NBER WORKING PAPER SERIES

THE EFFECT OF HOSPITAL/PHYSICIAN INTEGRATION ON HOSPITAL CHOICE

Laurence C. Baker
M. Kate Bundorf
Daniel P. Kessler

Working Paper 21497
http://www.nber.org/papers/w21497

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 2015

We would like to thank Aileen Devlin for exceptional research assistance. All errors are our own. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

At least one co-author has disclosed a financial relationship of potential relevance for this research. Further information is available online at http://www.nber.org/papers/w21497.ack

The Effect of Hospital/Physician Integration on Hospital Choice
Laurence C. Baker, M. Kate Bundorf, and Daniel P. Kessler
NBER Working Paper No. 21497
August 2015
JEL No. I11

ABSTRACT

In this paper, we estimate how hospital ownership of physicians' practices affects their patients' hospital choices. We match data on the hospital admissions of Medicare beneficiaries, including the identity of their admitting physician, with data on the identity of the owner of the admitting physician's practice. We find that a hospital's ownership of an admitting physician's practice dramatically increases the probability that the physician's patients will choose the owning hospital. We also find that patients are more likely to choose a high-cost, low-quality hospital when their admitting physician's practice is owned by that hospital.

Laurence C. Baker
Department of Health Research & Policy
HRP Redwood Bldg, Rm T110
Stanford University
Stanford, CA 94305-5405
and NBER
laurence.baker@stanford.edu

M. Kate Bundorf
Health Research and Policy
Stanford University
HRP T108
Stanford, CA 94305-5405
and NBER
bundorf@stanford.edu

Daniel P. Kessler
Stanford University
434 Galvez Mall
Stanford, CA 94305
and NBER
fkessler@stanford.edu

Introduction

Over the past decade, hospitals and physicians have become more integrated due to increases in hospitals' ownership of physician practices (Baker, Bundorf, and Kessler 2014). There is considerable debate over how integration has affected agency problems between physicians and their patients. Agency problems arise in this context because patients depend on their physician not only for health services but also for advice about the types of services that they need (Evans 1974).

Integration is often hypothesized to increase the incentive physicians have to refer patients to the owning hospital (O'Malley, Bond, and Berenson 2011). Optimists about integration think that this reduces agency problems. According to this reasoning, closer ties between physicians and hospitals improve coordination across care settings and reduce wasteful duplication of effort. Integration also facilitates the sharing of gains from increased efficiency, thereby encouraging greater uptake of integration's opportunities. This is one goal of Accountable Care Organizations, a new form of integration promoted by the Affordable Care Act.

Pessimists think that integration's impact on patient referrals increases agency problems. According to this reasoning, coordination of referrals allows physicians and hospitals to increase their market power, raise prices, and share the gains from doing so. Some pessimists also believe that integration allows hospitals to pay physicians covertly for referrals, which has the potential to allow physicians to profit from recommending care that is cost-ineffective or even medically unnecessary.

For this reason, how integration affects hospital choice is an important empirical issue. Yet, despite this, no previous work has identified how a hospital's ownership of a

physician's practice affects her patients' hospital choices, or even whether it affects patients' hospital choices at all.

In this paper, we seek to fill this gap. We use 2009 data on the ownership status of the practices of approximately 400,000 physicians from SK&A, matched with data on which hospitals own physician practices from AHA. Together, these data identify which hospitals own physician practices, and among those that do, the identity of the physicians in the practices they own. We match these data to Medicare beneficiaries' hospital admissions by the National Provider Identifier (NPI) of the physician who admitted the patient to the hospital. We estimate conditional logit models that specify the probability of a patient choosing a particular hospital as a function of characteristics of the hospital (including its size, for profit/nonprofit status, whether it owns physician practices, and measures of its cost and quality of care), the admitting physician (owned by some hospital and owned by the hospital of admission), and interactions between the two. The parameters of interest are the effect on hospital choice of an admitting physician's ownership status, and the effects of interactions between an admitting physician's ownership status and measures of the hospital's cost and quality of care.

Previous Literature

Our paper contributes to three literatures: the effects of physicians' financial incentives on agency conflicts between physicians and patients, the effects of hospital-physician integration, and the effects of hospital and patient characteristics on hospital choice. It is most closely related to papers about financial incentives and physician agency such as Ho and Pakes (2014), Iizuka (2012), and Afendulis and Kessler (2007).

