Superbugs vs. Outsourced Cleaners: Employment Arrangements and the Spread of Healthcare-Associated Infections†

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ABSTRACT

On any given day, about one in 25 hospital patients in the U.S. has a healthcare-associated infection (HAI) that the patient contracts as a direct result of his or her treatment. Fortunately, the spread of most HAIs can be halted through proper disinfection of surfaces and equipment. Consequently, cleaners—"environmental services" (EVS) in hospital parlance—must take on the important task of defending hospital patients (as well as employees and the broader community) from the spread of HAIs. Nevertheless, despite the importance of this task, hospitals frequently outsource this function, increasing the likelihood that these workers are under-rewarded, undertrained, and detached from the organization and the rest of the care team. As a result, the outsourcing of EVS workers could have the unintended consequence of increasing the incidence of HAIs. We demonstrate this relationship empirically, finding support for our theory by using a self-constructed dataset that marries infection data to structural, organizational, and workforce features of California's general acute care hospitals. The study thus advances the literature on nonstandard work arrangements—outsourcing, in particular—while sounding a cautionary note to hospital administrators and healthcare policymakers.

KEYWORDS: outsourcing, externalization, employment arrangements, employment relations, labor relations, industrial relations, healthcare, hospitals, infections, healthcare-associated infections (HAIs), hospital-acquired infections (HAIs), *Clostridium difficile* (*C. diff.*)

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On any given day, one in every 25 patients in U.S. hospitals has a healthcare-associated or hospital-acquired infection (HAI)—one of a handful of so-called "superbugs" that contributes to the deaths of 75,000 of these patients (Magill, Edwards, Bamberg, Beldavs, Dumyati, Kainer, Lynfield, Maloney, McAllister-Hollod, Nadle, Ray, Thompson, Wilson, and Fridkin 2014) and exacts direct medical costs of nearly $34 billion per year (Scott 2009). What is more, these HAIs—with names like Methicillin-resistant *Staphylococcus aureus* (MRSA), Vancomycin-resistant *Enterococcus* (VRE), and *Clostridium difficile* (*C. diff.*) are the direct result of the patient's hospital treatment (Peleg and Hooper 2010) and in most cases, preventable.

Not surprisingly, healthcare practitioners and scholars have turned their attention to clinical and delivery-of-care factors that might account for hospital acquired infections (Calfee 2012; Glance, Stone, Mukamel, and Dick 2011; Magill et al. 2014). Thus, healthcare researchers have been paying careful attention to the general clinical and hygiene-related practices employed by frontline providers (Ducel, Fabry, and Nicolle 2002; Krein, Kowalski, Hofer, and Saint 2012; Peleg and Hooper 2010). Providers' hand washing routines, for example, have been studied as a likely contributor to the spread of HAIs (Calfee 2012), garnering the attention and scrutiny of more than one MacArthur "genius" grantee (Gawande 2009; Pronovost and Vohr 2010). Other scholars have examined the cleaning standards and requirements applied to hospital spaces and medical devices (Carling and Bartley 2010; Currie 2013; Dancer 2009; Ducel et al. 2002), while still others have examined the financial incentives driving the allocation of hospital resources for dealing with HAIs (e.g., Calfee 2012; Lee, Kleinman, Soumerai, Tse, Cole, Fridkin, Horan, Platt, Gay, Kassler, Goldmann, Jernigan, and Jha 2012). These areas of inquiry are clearly important to addressing the HAI crisis. However, as we will argue in this paper, combating HAIs also requires a better understanding of the link between organizational and employment relations factors and quality-of-care deficiencies. According to this argument, HAIs are likely associated with employment practices and patterns that are inconsistent with high-quality care delivery. Specifically, the outsourcing of some logistical and support staff functions to non-hospital employees is likely to increase HAI rates.

