeries that were initiated by a physician, insurer, or clinic. As such, these counts do not necessarily reflect the total number of operations performed by a given physician in each year. Also from Table 2, we see that just 18% of physicians in our data were integrated with a hospital or hospital system in 2008 compared to 42% in 2015.

Tables 2-4

Table 3 describes the average hospital in our data. Note that our analysis of hospital-level outcomes in Section 5 makes additional sample restrictions regarding hospital size, hospital type, and urban versus rural locations. We present here the descriptive statistics for our full dataset since this describes the average hospital at which physicians operate in the claims data (with the sample restrictions discussed previously). From Table 3, we see that the average hospital is responsible for nearly 600 planned and elective operations per year (from Medicare claims data) and about 9,500 total discharges (from HCRIS data). Hospitals have an average of 213 staffed beds. The percentage of hospitals that are designated as for-profit has increased slightly from 19% in 2008 to

21% in 2015, as has the percentage of hospitals reporting membership in a larger hospital system (from 59% in 2008 to 69% in 2015) and the percentage of hospitals identified as major teaching hospitals (19% in 2008 up to 21% in 2015).

4 Effects of integration on physician loyalty

We first examine the extent to which a hospital's acquisition of a physician practice influences how frequently a physician operates at that hospital. We estimate the effects of integration on physician loyalty with the following regression specification:

$$y_{jht} = \delta \times 1[VI_{jht}] + \beta_1 x_{jt} + \beta_2 z_{ht} + \beta_3 w_{mt} + \Theta_{jhmt} + \varepsilon_{jht}, \tag{1}$$

where $1[VI]$ denotes an indicator for whether physician j is integrated with hospital h at time t; x_{jt} denotes time-varying physician characteristics, which consists of the physician's total number of operations in the year and the physician's practice size; z_{ht} denotes a vector of time-varying hospital characteristics, including the number of staffed beds and total hospital admissions in the year; w_{mt} denotes a vector of time-varying county demographics capturing the number of people in the county, age, race, income, education, and employment; and Θ_{jhmt} denotes a set of fixed effects, including indicators for physician NPI, hospital NPI, year, state, and physician specialty. Finally, y_{jht} denotes the share of physician j's operations performed at hospital h in year t.

The specification in equation 1 includes a rich set of fixed effects, allowing for time-invariant and unobservable effects by physician, hospital, year, state, and physician specialty. However, we remain concerned of potential endogeneity to the extent that vertical integration is influenced by existing physician-hospital relationships. For example, hospitals may pursue integration with physicians for whom loyalty is already high, or vice versa. Therefore, in addition to ordinary least squares (OLS) estimates, we estimate equation 1 using two-stage least squares (2SLS). We employ three instruments in particular: 1) for a given physician, the share of other physicians in the zip code that are vertically integrated with a hospital; 2) for a given physician and specialty, the share of other physicians of that specialty that are vertically integrated with a hospital; and 3) the average distance of a physician's patients treated at other hospitals relative to the patient's distance to the current hospital.

The first two of our instruments rely on observed integration patterns among other physicians in the same market or among other physicians of the same specialty also in the same market, where we define market as the zip code of a given physician's primary office. These instruments are valid provided physician j's share of operations to hospital h is not directly influenced by the share of other physicians in the same zip code that are integrated with any hospital. Our final instrument exploits the location of a physician's patients treated at other hospitals and is essentially based on the differential distance of these patients to hospital h. Our intuition is that physicians may be less likely to integrate with a given hospital if their other patients (i.e., patients not treated at hospital h) live further away from hospital h.

4.1 Results

Estimates are presented in Table 5 with standard errors in parentheses clustered by physician. Columns 1 and 2 present results for OLS and 2SLS, respectively. We present results for physician and hospital characteristics, with estimates for our county-level demographic variables excluded for brevity.