Using hospital discharge data for managed care enrollees from California in 2003, Ho and Pakes (2014) investigate how insurer capitation rates affect the relationship between hospital characteristics and enrollee hospital choices. They ask whether the observed referrals for enrollees whose physicians face different financial incentives indicate different tradeoffs between price, quality, and convenience. They find that physicians with capitated insurance contracts send their patients to lower-priced, more-distant hospitals, but that there is no effect on health outcomes or quality of care. Using patient-level data on prescriptions from Japan from 2003-2005, Iizuka (2012) shows that the choice between generic and branded drugs is influenced by the markups that doctors earn between the two versions. In particular, he finds that physicians who are vertically integrated with a pharmacy prescribe drugs with higher margins more frequently than do physicians who are not, holding other factors constant. Using patient-level data on elderly Medicare beneficiaries with coronary artery disease from 1998, Afendulis and Kessler (2007) compare patients who were diagnosed by a cardiologist who also provides surgical treatment to patients who were diagnosed by a cardiologist who does not. They find that diagnosis by a cardiologist who provides surgical treatment leads to increases in health spending, but not better health outcomes. Although these three papers show that physicians' financial incentives affect the extent of agency problems, none of them examine the effects of hospital/physician integration.

Other papers examine the effects of hospital-physician integration without focusing on the extent of agency problems (e.g., Cuellar and Gertler 2006; Ciliberto and Dranove 2006; Baker, Bundorf, and Kessler 2014). For example, using hospital claims from Truven Analytics for the nonelderly privately insured from 2001-07, Baker,

Bundorf, and Kessler (2014) investigate the consequences of hospital/physician integration for hospital prices, the volume of admissions, and spending. They find that increases in the market share of hospitals that own physician practices is associated with higher hospital prices and spending, whereas increases in the market share of hospitals that are contractually integrated with physicians is associated with a small reduction in the volume of admissions.

We build on the modeling strategy used in a long literature investigating the determinants of hospital choice (see Gaynor and Town 2012 for an excellent review). These papers specify a patient's hospital of admission as a conditional logit function of hospital characteristics and interaction between hospital and patient characteristics. These papers generally find that cost, distance to patients' residence, and measured quality all affect hospital choice in the expected direction (Kessler and McClellan 2000; Gaynor and Vogt 2003; Tay 2003; Romley and Goldman 2011; Beckert, Christensen, and Collyer 2012).

We extend the standard hospital choice model to include the ownership status of the physician admitting the patient to the hospital, the ownership status of the hospitals in the choice set, and the interaction between these factors and the hospital's cost, quality, and distance to the patient's residence. In this way, we identify the extent to which hospital ownership of physicians affects choice, and the influence of cost, quality, and distance on choice.

Model

We model the utility of patient *i* living in zip code *z* from choosing hospital *j* (Y_{ijz}^{*}) as a function of the attributes of *j*: the hospital's size, ownership, and teaching status (W_j); its quality, cost, and distance from patient *i* ($Q_{jz} \mid C_{jz} \mid D_{ijz} = X_{ijz}$); its relationships with physicians, including the physician who admitted patient *i* to the hospital (V_{ijz}); and unobserved variation in the attributes of hospitals, which may interact with the characteristics of patient *i* (ε_{ijz}). For ease of interpretation, we define higher values of X_{ijz} to be unfavorable, i.e., worse quality, higher cost, and longer distance. We do not observe Y_{ijz}^{*}, but only Y_{ijz}, where

$$Y_{ijz} = \begin{cases} 1 & \text{if } Y_{ijz}^{*} = \max(Y_{i1z}^{*}, Y_{i2z}^{*}, Y_{i3z}^{*}, .., Y_{iJz}^{*}) \\ 0 & \text{otherwise.} \end{cases}$$

If $Y_{ijz}^{*} = W_j\alpha + X_{ijz}\beta + V_{ijz}\gamma + \varepsilon_{ijz}$ and ε_{ijz} are independently and identically distributed with a type I extreme value distribution (McFadden 1973), then

$$\Pr(Y_{ijz} = 1) = \frac{\exp(W_j\alpha + X_{ijz}\beta + V_{ijz}\gamma)}{\sum_{j \in J} \exp(W_j\alpha + X_{ijz}\beta + V_{ijz}\gamma)} \qquad (1)$$

V_{ijz} contains three variables: whether *j* owns any physician practices (V_{ijz}^{O}); whether *i*'s admitting physician is part of a practice that is owned by any hospital interacted with whether *j* owns any physician practices (V_{ijz}^{OO}); and whether *i*'s admitting physician is part of a practice that is owned by *j* (V_{ijz}^{OO*}). The effect of the ownership status of *i*'s admitting physician is not identified in the conditional logit model -- as are none of the patient characteristics that are constant across choices.