We contend that alongside clinical and delivery-of-care factors, employment relations patterns and arrangements also help to explain hospital-level variance in the ability to keep patients safe from HAIs. More specifically, we maintain that the employment patterns and conditions of what some might refer to as "ancillary" or "peripheral" workers have a significant effect on the spread of HAIs. Unlike some infections, the etiology of these HAIs is—from a medical perspective—simple and tractable: the spread can be halted through strict infection control practices, namely proper disinfection of surfaces and equipment. As a result, cleaners or "environmental service" (EVS) workers—in hospital parlance—are likely to play a central role in combating the spread of HAIs. As such, the employment arrangements under which these employees perform their work and which govern the manner in which they managed, trained, compensated and treated are likely to contribute to their preparedness and ability to do so.

This paper makes two explicit contributions, one specific to the healthcare setting and a second one that informs the general outsourcing and contracting literature. First, we provide novel, quantitative, empirical evidence linking a specific type of employment arrangement—outsourcing—to patient safety. Thus, we show that in addition to the more widely-examined clinical culprits, the HAI challenges plaguing the U.S. healthcare system are also a function of the strategic employment choices that organizations make in relating to their nonclinical staff. Indeed, employment relations scholars have long maintained that in the healthcare context, the manner in which work is organized and managed has dramatic implications for a host of organizational performance metrics, including patient care (e.g., Avgar, Givan, and Liu 2011; Givan, Avgar, and Liu 2010). Nevertheless, the focus of much of this research has been on the employment practices and arrangements designed for highly-skilled clinical employees. Building on Zuberi's (2013) qualitative research, we focus on a segment of the healthcare workforce that is often ignored when it comes to patient care-related outcomes.

Second, our study contributes to the more general and longstanding debate around the deployment of flexible work arrangements and their implications for different stakeholder outcomes. Scholars across disciplines have provided mixed evidence on the consequences associated with the use of flexible work arrangements, in general, and of contracted employees, in particular. Some scholars have pointed to the flexibility benefits associated with the use of such work arrangements (Lepak and Snell 1999; Lepak, Takeuchi, and Snell 2003), while others have documented their potential negative effects on employees' wages, working conditions, and overall wellbeing (e.g., Kalleberg, Reskin, and Hudson 2000). Flexible work arrangement have, therefore, been both promoted as an effective tool through which to improve organizational efficiencies on the one hand, and as an antecedent to poor employment conditions and decreased quality in the production of goods or the delivery of services, on the other.

In what follows, we review the existing research on flexible work arrangements and contracted work. We next move from the general to the specific and focus on flexible work arrangements in the healthcare setting, outlining what we know empirically about the outsourcing of hospital cleaners. Building on this discussion, we then present the data and methods we will use to show that the use of outsourced cleaners, in fact, positively predicts infection rates, after which we offer statistical support for the hypothesis. We conclude with a discussion regarding the implications our findings have for understanding the link between organizational employment practices for noncore employees and the quality of patient care.

Nonstandard Employment Arrangements for Peripheral Workers

Like many managerial decisions surrounding human resources (HR) or labor relations, the decision to contract out is a strategic one (Kochan, McKersie, and Cappelli 1984). In deciding what organizational functions to perform internally and which ones to outsource, organizations make strategic choices about the costs and benefits associated with each of these alternatives (Dey, Houseman, and Polivka 2010; Kalleberg et al. 2000; Mayer and Nickerson 2005). Organizations that decide to outsource specific functions are, therefore, doing so because they are convinced that the benefits associated with this decision outweigh the potential costs. Davis-Blake and Uzzi (1993) provide evidence that demonstrates that this cost-benefit analysis varies as a function of a number of internal and external factors.

Over the past three decades, a growing proportion of American firms have increased their reliance on flexible work arrangement, and evidence suggests that this trend will persist (Davis-Blake and Uzzi 1993; Houseman 2001; Lepak and Snell 1999; Lepak et al. 2003; Mayer and Nickerson 2005). These organizations have sought out employment models that provide the promise of reduced costs (Kalleberg et al. 2000; Lepak et al. 2003), increased flexibility, and greater efficiency (Davis-Blake and Uzzi 1993; Dey et al. 2010). In this quest, many firms across an array of industries have turned to the deployment of nonstandard work arrangements that weaken the traditional attachment between employees and their employers and, therefore, reduce many of the transaction costs associated with the traditional employment pattern (Dey et al. 2010; Kalleberg 2008). A number of nontraditional or nonstandard work arrangements have proliferated under this general category, from temporary employment to the outsourcing of positions and functions (Davis-Blake, Broschak, and George 2003; Kalleberg et al. 2000).

