Does competition from ambulatory surgical centers affect hospital surgical output?

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Abstract:
This paper estimates the effect of ambulatory surgical centers (ASCs) on hospital surgical volume using hospital and year fixed effects models with several robustness checks. We show that ASC entry only appears to influence a hospital's outpatient surgical volume if the facilities are within a few miles of each other. Even then, the average reduction in hospital volume is only 2–4%, which is not nearly large enough to offset the new procedures performed by an entering ASC. The effect is, however, stronger for large ASCs and the first ASCs to enter a market. Additionally, we find no evidence that entering ASCs reduce a hospital's inpatient surgical volume.
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Article:

1. Introduction

Many studies have examined how hospitals compete on price and non-price dimensions (i.e. Zwanziger and Mooney, 2005; Abraham et al., 2007). However, when defining hospital markets, these studies have assumed that hospitals only compete with other hospitals. The impact of ambulatory surgical centers (ASCs), which also provide some services offered by hospitals, on the competitive environment of hospital markets has rarely been considered.

ASCs are small healthcare facilities that predominately offer outpatient surgeries and certain high-tech diagnostic tests. ASCs are typically for-profit facilities located in urban areas (MedPAC, 2005). The number of Medicare certified ASCs has grown from 2,462 in 1997 to 4,700 in 2006, with roughly 1.7% of facilities exiting annually during that time (MedPAC, 2005, 2009). Outpatient surgeries are increasingly performed at ASCs rather than hospitals; in 2006 ASCs provided an estimated 42.8% of all outpatient surgeries in the United States (Cullen et al., 2009). ASCs are appealing to physicians and patients since they offer nicer amenities than hospitals and may cost less than hospitals due to specialization.

ASCs have been criticized, however, for potentially reducing the volume of high revenue services from hospitals' outpatient departments, hindering their ability to subsidize less profitable services such as uncompensated care (Higgins, 2005; Kelly, 2003a,b; Casalino et al., 2003). For example, one hospital administrator claimed that in 2005 only 31% of his hospital's revenue came from outpatient services, compared to 52% 5 years earlier (Feldstein, 2006). The administrator cited a nearby ASC that specialized in orthopedic surgery as a primary reason for the decline.[2] Since physicians who treat patients at an ASC are generally partial owners of that facility, ASCs allegedly "have an unfair edge in referrals from physicians with a financial interest" (Kelly, 2003a,b). Physician-owners of ASCs may cherry pick by treating their high revenue-low cost patients at facilities they own and their low revenue-high cost patients at hospitals (Abelson, 2004; Gawande, 2009).

We contribute to the debate over ASC-hospital competition by examining the impacts of ASC entry into a hospital's market on the hospital's outpatient and inpatient surgical volume. We estimate hospital and year fixed effects models with a detailed set of hospital- and area-level controls, computing ASC presence in a hospital's market using both fixed and variable radius market definitions. As robustness checks, we estimate models including MSA-by-year effects, hospital-specific time trends, and future ASC presence, as well as instrumental variable models that use lagged ASC presence as an instrument for current ASC presence. We find that an additional ASC in a hospital's market reduces the hospital's annual outpatient surgical volume only if the facilities are very close to each other – less than 4 miles apart – and even then the average reduction is a modest 2–4%. This magnitude is not nearly large enough to offset the additional procedures performed at the typical ASC. The effect is somewhat more substantial, however, if the entering ASC is large or an early entrant: an ASC with three of more operating rooms reduces outpatient volume by about 7%, while the first ASC in a market reduces outpatient volume by 5–6%. We find no evidence that ASC entry lowers a hospital's inpatient surgical volume.

The rest of this paper proceeds as follows. Section 2 discusses the relevant literature, while Section 3 describes the data. In Section 4, we attempt to determine the approximate size of the market in which ASCs and hospitals compete. Using these results to guide our choice of market definitions, in Section 5 we estimate the average effect of ASCs in a hospital's market on the hospital's outpatient and inpatient surgical volume. In Section 6, we test for heterogeneity in the effect on the basis of the size of the ASCs and the number of pre-existing ASCs in the market. Section 7 concludes.

2. Literature review

To date, few authors have examined the effect of ASCs on hospital output. Lynk and Longley (2002) present two case studies where the entry of ASCs into rural hospitals' markets led the hospitals to perform dramatically fewer outpatient surgeries. Bian and Morrisey (2007) extend this type of research to a national sample. Using MSA-level panel data from 1993 to 2001, they find an additional ASC per 100,000 individuals is associated with a 4.3% decrease in hospital outpatient surgeries but no statistically significant change in hospital inpatient surgeries. Their model includes MSA and year fixed effects as well as controls for hospital concentration, HMO penetration, number of specialty surgeons, number of non-federal physicians, per capita income, unemployment rate, total population, and the proportion of the population age 65 years or older.

Our paper builds on the analysis of Bian and Morrisey in three ways. First, we directly examine how ASC presence in a hospital's market affects that hospital's output. It is not clear how Bian and Morrisey's estimated MSA-level associations could measure that relationship, as the typical market in which ASCs and hospitals compete is likely much smaller than an entire MSA. Also, defining markets using MSA borders may misclassify the markets of hospitals located close to a border. We conduct a hospital-level instead of MSA-level analysis, defining hospital markets using both fixed and variable radius techniques that approximate the size of a typical market.

Second, we perform numerous robustness checks to investigate omitted variable bias and reverse causality. Omitted variable bias is a potential concern in Bian and Morrisey's model, as an increase in demand for outpatient services over time not captured by the control variables could lead to both ASC entry and an increase in hospital outpatient surgical volume. Reverse causality is also possible, as an increase in the number of outpatient surgeries performed by a hospital may encourage the entry of ASCs.