The coefficient of interest in equation (1) is the effect of V_{ijz}^{OO*} on hospital choice. It measures how hospital ownership of a physician practice affects the probability that a patient admitted by a member of the owned practice will choose the owning hospital, holding all else constant. Our estimate captures the incremental effect of hospital ownership of a patient's physician's practice, over and above the general effect of owning any physician's practice and the patient's physician's ownership status. Estimates from this model, however, do not indicate the likely consequences of hospital ownership of physician practices for patient well-being. If hospital ownership of a physician's practice leads the owned physicians to direct their patients to the owning hospital, patients may be better off if the owning hospital is of higher quality or lower cost, or is a better match for the patient's condition or location. Conversely, patients may be worse off if the owning hospital is lower quality, higher cost, or a worse match. To investigate this question further, we estimate an expanded version of equation (1) that includes interactions between X_{ijz} and V_{ijz}:

$$\Pr(Y_{ijz}=1) = \frac{\exp(W_j\alpha + X_{ijz}\beta + V_{ijz}\gamma + (X_{ijz}\times V_{ijz})\delta)}{\sum_{j\in J}\exp(W_j\alpha + X_{ijz}\beta + V_{ijz}\gamma + (X_{ijz}\times V_{ijz})\delta)}. \quad (2)$$

The coefficients of interest in this model are the interactions between X_{ijz} and V_{ijz}^{OO*}. They measure, respectively, whether hospital ownership of a physician practice affects *i*'s valuation of (i.e., the responsiveness of *i*'s choice to) quality, cost, and distance. If the coefficients on these interactions are positive, then ownership of a physician's practice leads patients admitted by that physician to choose hospitals that are lower quality, higher cost, or farther away. We also estimate a fully-interacted model that includes interactions between X_{ijz} and W_j:

$$\Pr(Y_{ijz}=1) = \frac{\exp(W_j\alpha + X_{ijz}\beta + V_{ijz}\gamma + (X_{ijz}\times V_{ijz})\delta + (X_{ijz}\times W_j)\lambda)}{\sum_{j\in J}\exp(W_j\alpha + X_{ijz}\beta + V_{ijz}\gamma + (X_{ijz}\times V_{ijz})\delta + (X_{ijz}\times W_j)\lambda)}. \quad (3)$$

We estimate equations (1) - (3), allowing for arbitrary clustering of ε_{ijz} within 3-digit zip codes. We report coefficients in terms of their average marginal effects on choice probabilities.

Data

Our paper uses data from five sources: SK&A, Medicare (inpatient, carrier, and denominator files), the American Hospital Association (AHA) Survey, CMS Hospital Compare, and the Dartmouth Atlas.

The SK&A data are a sample of 422,312 office-based physicians, or approximately 75% of the population of active office-based physicians involved in patient care in the AMA Masterfile (National Center for Health Statistics 2011). The SK&A data contain, for each sampled physician, the physician's National Provider Identifier (NPI), whether or not the physician is part of a practice that is owned by a hospital, and if s/he is, the name and state of that hospital. We used the 2009 Medicare Provider of Service file to obtain a Medicare Provider Number for each hospital in the SK&A that had a sufficiently specific name/state combination to enable us to identify the facility. For each physician we have up to three owning hospitals. This occurs when ownership of a physician's practice is shared among several facilities.

We define the physician that admits a patient to the hospital in two ways. First, we use the "admitting physician" field from the 2009 Medicare inpatient file. The Medicare inpatient file contains 100% of all hospital admissions for fee-for-service

Medicare beneficiaries to short-stay, general/medical, acute care hospitals. We limit our sample to only those beneficiaries aged 65-99, originally eligible for Medicare by reason of their age, resident in a non-rural (metropolitan statistical) area, and those who choose a hospital within 35 miles of their residence of record (within 100 miles for those who choose a large teaching hospital) according to the Medicare enrollment file.

Second, to validate this approach, we define a patient's admitting physician as the physician in the carrier file with whom the patient had the greatest number of outpatient encounters in the 30 days prior to and including the date of admission (excluding emergency department encounters). Because the carrier data contain information only on a 20% random sample of beneficiaries, we restrict our hospital choice analysis based on the carrier admitting physician to this same 20% sample.

We construct an analysis file in four steps. First, we match the SK&A data to the universe of hospital admissions based on the NPI of the admitting physician, as defined in the two ways described above. This yields two sets of admissions: one containing all of the admissions of the physicians in SK&A, and one containing a 20% random sample of these physicians' admissions. Admissions by physicians not in SK&A are excluded from both sets; admissions of patients without a qualifying outpatient visit in the 30 days prior to and including their hospitalization are additionally excluded from the latter set.