Researchers have documented the pressures that have pushed firms to experiment with flexible work arrangements and to outsource positions and functions to external contractors (e.g., Houseman 2001). Use of nonstandard employment arrangement has been seen by scholars and practitioners as a vehicle through which organizations can, among other things, confront environmental uncertainties and volatility (Davis-Blake et al. 2003). Outsourcing of functions that could alternatively be integrated vertically, for instance, provides firms with increased flexibility to expand or shrink employment levels in response to financial or competitive pressures (Osterman 1987).

Alongside evidence regarding the potential and anticipated benefits that motivate employers to adopt flexible work arrangements, there is considerable evidence regarding the negative consequences associated with this employment pattern (e.g., Erickcek, Houseman, and Kalleberg 2003; Kalleberg 2008). For example, empirical evidence has demonstrated the negative effects that flexible work arrangements have on employees in nonstandard employment relationships (Kalleberg 2008; Kalleberg et al. 2000). Among these are decreased wages and benefits (Dube and Kaplan 2010) and greater levels of job insecurity (Kalleberg 2008; Kalleberg et al. 2000). In addition to the consequences for employees, the flexibility benefits associated with nonstandard work practices often come at the expense of internal organizational control (Davis-Blake and Uzzi 1993; Lepak and Snell 1999): nonstandard work arrangements challenge the firm's ability to provide for a stable and predictable workforce and to ensure adequate coordination and control over task-interdependent production or service processes.

In an effort to reconcile this mixed track record—flexibility benefits on the one hand and control and coordination costs on the other hand—some scholars have proposed a contingent approach to the use of nonstandard employment arrangements, one that accounts for the organization's HR architecture. Lepak and Snell (1999), for example, identify four distinct employment models that correspond to different human capital needs and characteristics. According to this perspective, the adoption of flexible work arrangements is suitable for certain roles and positions within the organization but not for others. Organizations, according to this argument, assess the extent to which the benefits associated with a nonstandard work arrangements outweigh the costs under different organizational conditions and for different organizational and worker groups (Davis-Blake and Uzzi 1993). More specifically, managers must scrutinize the human capital required of each job to determine the extent to which the firm is "inherently dependent upon its potential to contribute to the competitive advantage or core competence of the firm" (Lepak and Snell 1999: 35) and the degree to which the skills in question are uniquely valuable to the particular employer—"firm-specific," as the human capital literature would label them (Becker 1964 [1994]). Our empirical evidence contributes to this area of inquiry by examining the relationship between the outsourcing of EVS employees and HAIs. In what follows, we develop the proposition that in the healthcare context, both core and noncore employees can play an important role in advancing patient care. As such, outsourcing of noncore functions engenders many of the same costs associated with the outsourcing of core functions.

Outsourcing of Noncore Employees and Performance Outcomes in Healthcare

The healthcare sector serves as a uniquely fitting setting in which to examine the relationship between outsourcing and organizational performance. Persistent regulatory and market-related pressures have engendered widespread organizational restructuring (Fennell and Alexander 1993; Scott, Ruef, Mendel, and Caronna 2000), including an increased reliance on nontraditional work arrangements, outsourcing, in particular (Appelbaum, Berg, Frost, and Preuss 2003; Davies 2010). Much of the empirical evidence regarding this phenomenon, however, focuses on the outsourcing of frontline, clinical staff. Our general argument builds on this stream of research, but, as noted above, focuses on the outsourcing of nonclinical work in the form of EVS.