Third, we test for heterogeneity in the effect of ASC entry on hospital outpatient surgical volume based on ASC size and the number of ASCs already in the market. Large ASCs serve more patients than small ASCs and therefore likely cause more substantial reductions in hospital volume. The effect of the first ASC to enter a market may be stronger than the effect of an additional ASC once the market is saturated, at which point ASCs compete with other ASCs in addition to hospitals.

Researchers have also examined other aspects of ASCs besides their effect on hospital volume. Wynn et al. (2004) found that older and unhealthier patients (who are more costly to treat) are more likely to be treated at a hospital than at an ASC. Winter (2003) shows the average risk score (a measure of the cost of treating a patient based on factors such as age and comorbidities) of patients is higher at hospital outpatient departments than at ASCs. Gabel et al. (2008) show that physicians are more likely to treat well-insured patients at their ASC and send Medicaid patients to hospitals. Plotzke and Courtemanche (forthcoming) analyze a sample of Medicare patients and find that a 10% increase in a patient's profitability is associated with a 1–2 percentage point increase in the probability that the patient is treated at an ASC instead of a hospital. They find, however, that profitability is only one of many factors that affect surgery location decisions, with patient health and procedure complexity being potentially more important.[3] Most recently, Hollingsworth et al. (2010) used Florida data to show that physicians with an ownership stake in an ASC performed significantly more surgeries than other physicians. The authors pointed to financial incentives as a possible explanation.

3. Data

Our empirical analysis utilizes data from two main sources. First, we use the Centers for Medicare & Medicaid Services (CMS), Provider of Services (POS) files from 1999 to 2004 for information on every ASC in the U.S. certified to treat Medicare patients.[4] We obtain the entry date, geographic location, and services offered by ASCs from the POS files, allowing us to compute the number of ASCs in any given area in all years up to 2004.[5] We determine the latitudes and longitudes for the ASCs by using their street address and geocoding software from www.geocode.com.

Next, we use the 1997 through 2004 AHA annual surveys for information on a hospital's geographic location, ownership, teaching status, facility size, services offered, staffing arrangements, and number of outpatient and inpatient surgeries performed. The AHA survey includes the latitude and longitude of most hospitals, and we compute any missing information using the geocoding software. We then compute the distance between every pair of healthcare facilities in the sample using the "great circle" distance formula. To minimize differences between urban and rural hospital markets, we only examine hospitals located in urban areas.

We next match the hospitals in the sample to each of the ASCs in their markets. Several different market definitions have been used in the hospital competition literature.[6] The easiest approach is to define markets according to geopolitical boundaries, such as Metropolitan Statistical Areas (MSAs) or counties. However, this likely leads to markets that are too small or too large, while also inaccurately describing the markets of hospitals located near a border. Another possibility is to define market boundaries using a fixed radius. This method assigns the same fixed radius to all hospitals in the sample and assumes that the radius around each hospital represents the hospital's market. This definition may also provide an inaccurate description of the market since different hospitals have different market sizes. Gresenz et al. (2004) accounted for this problem by constructing a variable radius measure for hospital markets. The authors calculate the actual radii from which hospitals in nine states admit 75% of their inpatients and also the radii from which those hospitals admit 90% of their inpatients. They then calculate the predicted radii for the remaining hospitals in the 1997 AHA survey.[7]

We utilize both the variable and fixed radius approaches. We begin with the 75% variable radius market definition of Gresenz et al. (2004). Since the average 75% variable radius in our sample is 11.5 miles, we also use an 11.5 mile fixed radius to examine the robustness of our results.[8] After creating these markets, we split them into thirds to examine how the effects of ASCs differ by their distance from a hospital. It is possible that inpatient market sizes may be too large for outpatient surgeries, or that ASC versus hospital competition occurs in a smaller area than hospital versus hospital competition. Using the 75% variable radius definition, we determine the number of ASCs within the first, second, and third thirds of that radius. For instance, if a hospital admits 75% of its inpatients within 15 miles of the hospital, we compute the number of ASCs that are less than 5 miles, between 5 and 10 miles, and between 10 and 15 miles away from that hospital. With the 11.5 miles fixed radius definition, we compute the number of ASCs that are less than 3.83 miles away from a hospital, between 3.83 and 7.67 miles away, and between 7.67 and 11.5 miles away.

Table 1
Summary statistics: sample means and standard deviations (in parentheses).

	Variable radius	Fixed radius
Annual number of outpatient surgeries [Hospital]	5623.108	5634.279
	(5172.217)	(5149.231)
Annual number of inpatient surgeries [Hospital]	3609.085	3631.386
	(3511.217)	(3527.543)
Number of ASCs within 1/3 of the radius [Market]	2.164	2.225
	(3.556)	(3.195)
Number of ASCs between 1/3 and 2/3 of the radius [Market]	1.939	2.541
	(4.587)	(4.697)
Number of ASCs beyond 2/3 of the radius [Market]	1.989	3.137
	(4.484)	(5.795)
Small hospital [Hospital]	0.168	0.171
	(0.374)	(0.377)
Private hospital [Hospital]	0.148	0.154
	(0.356)	(0.361)
Public hospital [Hospital]	0.131	0.129
	(0.338)	(0.335)
Teaching hospital [Hospital]	0.203	0.205
	(0.402)	(0.403)
Separate location for outpatient surgery [Hospital]	0.375	0.374
	(0.484)	(0.484)
Number of operating rooms [Hospital]	10.761	10.811
	(8.867)	(8.900)
Full time physicians and dentists [Hospital]	21.950	22.031
	(85.327)	(85.682)
Herfindahl Hirschman Index [Market]	0.464	0.385
	(0.329)	(0.313)
Number of hospitals [Market]	9.123	11.872
	(13.461)	(14.555)
Total population over 65 (100,000) [County]	1.134	1.131
	(1.849)	(1.839)
Total population (100,000) [County]	10.154	10.145
	(18.130)	(18.057)
Percentage without health insurance [County]	13.722	13.741
	(4.401)	(4.407)
Unemployment rate [County]	4.925	4.939
	(1.826)	(1.820)
Percentage living in poverty [County]	11.951	11.970
	(4.579)	(4.582)
Log of median income [County]	10.654	10.655
	(0.215)	(0.215)

Table 2
Estimated Effects on ln(outpatient surgeries).