TABLE 5

The estimates in Table 5 show a positive and significant effect of physician-hospital integration on the share of a physician's operations going to that hospital. Specifically, when physicians are acquired by a hospital, they increase their share of operations at that hospital by between 17 and 19 percentage points. On a base of approximately 60%, these estimates reflect an increase of around 30%. These estimates are similar to those in Baker *et al.* (2016), who found that patients were 33 percentage points more likely to choose hospital h if the patient's admitting physician was part of a practice owned by hospital h. The bottom panel of Table 5 also includes the first-stage results for our instruments. The instruments are individually and jointly significant, with a joint F-statistic of over 1,900.

5 Effects of integration on hospital outcomes

Importantly, our central focus in this paper is not on the overall effect of vertical integration on hospital behaviors, as has been examined in Cuellar & Gertler (2006), Ciliberto & Dranove

(2006), Baker *et al.* (2014), and Lin *et al.* (2017). We instead aim to disentangle the effects of vertical integration between effects driven by a hospital's bargaining motive versus patient-care motives. As discussed in Section 3, we argue that these motives are revealed, at least in-part, by the effects of vertical integration on physician loyalty. If integrated physicians behave identically to non-integrated physicians, then we interpret this as more suggestive of a bargaining motive. Essentially, this is a case in which the hospital has incurred the cost of integration but has not influenced physician behavior (at least in the dimension of physician loyalty).

To disentangle these effects, we seek a simple measure of differential physician behaviors among vertically integrated versus non-vertically integrated physicians. Following Baker *et al.* (2016) and our results in Section 4, the share of a physician's operations going to hospital h is a natural candidate given its ease of computation and its strong relationship with physician-hospital integration. Denoting by s^1_{ht} and s^0_{ht} the average physician share of operations to hospital h among physicians that are vertically integrated and non-integrated at time t, respectively, we quantify this differential with the difference in average shares, $\triangle s_{ht} = s^1_{ht} - s^0_{ht}$. We then form the indicator, $1[\triangle s_{ht} <= 0]$, which identifies hospitals for whom integrated physicians are no more loyal in terms of share of operations than non-integrated physicians. We refer to this indicator as a "bargaining" indicator.

We estimate the effects of vertical integration and bargaining motives on hospital outcomes with the following regression specification:

$$y_{ht} = \alpha \times 1[VI_{ht}] + \pi \times (1[VI_{ht}] \times 1[\triangle s_{ht} < 0]) + \gamma_1 x_{ht} + \gamma_2 w_{mt} + \Omega_{hmt} + \nu_{ht}, \qquad (2)$$

where $1[VI_{ht}]$ denotes an indicator for whether hospital h owns at least one physician practice at time t; x_{ht} denotes time-varying hospital characteristics, which consists of the hospital's bed size and, in our regression of hospital prices, the hospital's log case mix index, the log cost per discharge, the fraction of discharges from Medicaid, and the fraction of outpatient revenue to total revenue; w_{mt} denotes a vector of time-varying county demographics capturing the number of people in the county, age, race, income, education, and employment; and Ω_{ht} denotes a set of fixed effects, including indicators for hospital NPI, year, and county.

y_{ht} denotes the outcome of interest, where we consider measures of hospital quality as well as price. Readily available quality measures from CMS Hospital Compare, such as 30-day risk-adjusted mortality for pneumonia or heart attack patients, are inappropriate in our case since our dataset consists only of elective procedures. We instead exploit our patient-level claims data to estimate an overall risk-adjusted mortality measure for each hospital in each year. Specifically, we estimate the following regression with OLS:

$$m_{ih} = \lambda_1 x_i + \lambda_2 z_h + \lambda_3 x_i \times z_h + \lambda_4 w_i + \kappa_h + \mu_{ih}, \tag{3}$$

where m_{ih} is an indicator for mortality, set to 1 if patient i died within 30/60/90 days of discharge from hospital h; x_i denotes a vector of patient characteristics including age, gender, and race; z_h denotes a vector of hospital characteristics, composed of the hospital's bed size as well as indicators for whether the hospital is a major teaching hospital, ownership status (nonprofit or for-profit), and membership in a hospital system; w_i is a set of indicators for each of the first five ICD diagnosis codes for the inpatient stay (grouped by disease area); and κ_h denotes a hospital fixed effect.