Hospital efforts to address increasing financial and competitive pressures by restructuring internal staffing practices have rendered a dramatic shift in the organization of work. Employment relations scholars have provided extensive evidence for the relationship between work practices and arrangements and outcomes for employees and patients in the healthcare setting (e.g., Avgar et al. 2011; Gittell, Seidner, and Wimbush 2010). According to this stream of research, work arrangements and the manner in which a healthcare organization's workforce is managed influence both the ease with which coordination across disciplinary boundaries occurs (Gittell et al. 2010) and employee attitudes and perception towards these organizations, including commitment and attachment to the organization (Avgar et al. 2011; Clark, Clark, Day, and Shea 2001). Taken together, this evidence provides support for the longstanding employment relations argument that practices that promote and facilitate greater employee voice, discretion, and connection to the organization are likely to affect outcomes for both employees and employers, consistent with findings reported above linking flexible work arrangements to negative employee and performance outcomes.

Healthcare scholars have also documented the significant relationship between staffing practices and patient care outcomes (e.g., Aiken, Clarke, Sloane, Sochalski, and Silber 2002). Nevertheless, the empirical evidence linking flexible staffing practices and negative patient care outcomes has been predicated on the study of highly-skilled healthcare professionals, registered nurses, in particular. What about the relationship between flexible work practices pertaining to noncore employees and their impact on hospital performance? Scholars distinguishing between core and peripheral employees would argue that the negative relationship between flexible work arrangements for nurses and patient care outcomes is not necessarily generalizable to noncore employees such as EVS workers.

We maintain that that the tradeoff between flexibility and control that inheres in the use of flexible work arrangements can create coordination and workforce attachment challenges for low-skilled, noncore workers as well as for highly-skilled, core employees. The healthcare setting, characterized by a high degree of complexity and task-interdependence, requires sophisticated coordination across diverse employee groups (Gittell et al. 2010). As noted above, EVS employees play a central role in performing tasks that, while nonclinical in nature, are essential to halting the spread of HAIs. Furthermore, these nonclinical tasks influence and are influenced by tasks performed by clinical staff (Calfee 2012; Dancer 2011). Thus, in the wake of this fundamental task interdependence and the need for cross-functional coordination, we build on the employment relations evidence reviewed above to hypothesize that greater levels of EVS workforce outsourcing will be associated with higher incidence of HAIs.

Indeed, rich ethnographic evidence offered by Zuberi (2013) paints a detailed portrait of the pressures that have driven hospitals to outsource their EVS function and the consequences this has had for employees and their ability and preparedness to do the work that is necessary to keep hospitals clean and safe (Litwin 2014). He documents the many challenges outsourced EVS workers face in their efforts to meet the cleaning standards required for the prevention of HAIs. Zuberi also argues that outsourced EVS workers are overworked and understaffed, a combination that makes their work stressful and extremely difficult. His interviews with outsourced employees also support the claim that outsourcing EVS work leads to a reduction in employee training and education. Finally, Zuberi's study points to the lack of hospital control and weak supervision associated with EVS outsourcing and highlights the inextricable relationship between shedding the responsibility for the management of an EVS workforce and the ability to adequately control and monitor required cleaning standards.