	Variable radius	Fixed radius
Number of ASCs within 1/3 of the radius	**−0.031**	**−0.027**
	(0.006)***	**(0.006)*****
Number of ASCs between 1/3 and 2/3 of the radius	0.001	−0.005
	(0.005)	(0.005)
Number of ASCs beyond 2/3 of the radius	−0.008	0.006
	(0.006)	(0.004)
Small hospital	−0.062	−0.064
	(0.036)	(0.036)
Private hospital	0.054	0.054
	(0.046)	(0.046)
Public hospital	0.008	0.005
	(0.059)	(0.061)
Teaching hospital	0.045	0.040
	(0.024)	(0.024)
Separate location for outpatient surgery	−0.002	−0.002
	(0.013)	(0.013)
Number of operating Rooms	**0.016**	**0.015**
	(0.002)***	**(0.002)*****
Full time physicians and dentists	−0.00008	−0.00002
	(0.00012)	(0.00010)
Herfindahl Hirschman Index	−0.057	0.029
	(0.079)	(0.076)
Number of hospitals	**−0.008**	−0.001
	(0.004)*	(0.003)
Total population over 65 (100,000)	0.227	0.209
	(0.263)	(0.267)
Total population over 65 (100,000) squared	−0.017	−0.004
	(0.027)	(0.027)
Total population (100,000)	−0.003	−0.002
	(0.026)	(0.027)
Total population (100,000) squared	0.0001	0.0001
	(0.0003)	(0.0003)
Percentage without health insurance	0.028	0.047
	(0.033)	(0.032)
Unemployment rate	**0.025**	**0.025**
	(0.007)***	**(0.007)*****
Percentage living in poverty	−0.004	−0.005
	(0.006)	(0.006)
Log of median income	0.189	0.186
	(0.191)	(0.197)
Observations	13322	13405
R^2	0.921	0.921

Standard errors in parentheses are heteroskedasticity-robust and clustered at the hospital-level.
Hospital and year fixed effects are included in all regressions.
* Indicates significant at the 5% level.
**Indicates significant at the 1% level.
*** Indicates significant at the 0.1% level.

We utilize a wide range of hospital-level, market-level, and county-level variables as controls. Our hospital-level controls include the number of operating rooms and full time physicians as well as dummy variables for whether the hospital is small (has less than 100 beds); is non-profit, for-profit, or public; is a teaching hospital (as defined by having at least 20 residents); and has an additional facility (besides the main hospital) where it provides outpatient surgery. Our market-level variables are the total number of hospitals and the Herfindahl Hirschman Index (HHI).[9] Our county-level controls consist of demographic characteristics (total population and the population that is age 65 or older) from the Area Resource Files produced by Quality Resource Systems Inc., economic characteristics (unemployment rate, percentage living in poverty, and log of median income) from the Bureau of Labor Statistics, and the percentage of people without health insurance from the U.S. Census Bureau.[10]

Table 1 reports the variables' summary statistics using both the 75% variable radius and 11.5 mile fixed radius market definitions. In brackets, we report whether a variable is hospital-level, market-level, or county-level. The fixed radius sample consists of 13,405 observations from 2349 hospitals, while the variable radius sample consists of 13,322 observations from 2243 hospitals.[11] The average hospital performs approximately 5600 outpatient and 3600 inpatient surgeries per year. Using the variable radius, the average hospital's market contains 6.1 ASCs: 2.2 in the closest third of the radius, 1.9 in the middle third, and 2.0 in the farthest third.

Using the fixed radius, 7.8 ASCs are in the average hospital's market: 2.2 less than 3.83 miles away, 2.5 between 3.83 and 7.67 miles away, and 3.1 between 7.67 and 11.5 miles away.

4. Market size

We begin the empirical analysis by attempting to determine the approximate size of the market in which hospitals and ASCs compete. We regress the natural log of hospital outpatient surgeries (ln(OS)) on the number of ASCs in the first third (ASC1), second third (ASC2), and third third (ASC3) of the market, as well as the set of controls (Controls) and hospital and year fixed effects (α and ω).[12] In unreported regressions, we find that splitting the market radius into more than three pieces does not reveal additional information, and also that the results are similar using the total number of ASC operating rooms in the market instead of the number of ASCs. The regression equation is

$$[\ln(OS)_{it}] = \beta_0 + \beta_1 ASC1_{it} + \beta_2 ASC2_{it} + \beta_3 ASC3_{it} + \beta_4 \mathit{Controls}_{it} + \alpha_i + \omega_t + \varepsilon_{it} \quad (1)$$

where subscripts *i* and *t* indicate hospital and year. We take the log of surgeries following Bian and Morrisey (2007); this gives the coefficients an approximate percentage interpretation.[13] Controls includes the set of control variables described in Section 3, plus the squares of population and population 65 and over. We estimate (1) using both the 75% variable radius and the 11.5 miles fixed radius market definitions. Since 11.5 miles is the average of the 75% variable radii for the hospitals in the sample, the coefficient estimates for the market-level variables in the two regressions are somewhat comparable. We compute heteroskedasticity-robust standard errors corrected for clustering at the hospital-level.

Table 2 reports the results. In both regressions, an increase in the number of ASCs within 1/3 of the radius is associated with a statistically significant but modest reduction in hospital outpatient volume. An additional ASC within 1/3 of the 75% radius reduces the hospital's outpatient surgeries by approximately 3.1 %, while an additional ASC within 3.83 miles reduces the hospital's outpatient surgeries by 2.7%. However, we find no evidence in either regression of an association between ASCs in the second and third thirds of the market and hospital output even though the coefficients are precisely estimated.