We estimate this regression separately for each year t and obtain the estimated hospital fixed effects, $\hat{\kappa}_h$ for all t. This provides a time-varying measure of hospital quality that is arguably not due to patient risk factors or other observable aspects of the admission. We estimate κ_h separately for three different quality measures: mortality within 90 days of discharge, mortality within 60 days of discharge, and mortality within 30 days of discharge. To aide in interpretation, we de-mean the estimate, so that our final estimate of quality is $q_{ht} = \hat{\kappa}_{ht} - \frac{1}{H}\sum_{n=1}^{H} \hat{\kappa}_{nt}$. Higher values of q_{ht} therefore reflect a higher than expected mortality rate for hospital h in year t based on the patients admitted and relative to the average hospital in that year.

Finally, we follow Dafny (2009) in measuring hospital prices using the average net revenue for non-Medicare inpatient discharges. Although HCRIS data include the total gross inpatient as well as outpatient charges (i.e., the revenue received if patients paid list prices), these prices are irrelevant to the majority of patients due to administratively set Medicare and Medicaid rates and negotiated rates for commercial insurers. Consequently, inpatient gross charges are converted to inpatient net revenue by multiplying the hospital's total net revenues by the total gross charge ratio. Payments for Medicare inpatient services are then subtracted from inpatient net revenue to arrive at inpatient revenues from all non-Medicare patients, which can be divided by the corresponding number of discharges to derive the per discharge net revenue amount. Since Medicaid revenues are not provided in HCRIS, the measure is a weighted average of net revenue per discharge for commercially insured and Medicaid patients where the weights equal the share of inpatient discharges belonging to each payer. This same measure has been used in recent studies examining hospital pricing behavior, including Schmitt (2015) and Lewis & Pflum (2016). To eliminate outliers, we trim the lower and upper tails at the 5th and 95th percentile of the resulting price distribution.

5.1 Instruments

Identification of the effect of vertical integration from equation 2 relies on the assumption that the timing of integration is uncorrelated with unobserved factors that also affect changes in hospital outcomes. To relax this assumption, we pursue an instrumental variables approach where we take as our instrument the average predicted probability of vertical integration from our analysis in Section 4. Similarly, we suspect that physician loyalty among integrated and non-integrated physicians may be endogenous. We therefore also include a predicted bargaining indicator, formed from the predicted share differential in Section 4. Specifically, the results of our physician-level regressions provide an estimate of each physician's share of operations across hospitals. Predicting this share among physicians that are predicted to be vertically integrated provides an estimate of s^1_{ht}, denoted $\hat{s}^1_{ht}$. With an analogous estimate for non-integrated physicians, $\hat{s}^0_{ht}$, we form the predicted change due to vertical integration, $\triangle \hat{s}_{ht} = \hat{s}^1_{ht} - \hat{s}^0_{ht}$. The indicator, $1[\hat{s}_{ht} < 0]$ serves as an additional generated instrument for our estimation of equation 2 with two-stage least squares (2SLS).[5]

5.2 Results

Table 6 presents preliminary results for the effects of VI on hospital quality and prices. Columns (1) and (2) present OLS estimates, and columns (3) and (4) present 2SLS estimates. All standard errors are clustered at the hospital level.

TABLE 6

The magnitude of these estimates are small, and the effects are generally insignificant. Nonetheless, we do see some suggestive evidence of differential effects of VI by observed changes in physician loyalty. For example, in the case of 30-day mortality, we find a reduction of 0.06 percentage points (statistically significant at the 90% confidence level) if VI can facilitate some observed change in

[5]As discussed in Wooldridge (2010), "we can ignore the fact that the instruments were estimated in using 2SLS for inference."

physician behaviors. If instead physician behaviors remain unchanged, the coefficient switches sign. Similarly, if unaccompanied by any noticeable change in physician behaviors, we estimate positive effects of VI on prices (though, again, insignificant).