Zuberi's findings, therefore, provide an important foundation for our study by supporting the link between outsourced EVS workers and employment conditions that are likely to constrain hospital efforts to combat HAIs. What his rich descriptive work cannot do—owing to the qualitative methods he employs to examine the outsourcing phenomenon—is demonstrate statistically that outsourcing drives the spread of HAIs at the hospital level. Thus, we couch our argument in three, related rationales that stem from received ethnographic research and from the literature touched on above. First, outsourcing is likely to significantly reduce EVS worker attachment and commitment to the hospital, which may affect the diligence with which important HAI prevention tasks are performed. HAIs can spread when even minor flaws in cleaning of hospital surfaces occur. Consider, for example, the potential impact of infectious spores being left uncleaned (or improperly cleaned) on the portable pole on which an IV bag is hung or even on the floor in a single patient room. The danger extends far beyond the handful of patients who stay in that room, spreading from room to room to potentially impact the entire facility (Koppel, Gordon, and Telles 2012). Furthermore, outsourcing of EVS workers is, by construction, associated with reduced hospital control over this workforce. As noted above, by externalizing this function, hospitals gain flexibility, but give up managerial control. To the extent that EVS employees perform tasks that, combined with clinical care, are central to the prevention of HAIs, relinquishing this control is likely to limit the hospital's ability to insure adequate compliance with evidence-based standards and requirements. Second and closely-related to this point, outsourcing of EVS worker will hinder coordination, which may limit the effectiveness of interdependent efforts between contracted cleaners and employee staff to prevent HAIs. And finally, the reduction in managerial control over this segment of the workforce is likely to have implications for investments made in EVS workers' skills and training (Lynch and Black 1998), which are central to their ability to combat the conditions that lead to HAIs.

Data and Methods

Data

This analysis focuses on one superbug in particular—*Clostridium difficile* (*C. diff.*) More so than any other HAI, *C. diff.* is the most closely tied to the overall cleanliness of hospitals, and thus, to the work undertaken by hospital cleaners. According to Zuberi (2013), *C. diff.* lingers for extended periods of time on sheets, floors, toilets, and other surfaces, but only in the absence of proper cleaning. Whereas other superbugs die when they dry out, *C. diff.* instead forms spores that readily spread even under arid conditions via workers' hands and contaminated equipment. Even alcohol-based hand sanitizers, so effective on other virulent germs, cannot contain *C. diff.* Yet, it can be contained quite easily with the proper chemicals, as long as they are provided to EVS staff and workers are trained in their use. Specifically, infectious disease experts recommend the use of an accelerated hydrogen peroxide solution or a 1:10 bleach solution, both of which eradicate *C. diff.* spores (Boyce 2007; Boyce, Havill, Otter, McDonald, Adams, Cooper, Thompson, Wiggs, Killgore, and Tauman 2008; Zuberi 2013). When this does not occur, and patients are stricken with *C. diff.*, the symptoms include dehydration, debilitating diarrhea, perforated bowel, gastrointestinal bleeding, and fatal inflammation of the colon (Zuberi 2013). Based on recent estimates from the Centers for Disease Control and Prevention, *C. diff.* was responsible for almost half a million infections in the U.S. alone in 2011, 29,000 of which directly resulted in death from the infection (Lessa, Mu, Bamberg, Beldavs, Dumyati, Dunn, Farley, Holzbauer, Meek, and Phipps 2015).

In analyzing the spread of *C. diff.*, we draw on a cross-section of general acute care hospitals operating in the state of California in 2012. We chose California because of its large number of hospitals. It leads the country in the number of staffed hospital beds, total discharges, patient days, and gross patient revenue. From a more pragmatic perspective, it also compels its hospitals to report reliable data on the incidence of HAIs—*C. diff.*, in particular—to its state Department of Public Health (CDPH) on an annual basis. Likewise, the state's hospitals are also required to submit an annual financial disclosure report to the Office of Statewide Health Planning and Development (OSHPD) from which we can construct dollarized proxies for a hospital's employment arrangements. Finally, we can marry these and other data provided by the CDPH to data on a hospital's structural characteristics culled from the American Hospital Association (AHA) annual survey database.

[--------------Insert Table 1 about here.--------------]

Table 1 defines, constructs, and sources each of the variables called upon in the quantitative analysis. Our focal dependent variable is the number of laboratory-identified "hospital-onset" cases of *C. diff.*, measured as the number of positive stool samples obtained on day four or later during the hospital stay, recorded over the 12-month reporting period. Note that aside from being a hard outcome as opposed to a "process measure" such as compliance, this is a more conservative and more reliable operationalization than "community-onset" cases, which would include positive samples collected during the first three days of a hospital stay. Also note that in addition to this count measure, parts of our analysis employ a binary transformation of the count variable, equal to one for those facilities revealing a non-zero count.