When examining ASC versus hospital competition, the appropriate market size therefore appears to be small relative to the market sizes typically used when studying competition in a hospital's inpatient market (e.g. Rogowski et al., 2007; Dafny, 2005). Outpatient surgeries are generally simpler than inpatient surgeries, so patients may not need to travel as far to receive adequate care. Given the results from this section, in Sections 5 and 6 we define markets using 1/3 of the 75% variable radius and a 3.83 miles fixed radius.

Only two of the control variables – number of operating rooms and unemployment rate – are significant in both regressions, while number of hospitals in the market is also significant in the variable radius regression. We suspect that the other controls are not significant in these fixed effects models because of a lack of variation in these variables over time during our sample period. Fortunately, there is ample variation over time in the number of ASCs (MedPAC, 2005). The independent variables together explain over 90% of the variation in outpatient surgeries, largely due to the explanatory power of the hospital and year fixed effects.

5. Average effects

5.1. Models

Defining markets using both 1/3 of the 75% variable radius and a 3.83 miles fixed radius, we next estimate the average effects of additional ASCs in a hospital's market on the hospital's outpatient and inpatient surgical volume. While it is less likely that ASC entry would affect inpatient volume than outpatient volume, a connection is possible. Hospitals that lose outpatient surgeries to an ASC may use excess capacity to treat more inpatients. Alternatively, an entering ASC may treat some patients on an outpatient basis who previously would have been treated on an inpatient basis at a hospital.

Our baseline regression equation is

$$Y_{it} = \beta_0 + \beta_1 \text{ASC1}_{it} + \beta_2 \text{Controls}_{it} + \alpha_i + \omega_t + \varepsilon_{it} \quad (2)$$

where Y is either ln(outpatient surgeries) or ln(inpatient surgeries). We also estimate the model without controls in order to assess the sensitivity of $\hat{\beta}_1$ to their inclusion.

The fixed effects estimator is unbiased if there are no unobserved variables that change over time that are correlated with the error term during any time period. That is, the error term must be strictly exogenous. With respect to $\hat{\beta}_1$, our controls should capture some of the potential sources of omitted variable bias, such as age and income. As discussed in Section 2, however, potential endogeneity concerns remain. The controls may not capture all time-varying factors that affect demand for healthcare services, and changes in demand could determine both ASC entry and changes in hospital output. Reverse causality is also possible, as physicians may observe an increase in a hospital's outpatient surgical volume and decide to open an ASC. We conduct a number of robustness checks to examine these concerns.

First, we add MSA-by-year effects to the model by interacting each of the year fixed effects with each of a set of MSA fixed effects. The inclusion of MSA-by-year effects restricts identification of the parameters of interest to variation between hospitals in the same MSA over time.[14] To illustrate, suppose an ASC opens in the markets of two hospitals in the Boston MSA but not in the markets of the other hospitals in the MSA. If demand for healthcare services has been growing faster in the Boston MSA than in other parts of the country, the baseline fixed effects estimator may be biased upward, and adding MSA-by-year effects would eliminate this bias.

We next replace the MSA-by-year effects with hospital-specific linear time trends, created by interacting year with each of the hospital fixed effects.[15] Controlling for unobservable time-variant MSA characteristics may not remove all sources of bias, as there is heterogeneity within MSAs. For instance, some areas of an MSA are wealthier than others, which may impact hospital outpatient surgical volume as well as ASC entry patterns. If secular trends in demand or other unobservable characteristics of a hospital or its market are biasing the baseline fixed effects estimator, including hospital trends will affect the results. A limitation of this approach is that changes over time in the unobservable variables are assumed to be linear; including hospital trends may not impact the results if changes in the sources of omitted variable bias are sufficiently non-linear.

While including MSA-by-year effects or hospital trends can reduce or eliminate omitted variable bias, they do not solve the problem of reverse causality. We therefore next estimate (2) including as an additional regressor the number of ASCs in the market at the end of the following year. If the lead of the number of ASCs is correlated with the dependent variable conditional on the current number of ASCs, this would provide evidence of reverse causality.

We next estimate instrumental variable models using lagged ASC presence as an instrument for current ASC presence. If reverse causality is a problem, using lagged number of ASCs as an instrument for current number of ASCs should impact the results. We estimate two-stage least-squares fixed effects models of the following form:

$$\text{ASC1}_{it} = \gamma_0 + \gamma_1 \text{ASC1}_{i,t-j} + \gamma_2 \text{Controls}_{it} + \mu_i + \sigma_t + \varepsilon_{it} \quad (3)$$

$$Y_{it} = \beta_0 + \beta_1 \overline{\text{ASC1}}_{it} + \beta_2 \text{Controls}_{it} + \alpha_i + \omega_t + \varepsilon_{it} \quad (4)$$

where u_i and σ_t are the first-stage hospital and year effects, ε_{it} is the first-stage error term, j is the number of years before the cur-rent year (j = 1, 2,. .., 10), and the other terms are defined as in (2).[16] We present the results when j = 1 and j = 10; results using the lag lengths in between these are similar. The identifying assumption in the model is that, conditional on the controls, lagged ASC presence is only correlated with hospital output and profit through its effect on contemporaneous ASC presence. This assumption would be violated (for at least some of the shorter lag lengths) if the effects of ASC entry are gradual or temporary. To test the validity of the exclusion restriction, we estimated the baseline model (2) including up to five annual lags of the number of ASCs in addition to the number of contemporaneous ASCs. The lags in all cases were highly insignificant, suggesting that the effects of ASCs occur relatively quickly.[17]

5.2. Results

Tables 3 and 4 report the results for outpatient and inpatient surgeries. Panel A of each table uses 1/3 of the 75% variable radius, while Panel B uses the 3.83 miles fixed radius. The first column reports the results from the regression excluding the controls, while the second column displays the results from the baseline model in Eq. (2), which includes the controls. The third column adds the MSA-by-year effects and the fourth replaces the MSA-by-year effects with the hospital trends. The fifth column reports the estimates from the baseline model, but including the lead of the number of ASCs. The sixth and seventh columns use number of ASCs in *t*-1 and *t*-10, respectively, as instruments for current number of ASCs. The first and second rows of each panel report the coefficient estimates and standard errors for the number of ASCs and, when applicable, the lead of ASCs. For the instrumental variable models, the third row reports the F-statistic from the test of the null hypothesis that the instrument does not belong in the first-stage model.