6 Discussion

The direction of results are consistent with the hypothesis that the underlying motivation for physician-hospital integration may play an important role in gauging the effect of integration on hospital quality and prices. Hospitals that integrate with no observed changes in physician referral/admitting patterns may be more likely to increase prices with no improvements in patient care. Conversely, hospitals that integrate and change physician behaviors in some way are more likely to reduce mortality rates and may also reduce prices. From a policy perspective, these results suggest that acquisitions of physician practices for which physicians are already loyal to a given hospital are more likely to increase prices with no improvements in quality.

We are currently extending/adjusting this analysis in several ways. First, we would like to more carefully examine which types of physicians, physician practices, and hospitals ultimately become integrated. One way to do this is to exploit out physician-hospital level data to estimate a conditional logit model, with each physician practice effectively choosing whether to become integrated with a given hospital. We are also investigating "bilateral" conditional choice models to better account for the fact that both physicians and hospitals must agree to integrate (i.e., it is not just a choice of the physician practice and similarly not just a choice of the hospital).

Second, we would like to improve our measure of changes in physician behaviors due to integration. We are currently considering other outcomes to supplement our analysis of physician shares, and we are considering other moments of the distributions of such outcomes (as opposed to just the conditional mean). Ultimately, we would like to estimate a multi-dimensional distribution of several physician behaviors and measure the "distance" of this distribution between vertically integrated and non-integrated physicians.

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Tables and Figures

Table 1: **Descriptive Statistics for Physician-Hospital Variables**[a]

	2008	2009	2010	2011	2012	2013	2014	2015	Total
Operations	25.16	25.43	25.69	25.25	25.20	25.01	24.36	24.32	25.07
	(32.19)	(32.19)	(32.78)	(32.32)	(32.62)	(33.24)	(33.03)	(33.66)	(32.74)
Patients	23.94	24.16	24.43	24.03	23.99	23.84	23.26	23.24	23.87
	(30.15)	(30.12)	(30.71)	(30.26)	(30.66)	(31.26)	(31.16)	(31.80)	(30.75)
Distance	5.719	5.881	5.926	6.183	6.293	6.421	6.717	6.954	6.248
	(11.09)	(11.17)	(11.26)	(11.76)	(11.88)	(12.04)	(12.84)	(13.24)	(11.91)
Hospital Share	0.611	0.623	0.626	0.631	0.641	0.654	0.668	0.683	0.641
	(0.387)	(0.386)	(0.386)	(0.384)	(0.383)	(0.380)	(0.376)	(0.373)	(0.383)
Integrated	0.111	0.113	0.113	0.155	0.160	0.199	0.208	0.286	0.166
N	41,628	40,808	40,630	40,290	39,669	38,914	38,062	37,270	317,271

[a]Standard deviations in parenthesis.

Table 2: **Descriptive Statistics for Physicians**[a]

	2008	2009	2010	2011	2012	2013	2014	2015	Total
Total Operations	41.18	40.79	41.03	40.00	39.30	38.26	36.45	35.63	39.08
	(38.30)	(38.02)	(38.74)	(38.22)	(38.69)	(39.47)	(39.16)	(39.91)	(38.87)
Total Patients	39.07	38.67	38.93	37.97	37.34	36.40	34.74	33.99	37.14
	(35.69)	(35.35)	(36.11)	(35.65)	(36.23)	(37.01)	(36.83)	(37.56)	(36.36)
Integrated	0.180	0.180	0.180	0.245	0.249	0.304	0.310	0.417	0.258
N				25,437					203,496

[a]Standard deviations in parenthesis.

Table 3: **Descriptive Statistics for Hospitals**[a].