Second, we construct for each admission the set of hospitals the patient could have chosen, defined as hospitals within 35 miles (or 100 miles for large teaching hospitals) of the patient's zip code. Third, we match by Medicare identifier the characteristics of each hospital from SK&A, AHA, and the Dartmouth Atlas. We use the AHA data for information on hospital size, ownership status (for-profit, non-profit, or

public), system membership status, teaching status, and whether or not the hospital reports owning physicians. We use CMS Hospital Compare to compute a single-dimensional measure of quality equal to the average Z-score of each hospital's 30 day mortality and readmission rates for heart attack, heart failure, and pneumonia in 2009.[1] We use the Dartmouth Atlas to obtain the Z-score for each hospital of the average 2009 Medicare hospital reimbursements per decedent in the last two years of life. Fourth, we calculate for each choice any variables that are a function of the interaction between a patient and a choice. This includes distance (D_{ijz}), whether *i*'s admitting physician is part of a practice that is owned by a hospital interacted with whether *j* owns physician practices (V_{ijz}^{OO}), and whether *i*'s admitting physician is part of a practice that is owned by *j* (V_{ijz}^{OO*}), along with the explicitly-specified interaction effects in equations (2) and (3).

Results

Table 1 presents the distribution of admissions, by the ownership status of the admitting physician and the hospital of admission, defined in the two different ways discussed above (row percentages in the table are in parentheses; column percentages are brackets). According to the table, the distributions of admissions, stratified by the two definitions of admitting physician described above, are similar (although not identical). According to the inpatient file, an owned physician admits 83.4% of her hospitalized patients to the hospital that owns her practice; the comparable statistic, assigning patients to physicians based on the frequency of pre-admission encounters in the carrier file, is 69%. The two definitions agree that owned physicians are more likely to admit patients

[1] http://downloads.cms.gov/files/HospitalYear2009To2010.zip.

to their owning hospital than anywhere else, although the inpatient file's measure of admitting physician is more likely to assign the patient to the admitting physician's owning hospital. The two definitions also agree on the approximate share of patient admissions attributable to owned physicians (6.4% inpatient, 5.1% carrier).

Table 2 presents mean values for the other variables we use in analysis, and compares the means from our sample to those for all admissions of elderly Medicare beneficiaries in 2009. The first three rows of Table 2 are derived from Table 1A. The first row is simply the number of admissions by owned physicians to that physician's owning hospital divided by the total of admissions (0.0535 = 178,219 / 3,329,519). The second row is the number of admissions by owned physicians to any owning hospital divided by the total (0.0589 = ((178,219 + 17,755) / 3,329,519), and the third row is the number of admissions by owned physicians divided by the total (0.0642 = 213,830 / 3,329,519). Because these variables are, by definition, only available for the subset of admissions by SK&A physicians, we are not able to compare their means to those from Medicare as a whole.

The remainder of the table shows that the subsample of admissions by SK&A physicians closely resembles the nonrural Medicare population as a whole. Mean hospital ownership rates and cost and quality measures for our analysis sample are within approximately one percent of the Medicare population as a whole. The distributions of hospital choices are likewise similar. The greatest differences between our analysis subsample and the population are in patients' demographics, with slightly higher proportions of younger and Black patients, but even these differences are relatively small.

Table 3 presents estimates of equations (1) - (3) based on the inpatient file's definition of admitting physician. Column (1) presents estimates of β and γ from equation (1). Cost, quality, and distance all affect hospital choice in the expected direction. Hospitals with higher average Medicare hospital reimbursements per decedent in the last two years of life are slightly less attractive to patients; a one-standard-deviation increase in reimbursements per decedent decreases the probability that a patient will choose the hospital by 0.8 percentage points. Hospitals with higher mortality and readmission rates are also less-preferred; a one-standard-deviation increase in the average rate of adverse outcomes decreases the probability that a patient will choose the hospital by 1.1 percentage points. Hospitals that are farther away are also less attractive; a one-mile increase in distance decreases the probability of choice by 1.4 percentage points. A one standard deviation increase in travel distance (8.7 miles, not in any table) decreases the probability that a patient chooses a hospital by 12.2 percentage points.

The effects of the three ownership variables are also in the expected direction. Patients are 1.1 percentage points (standard error 0.3 percentage points) more likely to choose hospitals that own any physicians than those that do not own physicians, holding other factors constant. The effect of practice ownership is larger if the patient's admitting physician is part of a practice that is owned by any hospital (by 3.4 percentage points, standard error 1.3 percentage points), and substantially larger if the patient's admitting physician is part of a practice that the hospital owns (by 33.4 percentage points, standard error 2 percentage points). The model does not include a control for the (uninteracted) ownership status of the admitting physician because this variable is conditioned out of the likelihood function along with all other patient-specific characteristics.