Table 3
Estimated Effect of ASCs on ln(Outpatient Surgeries).

		No controls	Baseline	MSA-by-year	Hospital trends	Lead of ASCs	IV: ASCs in *t-1*	IV: ASCs in *t-10*
Panel A: variable radius	Number of ASCs	**−0.029** **(0.006)*****	**−0.032** **(0.006)*****	**−0.023** **(0.007)*****	**−0.029** **(0.007)*****	**−0.038** **(0.008)*****	**−0.035** **(0.006)*****	**−0.024** **(0.010)***
	Lead of number of ASCs	–	–	–	–	0.006 (0.008)	–	–
	First-stage *F*-statistic	–	–	–	–	–	2998.87	156.51
Panel B: fixed radius	Number of ASCs	**−0.028** **(0.006)*****	**−0.027** **(0.006)*****	**−0.022** **(0.008)****	**−0.022** **(0.008)****	**−0.031** **(0.009)*****	**−0.026** **(0.006)*****	**−0.028** **(0.012)***
	Lead of number of ASCs	–	–	–	–	0.005 (0.009)	–	–
	First-stage *F*-statistic	–	–	–	–	–	3197.71	119.09

Standard errors in parentheses are heteroskedasticity-robust and clustered at the hospital-level.
Hospital and year fixed effects and the controls from Table 3 are included in all regressions.
*** Indicates significant at the 0.1% level.
** Indicates significant at the 1% level.
* Indicates significant at the 5% level.

Table 3 shows that ASC entry is associated with a reduction in hospital outpatient surgical volume. In the baseline regression, an additional ASC reduces outpatient volume by approximately 3.2% using the variable radius and 2.7% using the fixed radius. Results are similar excluding the controls; adding MSA-by-year effects, hospital trends, or the lead of ASCs; and using short or long lags of ASC presence as an instrument for current ASC presence. Number of ASCs is significant in all 14 regressions, and the estimated effects range from 2.2% to 3.8%. We find no evidence of omitted variable bias or reverse causality, as none of the estimates from the robustness checks are statistically distinguishable from the base-line estimates, and the lead of ASCs is highly insignificant.

Table 4
Estimated effect of ASCs on ln(inpatient surgeries).

		No controls	Baseline	MSA-by-year	Hospital trends	Lead of ASCs	IV: ASCs in *t-1*	IV: ASCs in *t-10*
Panel A: variable radius	Number of ASCs	0.004 (0.003)	0.003 (0.003)	0.001 (0.005)	−0.001 (0.005)	0.002 (0.005)	0.003 (0.004)	−0.010 (0.007)
	Lead of number of ASCs	–	–	–	–	0.001 (0.006)	–	–
	First-stage *F*-statistic	–	–	–	–	–	2998.87	156.51
Panel B: fixed radius	Number of ASCs	0.005 (0.004)	0.006 (0.004)	0.008 (0.005)	0.004 (0.006)	−0.001 (0.006)	0.004 (0.005)	−0.016 (0.010)
	Lead of number of ASCs	–	–	–	–	0.008 (0.007)	–	–
	First-stage *F*-statistic	–	–	–	–	–	3197.71	119.09

See notes for Table 4.

Table 4 presents the results for inpatient volume. Number of ASCs is not statistically significant in any of the 14 regressions, even though the coefficients are precisely estimated. We again find no evidence that the baseline fixed effects estimator suffers from omitted variable bias or reverse causality, as the estimated effects in columns (3)–(7) are statistically indistinguishable from those in column (2), and the lead of ASCs in column (5) is statistically insignificant. The finding that ASC entry has no effect on a hospital's inpatient surgical volume is not surprising given that ASCs provide only outpatient surgeries.

In all, an additional ASC is associated with a 2–4% reduction in the average hospital's outpatient surgical volume but no statistically or economically significant change in inpatient volume. While this effect is non-trivial, it is not large enough to suggest that competition from ASCs poses a serious threat to the viability of the typical hospital. To illustrate, our baseline estimates imply that a 10% increase in the number of ASCs in a hospital's market at the sample mean (2.164 ASCs using the variable radius, 2.225 using the fixed radius) would reduce a hospital's outpatient volume by just 0.6–0.7%, and that the existence of ASCs has caused hospital outpatient volume to be just 6–7% lower than it would have been otherwise. These effects are economically meaningful but less severe than one might suspect given the anecdotes discussed in Section 1. For instance, recall the hospital whose share of revenues coming from outpatient procedures fell from 52% to 31% after the entry of a nearby ASC (Feldstein, 2006). If revenues from other sources were constant, then outpatient revenues must have fallen by 40% – an order of magnitude greater than the effect estimated in this paper. The impact on this hospital was therefore either an exceptional case or due largely to other factors besides the entry of the ASC.

We can also use these calculations to relate our estimates to those of Bian and Morrisey (2007). Bian and Morrisey's estimated impact is 4.3% and their sample mean for ASCs per 100,000 residents is 1.208, implying that the existence of ASCs has caused hospital volume to be 5.2% less than it would have been otherwise. This is slightly less than but similar to our estimates of 6–7% from the preceding paragraph. We caution against a direct comparison since the two papers estimate different parameters: Bian and Morrisey estimate the impact of ASCs per 100,000 residents in an MSA on outpatient surgeries performed by all hospitals in the MSA while we estimate the impact of the number of ASCs in a hospital's market on outpatient surgeries performed by that hospital. That said, the two papers appear to be in agreement about the order of magnitude of the aggregate effect. Our results, though, emphasize that ASC entry in an MSA will have very different effects on the hospitals in that MSA depending on their distance from the new ASC.