	2008	2009	2010	2011	2012	2013	2014	2015	Total
Admits in Claims	658.7	634.2	632.1	613.2	586.5	556.8	531.6	526.8	592.8
	(806.1)	(780.8)	(777.1)	(759.1)	(727.6)	(682.3)	(664.4)	(673.5)	(737.4)
Total Discharges	9701.4	9745.8	9630.6	9590.7	9447.7	9171.0	9206.4	9369.9	9484.5
	(10608.3)	(10743.4)	(10665.3)	(10757.1)	(10746.3)	(10687.8)	(10658.2)	(10821.5)	(10711.4)
Staffed Beds (100s)	2.140	2.139	2.132	2.121	2.129	2.115	2.113	2.133	2.128
	(2.220)	(2.206)	(2.178)	(2.170)	(2.205)	(2.202)	(2.231)	(2.293)	(2.213)
For-profit	0.188	0.196	0.203	0.204	0.211	0.212	0.212	0.212	0.205
System	0.585	0.600	0.617	0.627	0.645	0.655	0.676	0.691	0.637
Teaching Hospital	0.188	0.186	0.188	0.209	0.205	0.204	0.214	0.213	0.201
N	3,403	3,352	3,347	3,347	3,362	3,343	3,318	3,307	26,779

[a]Standard deviations in parenthesis

Table 4: **Descriptive Statistics for County Demographics**[a]

	2008	2009	2010	2011	2012	2013	2014	2015	Total
Total Population	199.5	174.8	176.7	175.9	177.6	178.3	180.8	183.1	180.5
	(451.7)	(425.0)	(424.4)	(424.5)	(428.3)	(431.2)	(437.2)	(441.7)	(432.7)
Ages 18 to 34	0.231	0.220	0.217	0.217	0.218	0.219	0.220	0.220	0.220
	(0.0423)	(0.0502)	(0.0507)	(0.0512)	(0.0507)	(0.0505)	(0.0501)	(0.0498)	(0.0498)
Ages 35 to 64	0.393	0.397	0.399	0.399	0.397	0.395	0.393	0.391	0.396
	(0.0330)	(0.0340)	(0.0326)	(0.0328)	(0.0322)	(0.0318)	(0.0312)	(0.0309)	(0.0324)
Age 65-plus	0.137	0.143	0.145	0.147	0.150	0.153	0.156	0.160	0.149
	(0.0341)	(0.0374)	(0.0377)	(0.0383)	(0.0387)	(0.0395)	(0.0388)	(0.0397)	(0.0387)
White	0.829	0.837	0.835	0.836	0.837	0.834	0.832	0.832	0.834
	(0.141)	(0.146)	(0.149)	(0.148)	(0.147)	(0.149)	(0.150)	(0.149)	(0.148)
Black	0.0933	0.0915	0.0917	0.0909	0.0903	0.0931	0.0937	0.0926	0.0921
	(0.125)	(0.132)	(0.133)	(0.132)	(0.131)	(0.134)	(0.135)	(0.133)	(0.132)
Income 50 to 75k	0.194	0.192	0.191	0.190	0.189	0.187	0.186	0.185	0.189
	(0.0260)	(0.0265)	(0.0249)	(0.0242)	(0.0234)	(0.0235)	(0.0232)	(0.0230)	(0.0245)
Income 75 to 100k	0.119	0.116	0.117	0.119	0.119	0.119	0.119	0.119	0.118
	(0.0272)	(0.0268)	(0.0255)	(0.0244)	(0.0237)	(0.0231)	(0.0227)	(0.0227)	(0.0245)
Income 100 to 150k	0.102	0.0959	0.0993	0.104	0.107	0.108	0.111	0.113	0.105
	(0.0418)	(0.0414)	(0.0409)	(0.0400)	(0.0396)	(0.0389)	(0.0385)	(0.0384)	(0.0403)
Income 150k-plus	0.0561	0.0513	0.0541	0.0581	0.0603	0.0621	0.0656	0.0680	0.0595
	(0.0440)	(0.0415)	(0.0428)	(0.0448)	(0.0458)	(0.0469)	(0.0484)	(0.0495)	(0.0459)
High School	0.338	0.341	0.339	0.336	0.333	0.331	0.330	0.328	0.334
	(0.0719)	(0.0708)	(0.0724)	(0.0726)	(0.0726)	(0.0732)	(0.0731)	(0.0737)	(0.0727)
Bachelor's	0.144	0.140	0.142	0.143	0.144	0.146	0.148	0.150	0.145
	(0.0566)	(0.0554)	(0.0559)	(0.0559)	(0.0559)	(0.0561)	(0.0563)	(0.0570)	(0.0562)
Employed Full Time	0.390	0.384	0.385	0.384	0.386	0.380	0.381	0.384	0.384
	(0.0516)	(0.0536)	(0.0543)	(0.0547)	(0.0559)	(0.0565)	(0.0560)	(0.0565)	(0.0550)
Total Admits	1136.5	1106.4	1112.1	1058.7	1027.5	974.0	917.8	882.9	1026.7
	(2726.7)	(2641.0)	(2635.6)	(2563.2)	(2469.8)	(2314.8)	(2126.6)	(2030.7)	(2450.6)
N	1,566	1,552	1,546	1,572	1,571	1,579	1,568	1,565	12,519