Column (2) presents estimates of β, γ, and δ from equation (2). It shows that patients are not only more likely to choose a high-cost, low-quality hospital *than they otherwise would* when their admitting physician's practice is owned by that hospital, but also more likely to choose a high-cost, low-quality hospital *than a low-cost, high-quality hospital*. In terms of the parameters of equation (2), the sum of the marginal effects on the interaction terms between cost (quality) and ownership is not only positive, but also greater in absolute value than the negative uninteracted effect of cost (quality).

The largest effect of owning physicians is on patients' preference for low- versus high-cost hospitals. This is not surprising. Medicare beneficiaries bear little of the marginal cost of choosing a hospital with high spending at the end of life, and the effect of high spending at the end of life on quality of care is (at least potentially) ambiguous. For a patient whose admitting physician's practice is not owned, a unit increase in the Z-score of the costliness of a hospital is associated with a 0.4 percentage point decrease in the likelihood of the patient choosing that hospital. But for a patient whose admitting physician's practice is owned by a hospital, a one standard-deviation increase in the costliness of the owning hospital is associated with a 2.1 percentage point *increase* in the likelihood of the patient choosing that hospital (0.021 = 0.027 + 0.002 - 0.004 - 0.004, the sum of the marginal effects of cost and the interactions between cost and ownership.

Along these lines, owning the admitting physician's practice also flips patients from preferring (i.e., being more likely to choose, all else constant) high-quality hospitals to low-quality hospitals. For a patient whose admitting physician's practice is not owned, a one standard-deviation increase in the adverse outcome rate of a hospital is associated with a 0.9 percentage point decrease in the likelihood of the patient choosing

that hospital. But for a patient whose admitting physician's practice is owned by a hospital, a one standard-deviation increase in the adverse outcome rate of the owning hospital is associated with a 1.4 percentage point *increase* in the likelihood of the patient choosing that hospital (0.014 = 0.018 + 0.007 – 0.002 – 0.009).

Although owning the admitting physician's practice doesn't flip patients from preferring closer hospitals to those farther away, it does substantially reduce patients' preference for proximity (compare -0.014, the marginal effect of distance, to the sum of the marginal effects of distance and the interactions between ownership and distance of -0.003 = 0.007 + 0.003 + 0.001 – 0.014. Column (3) of the Table (presenting estimates from equation (3)) shows that this result is robust to inclusion of a full set of interactions between X_{ijz} and W_j.

Table 4 presents estimates from alternative models of hospital choice, all of which are variants on equation (3). Column (1) presents estimates of equation (3) that define the admitting physician based on the frequency of pre-admission encounters in the carrier file rather than the admitting physician field in the inpatient file. The effects of hospital ownership of a physician's practice from column (1) of Table 4 is smaller in magnitude, but of similar sign and importance, as the analogous effect from Table 3 (column (3)). Owning an admitting physician's practice no longer flips patients from preferring high- to low-quality hospitals, although it does continue to flip patients from preferring low- to high-cost hospitals.

One potential concern about our analysis is the endogeneity of hospitals' decisions to purchase physician practices. In particular, hospitals may seek to buy practices with physicians who would have been predisposed to admit to the hospital, even in the

absence of an ownership relationship. In this case, estimates of the effect of ownership will overstate ownership's impact on hospital choice. Although our effect of interest is the interaction between ownership and cost, quality, or distance -- not the direct effect of ownership -- bias due to endogeneity in ownership may still be a problem. In particular, high-cost or low-quality hospitals may be differentially likely to seek to buy practices with physicians who would have been predisposed to admit to the hospital.

To investigate this hypothesis, columns (2) and (3) present estimates from models that include leads of V_{ijz} and W_j (and interactions between leads of V_{ijz}, W_j and X_{ijz}) in addition to the variables in equation (3), based on the inpatient and carrier file methods of assigning patients to physicians, respectively. Although there is a significant direct effect of the lead (2010) value of V_{ijz} on (2009) hospital choice, the effect of the interactions between the leads of V_{ijz} and X_{ijz} are small and insignificant. Hypothesis tests of the joint significance of the interactions between the leads of V_{ijz} and X_{ijz} fail to reject that the interactions between ownership and cost, quality, and distance are zero at conventional significance levels ($\chi^2_{(3)} = 1.19$ ($p = 0.756$) and 2.37 ($p = 0.500$) for columns (2) and (3), respectively).