5.3. Does the decrease in hospital volume offset the increase in ASC volume?

Given our results, an important question is whether the loss in hospital volume fully offsets the increase in ASC volume. The offset is likely somewhat less than one-to-one, as some procedures performed at a new ASC would otherwise be performed in physician offices or other ASCs as opposed to hospitals. However, if the offset is substantially less than one-to-one, this would provide indirect evidence that ASC entry increases a market's overall outpatient surgery volume. Such an increase in overall market volume could occur for three distinct reasons. First, ASCs provide greater convenience, comfort, and ease of scheduling than hospitals, which could increase the volume of surgeries on the margin in a welfare-enhancing way. Next, the opportunity to earn additional income from the facility fee could lead physician-owners of ASCs to induce demand, consistent with Hollingsworth et al.'s (2010) finding that ASC ownership leads physicians to perform more surgeries.[18] Finally, HOPDs faced with declining profits may induce demand to recoup some of the losses.[19]

Unfortunately, we are unable to directly estimate the relationship between a market's ASC volume and a market's hospital outpatient volume because our data do not include the number of surgeries performed by each ASC. We therefore calculate an approximation of this relationship using the following formula. We define OFFSET as the proportion of an entering ASC's outpatient volume lost by hospitals, $dY_H/dASC$ as the marginal effect of the number of ASCs in the market on the number of outpatient surgeries performed annually by the average hospital in the market, Y_{ASC} as the number of surgeries performed at the average ASC, and M as the number of hospitals' markets in which the average ASC is located. Therefore,

$$OFFSET = \frac{dY_H/\,dASC * M}{Y_{ASC}} \qquad (5)$$

We estimate $dY_H/dASC$ using regression equation (2) with the variable radius market definition and the level instead of the log of hospital surgeries as the dependent variable, obtaining the coefficient estimate −134 (standard error 47).[20] As sensitivity analyses, we also utilize as alternative values for $dY_H/dASC$ this point estimate plus or minus one or two standard errors (−40, −87, −181, and −228). We use three values for M: the number of hospitals' markets in which the average ASC in our sample is located in all years (5.5), in the year in which this number was the lowest (5.1 in 2004), and in the year in which it was the highest (5.9 in 1997).

Since our data do not contain information on the number of surgeries performed by ASCs, we calibrate Y_{ASC} as follows. We are not aware of any national estimates of the number of surgeries performed by the average ASC, but during 2002 ASCs in Indiana and Pennsylvania performed an average of 3494 and 3953 surgeries, respectively (Indiana State Department of Health, 2003; Pennsylvania Health Care Cost Containment Council, 2003). We also develop our own national estimate by dividing the number of surgeries performed at ASCs in the U.S. in 2006 (14.9 million; Cullen et al., 2009) by the number of ASCs in the U.S. in 2006 (4700; MedPAC, 2009), obtaining 3170. We set Y_{ASC} equal to each of the values 3494, 3953, and 3170.

Together, there are 45 possible parameter combinations. We report the results for each combination in Appendix Table 1. *OFFSET* ranges from 0.052 to 0.424, with a median of 0.211, mean of 0.210, and standard deviation of 0.108. Importantly, *OFFSET* is well below 1 even using the most extreme parameter values. For no combination of parameters do we find that the loss in hospital volume offsets even half of ASC volume. It therefore appears that only a portion of ASC surgical volume comes from hospitals. The remaining portion comes from surgeries previously performed in other outpatient settings or not performed at all. Future research should explicitly measure the increase in a market's surgical volume following ASC entry and also examine the extent to which the increase reflects welfare-enhancing procedures as opposed to ASC or hospital inducement.

6. Heterogeneity

Even if the average effect of ASC entry on a hospital's outpatient volume is modest, as suggested in Section 5, the possibility remains that the effect is more substantial for certain types of ASCs in certain types of markets. In this section, we explore potential heterogeneity in the effect based on the size of the ASC and the number of ASCs already in the market.

Table 5
Estimated effects of ASCs with 1, 2, and 3 or more operating rooms on ln(output surgeries).

	Variable radius	Fixed radius
Number of ASCs with 1 operating room	−0.002 (0.009)	−0.005 (0.008)
Number of ASCs with 2 operating rooms	**−0.034** **(0.010)*****	−0.017 (0.010)
Number of ASCs With 3 or more operating rooms	**−0.066** **(0.009)*****	**−0.073** **(0.011)*****

See notes for Table 4.

First, we estimate a model that includes three independent variables of interest: the number of "small" ASCs (one operating room), the number of "medium-sized" ASCs (two operating rooms), and the number of "large" ASCs (three or more operating rooms). We choose these divisions because approximately one-third of the ASCs in our sample fall into each of the three categories. The regression equation is

$$\ln(OS_{it}) = \beta_0 + \beta_1 \, ASC1S_{it} + \beta_2 ASC1M_{it} + \beta_3 ASC1L_{it} + \beta_4 Controls_{it} + \alpha_i + \omega_t + \varepsilon_{it} \quad (6)$$

where ASC1*S* is the number of small ASCs in the first third of the 75% variable or 11.5 miles fixed radius markets, ASC1*M* is the number of medium-sized ASCs, and ASC1*L* is the number of large ASCs.

Table 5 reports the results. In both the variable and fixed radius regressions, small ASCs have essentially no effect on outpatient volume. The effect of medium-sized ASCs is significant using the variable radius but not the fixed radius market definition. The magnitude of the effect is modest in both regressions, as an additional medium-sized ASC reduces hospital outpatient volume by about 3% using the variable radius and about 2% using the fixed radius. The effect of large ASCs is more substantial: an additional large ASC reduces hospital outpatient volume by a statistically significant 7% in both regressions. Therefore, while the average effect of

ASCs appears to be modest, large ASCs have an effect that is considerably stronger than the average. Nonetheless, even the impact of large ASCs is not as devastating as the anecdotal evidence might suggest.