[a]Standard deviations in parenthesis

Table 5: **Regression Results for Physician-Hospital Shares**[a]

	OLS	2SLS
Integrated	0.187***	0.168***
	(0.004)	(0.006)
Physician Patients	-0.001***	-0.001***
	(0.000)	(0.000)
Staffed Beds	0.003***	0.002**
	(0.001)	(0.001)
Hospital Patients	0.000***	0.000***
	(0.000)	(0.000)
N	204,640	201,840
R2	0.609	0.614
First-stage results		
Zip Share VI		0.277***
		(0.009)
Specialty Share VI		0.391***
		(0.008)
Other Distance		-0.003***
		(0.0001)
Joint F-stat		1,960

[a]Results based on OLS and 2SLS in columns (1) and (2), respectively, with standard errors in parenthesis clustered at the physician (NPI) level. Additional independent variables not in the table include time-varying county demographics (total population, age, race, income, education, and employment) and fixed effects for physician NPI, hospital NPI, physician specialty, year, and state. * p<0.1. ** p<0.05. *** p<0.01.

Table 6: **Regression Results for VI and Hospital Outcomes**[a]

	OLS			2SLS		
	$1[VI]$	$1[\triangle s_{ht} <= 0]$	N	$I[VI]$	$1[\triangle s_{ht} <= 0]$	N
90-day Overall Mortality	-0.002*	0.001	11,515	-0.005	0.004	
	(0.001)	(0.001)		(0.005)	(0.007)	
60-day Overall Mortality	-0.001	0.001	11,515	-0.006	0.004	
	(0.001)	(0.001)		(0.005)	(0.007)	
30-day Overall Mortality	-0.001	0.000	11,515	-0.006*	0.005	
	(0.001)	(0.001)		(0.003)	(0.005)	
Log Hospital Price	0.010	-0.023**	11,369	-0.065	0.059	
	(0.009)	(0.011)		(0.056)	(0.082)	

[a]Results from OLS and 2SLS with standard errors in parenthesis clustered at the hospital (NPI) level. We take as instruments the average probability of physician-hospital vertical integration and the predicted "bargaining" indicator, $1[\triangle \hat{s}_{ht} < 0]$ – both estimated from our physician-hospital analysis in Section 4. Additional independent variables not in the table include time-varying county demographics (total population, age, race, income, education, and employment) and fixed effects for hospital NPI, year, and county. Our regressions for price also include the hospital's log case mix index, the log cost per discharge, the fraction of discharges from Medicaid, and the fraction of outpatient revenue to total revenue. * $p<0.1$. ** $p<0.05$. *** $p<0.01$.