Conclusion

As medical care has grown more costly and complex, the value of coordination between physicians and other providers of health services such as hospitals has increased. In response, both public policy and private purchasers have created new incentives for hospital/physician integration. At least in part as a result of these incentives, such integration has increased dramatically.

But hospital/physician integration may have harmful as well as beneficial effects. One of the most obvious channels of integration's downside is the exacerbation of patient/physician agency problems through its effect on patients' choice of acute care hospital. Although long-standing economics literature has documented the consequences of agency problems inherent in the patient/physician relationship, no previous work has sought to identify how hospital ownership of physician practices affects patients' hospital choices.

In this paper, we integrate new data from several sources to fill this gap. We match data from SK&A on the owners of the practices of approximately 75% of the office-based physicians in the U.S. with data from the American Hospital Association, individual-level hospital and physician claims from Medicare, and quality and cost data from CMS Hospital Compare and the Dartmouth Atlas to investigate how hospital/physician integration affects the way that patients choose hospitals.

We find that a hospital's ownership of an admitting physician dramatically increases the probability that the physician's patients will choose the owning hospital. We also find that ownership of an admitting physician has large effects on how the hospital's cost and quality affect patients' hospital choice. Patients whose admitting physician is not owned by a hospital are more likely to choose facilities that are low cost and high quality. For these patients, the marginal effect on choice of a hospital's costliness is negative, as is the marginal effect of a hospital's rate of adverse health outcomes. By contrast, patients are more likely to choose a high-cost, low-quality hospital when their admitting physician's practice is owned by that hospital. The sum of the marginal effects on choice of cost and the interactions between ownership and cost

are positive, as is the sum of the marginal effects of a hospital's adverse outcome rate and the interactions between ownership and adverse outcomes. We conclude that hospital/physician integration affects patients' hospital choices in a way that is inconsistent with their best interests.

Our results support and extend the findings of other recent research on physician agency. Ho and Pakes (2014), for example, find that patients of physicians with capitated contracts choose hospitals that are lower-priced and more-distant (although of no lower quality); Iizuka (2012) finds that physicians who are integrated with a pharmacy in Japan prescribe drugs with higher margins more frequently than those who are not. Our results suggest that integration with a hospital operates along similar lines, with the important addition that we find some evidence of adverse consequences for the quality of care as well as cost and convenience.

One potential concern about our analysis is the endogeneity of hospitals' decisions to purchase physician practices. In particular, hospitals may seek to buy practices with physicians who would have been predisposed to admit to the hospital, even in the absence of an ownership relationship. Even if this were the case, however, it would not necessarily bias our key parameter estimates – the *interaction* between ownership and cost, quality, or distance. However, our estimates would be inconsistent to the extent that high-cost or low-quality hospitals were differentially likely to seek to buy practices with physicians who would have been predisposed to admit to the hospital. To investigate this hypothesis, we obtained leads of physicians' and hospitals' ownership status from 2010 and included them as exogenous variables in our models. We found no evidence that future ownership affected our estimates of the effects of cost, quality, and distance on

patient choice; hypothesis tests of the joint significance of the interactions fail to reject the null hypothesis of no effect at conventional significance levels.

Our results do not necessarily imply that hospital/physician integration is on net harmful for patients. Other recent work shows, at least under some circumstances, that it offers tangible benefits. Future work might investigate how these benefits can be reaped without the disadvantages we document here.

References

Afendulis, Christopher and Daniel P. Kessler. 2007. "Tradeoffs from Integrating Diagnosis and Treatment in Markets for Health Care." American Economic Review 97(3):1013-20.

_____. 2011. "Vertical Integration and Optimal Reimbursement Policy." International Journal of Health Care Finance and Economics 11:165-79.

Baker, Laurence, M. Kate Bundorf, Aileen Devlin, and Daniel P. Kessler. 2015. "Understanding Hospital/Physician Ownership." Draft.

Baker, Laurence, M. Kate Bundorf, and Daniel P. Kessler. 2014. "Vertical Integration: Hospital Ownership of Physician Practices Is Associated with Higher Prices and Spending." Health Affairs 33(5):756-63.

Beckert, Walter, Mette Christense, and Kate Collyer. 2012. "Choice of NHS-Funded Hospital Services in England." Economic Journal 122:400-17.

Ciliberto, Francis and David Dranove. 2006. "The Effect of Physician-Hospital Affiliations on Hospital Prices in California." Journal of Health Economics 25(1):29-38.

Cuellar, Allison E. and Paul J. Gertler. 2006. "Strategic Integration of Hospitals and Physicians." Journal of Health Economics 25(1):1-28.