We next examine whether the first ASCs to enter a market have a different effect on outpatient volume than later entrants. Later entrants may have a weaker effect because they compete not only with hospitals for patients but also with the other ASCs. We estimate a model that includes as variables of interest both the number of ASCs in the market and the square of the number of ASCs.21 This allows their marginal effect to change across the distribution. Our regression equation is

$$\ln(OS_{it}) = \beta_0 + \beta_1 ASC1_{it} + \beta_1 ASC1_{it}^2 + \beta_4 Controls_{it} + \alpha_i + \omega_t + \varepsilon_{it} \qquad (7)$$

In Figs. 1 and 2, we plot the marginal effect of ASCs on the log of hospital outpatient output for up to the 99th percentile of the ASC1 distribution in the sample. The coefficient estimates are reported at the bottom of the figures. Fig. 1 defines markets using 1/3 of the 75% variable radius; the 99th percentile is 18 ASCs. The first ASC in the market reduces hospital outpatient volume by about 6%. The marginal effect gradually decreases across the distribution, eventually reaching about 2% by the 17th ASC. Fig. 1 uses the 3.83 miles fixed radius market definition; the 99th percentile is 14 ASCs. The first ASC reduces volume by about 5%, and the marginal effect again gradually decreases across the distribution, eventually reaching about 2%. The evidence therefore suggests that if an ASC enters a market with no pre-existing ASCs, its effect on a hospital's outpatient output is likely to be stronger than the average effect reported in Section 5, but still not strong enough to pose a serious threat to hospital viability.

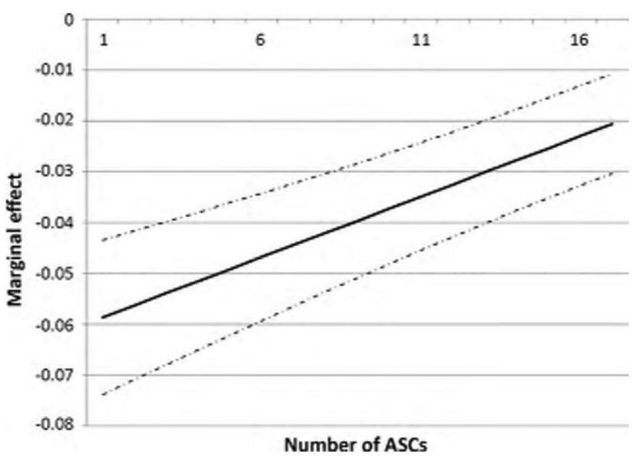

Fig. 1. Marginal effect of additional ASCs on ln(outpatient surgeries) – variable radius. Dashed lines represent 95% confidence intervals. Coefficient estimates and standard errors (in parentheses) for ASC variables: ASCs −0.061 (0.008); ASCs^2 0.0012 (0.0002).

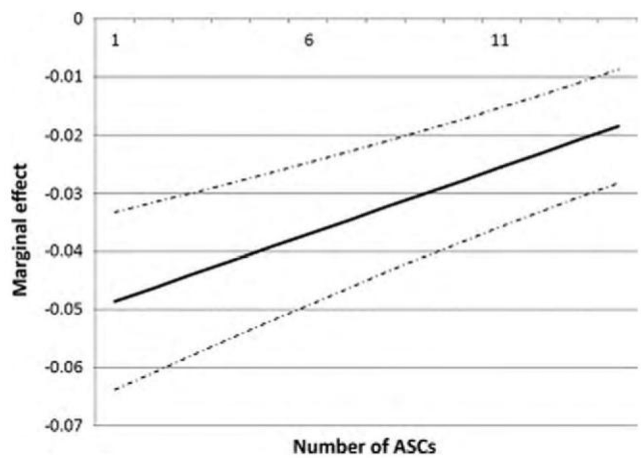

Fig. 2. Marginal effect of additional ASCs on ln(outpatient surgeries) – fixed radius. Dashed lines represent 95% confidence intervals. Coefficient estimates and standard errors (in parentheses) for ASC variables: ASCs −0.050 (0.008); ASCs^2 0.0012 (0.0002).

In unreported regressions, we also combined the two tests for heterogeneity in this section by estimating models including the number of small, medium, and large ASCs as well as their squares. These results indicate that if the first ASC in a market also happens to be large, the decline in hospital outpatient volume is about 9%.

7. Conclusion

This paper estimates the impact of ASC entry in a hospital's market on the hospital's outpatient and inpatient surgical volume. We begin by showing that ASC entry only appears to affect a hospital's outpatient surgical volume if the ASC is within 1/3 of the distance from which hospitals admit 75% of their patients, which is on average less than four miles. Even then, the average reduction in volume is a modest 2-4%, which implies that hospitals' lost volume accounts for only a fraction of the procedures performed at the typical ASC. The effect, however, is stronger if the entering ASC has three or more operating rooms or is an early entrant into the market. The estimated effect on inpatient volume is small and statistically insignificant. In all, the evidence suggests that the effect of ASCs on the productivity of hospitals is in most cases non-trivial but far from devastating. It seems unlikely that the estimated effects would lead to substantial reductions in the provision of uncompensated care, although future research should test this hypothesis more directly.

An understanding of the net effect of ASCs on social welfare is needed to evaluate the appropriateness of policies that govern ASCs, such as CON laws. ASCs lead to welfare gains for the physicians who profit from them, the patients for whom surgeries are more convenient, and the insurance companies for whom surgeries are potentially cheaper. However, ASCs may lead to welfare losses for hospitals, which in turn may lead to welfare losses for low-income patients for whom charity care is no longer available. Effects on outcomes and utilization should also be considered. ASCs could improve outcomes because of their specialization, or worsen outcomes because of limited treatment capability if complications arise. They could also increase the quantity of outpatient surgeries performed in ways that are either welfare-enhancing or wasteful. Further research is needed to fully understand the complex and multi-faceted effect of ASCs on social welfare.