Evans, Robert. 1974. "Supplier-induced Demand: Some Empirical Evidence and Implications." In M. Perlman, ed., The Economics of Health and Medical Care (London: Macmillan), 162-73.

Gaynor, Martin and Robert Town. 2012. "Competition in Health Care Markets." In Mark V. Pauly, Thomas G. McGuire, and Pedro P. Barros, eds., Handbook of Health Economics, Volume 2, Chapter 9.

Gaynor, Martin and Willam B. Vogt. 2003. "Competition Among Hospitals." RAND Journal of Economics 34(4):764-85.

Ho, Kate and Ariel Pakes. 2014. "Hospital Choices, Hospital Prices, and Financial Incentives to Physicians." American Economic Review 2014 104(12):3841-84.

Iizuka, Toshiaki. 2012. "Physician Agency and Adoption of Generic Pharmaceuticals." American Economic Review 102(6):2826-58.

Kessler, Daniel P. and Mark B. McClellan. 2000. "Is Hospital Competition Socially Wasteful?" Quarterly Journal of Economics 115(2):577-615.

McFadden, Daniel. 1973. "Conditional Logit Analysis of Qualitative Choice Behavior." In P. Zarembka, ed., Frontiers in Econometrics (New York: Academic).

National Center for Health Statistics. 2011. Health United States. Hyattsville, MD: U.S. Department of Health and Human Services.

O'Malley, Anne S., Amelia M. Bond, and Robert A. Berenson. 2011. "Rising Hospital Employment of Physicians: Better Quality, Higher Costs?" Washington, DC: Center for Studying Health System Change, available at http://www.hschange.com/CONTENT/1230.

Romley, John A. and Dana P. Goldman. 2011. "How Costly is Hospital Quality? A Revealed-preference Approach." Journal of Industrial Economics 59(4):578-608.

Tay, Abigail. 2003. "Assessing Competition in Hospital Care Markets: the Importance of Accounting for Quality Differentiation." RAND Journal of Economics 34(4):786-814.

Table 1: Number of Hospital Admissions, by Ownership Status of Admitting Physician and Hospital of Admission

A. Based on Admitting Physician Specified in Inpatient Record

	Physician is owned	Physician not owned	total
Hospital owns admitting physician	178219 (1.0000) [0.8335]	0 (0.0000) [0.0000]	178219 (1.0000) [0.0535]
Hospital owns physicians, but not admitting physician	17755 (0.0155) [0.0830]	1130050 (0.9845) [0.3627]	1147805 (1.0000) [0.3447]
Hospital does not own physicians	17856 (0.0089) [0.0835]	1985639 (0.9911) [0.6373]	2003495 (1.0000) [0.6017]
total	213830 (0.0642)	3115689 (0.9358)	3329519 (1.0000)

B. Based on Physician with the Greatest Number of Outpatient Encounters with Patient in 30 Days Prior to Admission

	Physician is owned	Physician not owned	total
Hospital owns admitting physician	17938 (1.0000) [0.6895]	0 (0.0000) [0.0000]	17938 (1.0000) [0.0350]
Hospital owns physicians, but not admitting physician	3691 (0.0196) [0.1419]	184365 (0.9804) [0.3786]	188056 (1.0000) [0.3666]
Hospital does not own physicians	4387 (0.0143) [0.1686]	302585 (0.9857) [0.6214]	306972 (1.0000) [0.5984]
total	26016 (0.0507)	486950 (0.9493)	512966 (1.0000)

Notes: Row percentages in parentheses; column percentages in brackets.

Table 2: Descriptive Statistics

	All nonrural Medicare	Admissions by SK&A Physicians
Hospital owns admitting MD* Hospital owns MDs*Admitting MD owned		0.0535
Hospital owns MDs*Admitting MD owned		0.0589
Admitting MD owned		0.0642
Hospital owns MDs	0.4083	0.3983
Cost (Z-score)	0.0000	-0.0077
Quality (Z-score)	0.0000	-0.0140
Distance (miles)	7.7660	7.6976
Small size (< 100 beds)	0.0370	0.0377
Large size (>300 beds)	0.5721	0.5704
Teaching hospital	0.3446	0.3318
System hospital	0.6868	0.6886
For-profit hospital	0.1231	0.1292
Public hospital	0.0884	0.0852
Patient age 65-74	0.3279	0.3597
Patient age 75-84	0.3952	0.3867
Patient age 85+	0.2769	0.2536
Black	0.1077	0.1107
Female	0.5793	0.5541
Number of observations	5550585	3329519

Table 3: Effects of Hospital/Physician Integration, Cost, Quality, and Distance on Hospital Choice