Appendix A.

Table A1
Estimates for percentage of surgeries ASCs perform that were previously performed at hospitals (*OFFSET*).

$dY_H/dASC$	*M*	Y_{ASC}	*OFFSET*
−134	5.5	3494	0.211
−134	5.5	3953	0.186
−134	5.5	3170	0.232
−134	5.1	3494	0.196
−134	5.1	3953	0.173
−134	5.1	3170	0.216
−134	5.9	3494	0.226
−134	5.9	3953	0.200
−134	5.9	3170	0.249
−40	5.5	3494	0.063
−40	5.5	3953	0.056
−40	5.5	3170	0.069
−40	5.1	3494	0.058
−40	5.1	3953	0.052
−40	5.1	3170	0.064
−40	5.9	3494	0.068
−40	5.9	3953	0.060
−40	5.9	3170	0.074
−87	5.5	3494	0.137
−87	5.5	3953	0.121
−87	5.5	3170	0.151
−87	5.1	3494	0.127
−87	5.1	3953	0.112
−87	5.1	3170	0.140
−87	5.9	3494	0.147
−87	5.9	3953	0.130
−87	5.9	3170	0.162
−181	5.5	3494	0.285
−181	5.5	3953	0.252
−181	5.5	3170	0.314
−181	5.1	3494	0.264
−181	5.1	3953	0.234
−181	5.1	3170	0.291
−181	5.9	3494	0.306
−181	5.9	3953	0.270
−181	5.9	3170	0.337
−228	5.5	3494	0.359
−228	5.5	3953	0.317
−228	5.5	3170	0.396
−228	5.1	3494	0.333
−228	5.1	3953	0.294
−228	5.1	3170	0.367
−228	5.9	3494	0.385
−228	5.9	3953	0.340
−228	5.9	3170	0.424

Notes:

2 Because of the perceived financial threat, some hospitals have attempted to limit the competition they face from ASCs in a number of ways including seeking exclusive contracts with health insurance providers (Casalino et al., 2003).

3 A related literature examines the impact of specialty hospitals on general hospitals. Barro et al. (2006) show that markets with specialty hospitals are associated with lower expenditures for cardiac care without significant changes in mortality. However, they and Greenwald et al. (2006) find that specialty hospitals treat healthier patients than general hospitals. In a study prepared for the AHA, McManis Consulting (2005) found hospitals in Wichita and Oklahoma City that shut down community medical education programs because of reductions in profits due to competition from specialty hospitals.
4 We use the end of year POS from 1999 through 2001 and the second quarter POS from 2002 through 2004. CMS was not able to provide the end of year POS for the years 2002 through 2004. Additionally, we examine services offered to exclude any ASCs that focus exclusively on cosmetic surgery.
5 We construct measures of ASC presence in the years before 1999 using the entry dates from the 1999 file. We therefore have no record of ASCs that existed before 1999. This should not be a major problem since, as mentioned earlier, shows that only a small number of ASC's exit each year.
6 Garnick et al. (1987) present more detailed explanations of these market definitions.
7 Wong et al. (2005) explored how using different market definitions impacted the estimated effect of competition between hospitals on a hospital's total operating expenses. Using seven different market definitions, they found as a hospital market became more competitive the hospital costs in that market decreased, implying that the sign of their estimate did not depend on market definition.
8 In unreported regressions, we find no evidence that ASCs located beyond these boundaries impact hospitals, so it seems unlikely that our markets are too small.
9 The HHI for each hospital is the sum of the squared market shares of admissions for all of the hospitals in a hospital's market.
10 For the percentage uninsured variable, we use the U.S. Census Bureau's Small Area Health Insurance estimates. This information is only available in 2000 and 2001, so we use the 2000 estimates for 1997 through 1999 and the 2001 estimates for 2002 through 2004.
11 We include only hospitals that perform at least 20 outpatient and inpatient surgeries in each year and have outpatient and inpatient department operating margins between —1 and 1. Only hospitals classified in the AHA survey as not-for-profit, for-profit, and nonfederal government were included. Also, only hospitals with a service code description in the AHA survey of general medical and surgical were included. Finally, since Gresenz, Rogowski, and Escarce only constructed the variable radius of a hospital market for those hospitals that completed the 1997 AHA survey, we do not include hospitals that entered after 1997.
12 We define the number of ASCs in a given year as the number of ASCs in operation at the end of the preceding year. Results (available upon request) are almost identical using the number of ASCs in operation at the end of the current year.
13 Data limitations prevent us from examining the impact of ASCs on specific hospital outpatient service lines, though this presents a fruitful avenue for future research.
14 The fixed radius sample consists of 2349 hospitals in 327 MSAs, while the variable radius sample consists of 2243 hospitals in 325 MSAs.
15 We do not interact each of the year fixed effects with each of the hospital fixed effects, as that would lead to perfect collinearity.
16 We use the Stata module xtivreg2 by Schaffer (2008).
17 In unreported regressions (available upon request), we also consider a different instrument: a binary variable indicating whether CON laws governed ASCs in the state in the preceding year. However, the instrument is weak according to the criteria of Staiger and Stock (1997), likely because there were only five changes in state CON law status during our sample period. (Alabama passed an ASC CON law in 1998, while Missouri, Nebraska, New Jersey, and Ohio repealed their ASC CON laws in 2000,1999,1999, and 1997, respectively.) Accordingly, the estimates are too imprecise to be useful, and they are statistically indistinguishable from the estimates from the other regressions.
18 Alternatively, earning income from the facility fee could reduce the number of surgeries physicians perform if the income effect dominates the substitution effect.
19 See McGuire (2000, pp. 503–520) for a review of the literature on physician-induced demand.
20 Our conclusion is not sensitive to the use of the other specifications or the fixed radius market definition.
21 Higher-order terms, such as number of ASCs to the third power, are insignificant.

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