	(1)	(2)	(3)
Cost*Hospital owns admitting MD*		0.0266***	0.0190***
Hospital owns MDs*Admitting MD is owned		(0.00713)	(0.00642)
Quality*Hospital owns admitting MD*		0.0175**	0.0133**
Hospital owns MDs*Admitting MD is owned		(0.00735)	(0.00610)
Distance*Hospital owns admitting MD*		0.00728***	0.00433***
Hospital owns MDs*Admitting MD is owned		(0.000745)	(0.000615)
Hospital owns admitting MD*	0.334***	0.170***	0.172***
Hospital owns MDs*Admitting MD is owned	(0.0195)	(0.0137)	(0.0199)
Cost*		0.00209	0.00603
Hospital owns MDs*Admitting MD is owned		(0.00570)	(0.00434)
Quality*		0.00685	0.00348
Hospital owns MDs*Admitting MD is owned		(0.00508)	(0.00422)
Distance*		0.00334***	0.00224***
Hospital owns MDs*Admitting MD is owned		(0.000720)	(0.000550)
Hospital owns MDs*Admitting MD is owned	0.0335***	-0.0106	-0.00174
	(0.0129)	(0.0119)	(0.0111)
Cost*		-0.00428**	-0.00202
Hospital owns MDs		(0.00195)	(0.00164)
Quality*		-0.00194	-0.000219
Hospital owns MDs		(0.00229)	(0.00183)
Distance*		0.000980***	-0.000263
Hospital owns MDs		(0.000310)	(0.000268)
Hospital owns MDs	0.0113***	0.00321	0.00678
	(0.00311)	(0.00414)	(0.00522)
Cost	-0.00773***	-0.00417*	-0.00344*
	(0.00192)	(0.00225)	(0.00199)
Quality	-0.0112***	-0.00874***	-0.00488**
	(0.00122)	(0.00213)	(0.00209)
Distance	-0.0144***	-0.0144***	-0.0133***
	(0.000372)	(0.000388)	(0.000726)
Included interactions	None	Cost, quality distance	All

Notes: Standard errors clustered at the 3 digit zip code level. Number of 3 digit zip codes = 773. Logit coefficients are marginal effects.

Table 4: Effects of Hospital/Physician Integration, Cost, Quality, and Distance on Hospital Choice -- Alternative Models

	(1)	(2)	(3)
Cost*Hospital owns admitting MD in 2009*	0.0177***	0.0180**	0.0124
Hospital owns MDs in 2009*	(0.00443)	(0.00727)	(0.00792)
Admitting MD is owned in 2009			
Quality*Hospital owns admitting MD in 2009*	0.00381	0.0106*	0.00234
Hospital owns MDs in 2009*	(0.00341)	(0.00645)	(0.00456)
Admitting MD is owned in 2009			
Distance*Hospital owns admitting MD in 2009*	0.00295***	0.00395***	0.00258***
Hospital owns MDs in 2009*	(0.000422)	(0.000591)	(0.000565)
Admitting MD is owned in 2009			
Hospital owns admitting MD in 2009*	0.113***	0.137***	0.0850***
Hospital owns MDs in 2009*	(0.0106)	(0.0188)	(0.0121)
Admitting MD is owned in 2009			
Cost*Hospital owns admitting MD in 2010*		0.00279	0.00980
Hospital owns MDs in 2010*		(0.00854)	(0.0115)
Admitting MD is owned in 2010			
Quality*Hospital owns admitting MD in 2010*		0.00487	0.00335
Hospital owns MDs in 2010*		(0.00745)	(0.00557)
Admitting MD is owned in 2010			
Distance*Hospital owns admitting MD in 2010*		0.000485	0.000340
Hospital owns MDs in 2010*		(0.000669)	(0.000649)
Admitting MD is owned in 2010			
Hospital owns admitting MD in 2010*		0.0652***	0.0415***
Hospital owns MDs in 2010*		(0.0122)	(0.0144)
Admitting MD is owned in 2010			
Cost	-0.00602***	-0.00319	-0.00590***
	(0.00194)	(0.00226)	(0.00223)
Quality	-0.00704***	-0.00360*	-0.00614***
	(0.00216)	(0.00212)	(0.00223)
Distance	-0.0134***	-0.0133***	-0.0134***
	(0.000775)	(0.000742)	(0.000834)
Definition of Admitting Physician	Carrier	Inpatient	Carrier

Notes: See Table 3. Estimates are from models with a full set of interactions between cost, quality, distance and choice characteristics. Number of 3-digit zip codes is 742 for columns (1) and (3), 773 for column (2) = 773.