Our focal explanatory variable is actually a ratio rooted in the data collected by the California OSHPD. Following Dalton and Warren (2014), we divide the dollars spent on purchased services for the housekeeping or environmental services (EVS) cost center by the total direct expenses incurred for EVS. Thus, the numerator explicitly excludes employee salaries, wages, and benefits as well as supplies purchased directly by the hospital, expenses that are among those that are captured in the denominator. We assessed the validity of this accounting or dollarized outsourcing measuring by reaching out to a random selection of hospitals included in our sample. We asked hospital administrators about their outsourcing and staffing arrangements for the EVS function in their facilities, and the answers bolstered our confidence in our outsourcing measure. Those hospitals that used only outside workers to staff the EVS function, including the management of the EVS function, had purchased services ratios between .85 and .97. Where all EVS workers were instead actual employees of the hospital, the purchased services ratio ranged from .01 to .22. Hospitals employed various mixtures of internal and outsourced workers, sometimes relying on outsourced workers to fill-in for vacationing employees. Some hospitals actually use their own employees on the frontlines, but use outsourced workers to supervise these internal employees. As one would expect, these cases mapped into purchased service ratios between those we found for the two "extreme" groups.

We call upon the next cluster of independent variables listed in Table 1 only as controls. First, since our focal independent variable is a ratio in which total direct expenses for EVS appears in the denominator, we believe it is important to include a direct measure of total direct EVS expenses in our estimates. Since the focal independent variable will—by construction—be correlated with total expenses and total expenses should be correlated with infection counts, the omission of a measure of total expenses would bias the estimate for the key variable of interest (Litwin, Avgar, and Pronovost 2012). The remaining controls capture "structural" features of hospitals. Certainly the size of the hospital—measured as the number of beds—should impact the number of *C. diff.* cases reported each year. Likewise, one could expect that a hospital's case mix could impact its ability to control infection rates, leading us to control for it as well. The case mix index represents the average diagnosis-related group (DRG) relative weight for each hospital. The OSHPD calculates the index by summing the DRG weights for all Medicare discharges and dividing by the number of discharges.

We also draw on three binary measures of whether or not a hospital is: 1.) operated on a for-profit basis, 2.) located in and serving an urban community, and 3.) academically-affiliated. One could imagine that for-profit hospitals are more likely to outsource and more likely to be concerned about infection rates, meaning the exclusion of this control variable could bias the focal estimates. Likewise, infections are expected to spread faster where population densities are greater, disadvantaging urban hospitals in their ability to contain infections. Finally, we also control for whether a hospital is an academic hospital or not. We do this for two reasons. First, one might expect academic hospitals to get more complicated cases than non-academic ones. Second, academic status could be construed as a proxy for the quality of care delivered in the hospital. Irrespective of which if either force dominates, the inclusion of this control variable should eliminate another potential source of bias.

The remaining four variables in Table 1 are drawn on in multiple ways to test the robustness of our principal analyses. The first pair, readmissions after heart attack and patient satisfaction with the hospital, represent an objective and a subjective measure of care quality, respectively. These provide more fine-grained controls for care quality than does the academic variable alone. They can also be used as dependent variables for robustness or falsification tests since the impact of EVS outsourcing should *not* be realized with respect to either of these quality measures as it is for the incidence of *C. diff.* cases. While these variables have the benefit of being sourced from entirely different datasets—the Centers for Medicare and Medicaid Services (CMS) Hospital Compare database and the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) annual survey—they do not exist independently for all hospitals in our larger sample. Furthermore, whereas all of the other variables called on in the study are contemporaneous, i.e., reflect 2012 values, these two quality measures are lagged by one year. While it takes an entire calendar year to accumulate the total number of *C. diff.* cases for the year, with respect to measures of care quality, it makes more sense to consider the degree of care quality in place at the beginning of the year. Having said that, hospital-level quality scores tend to change minimally if at all from year to year.

The final pair of variables pertain to hospital security and bear a striking similarity to the two previously-employed measures related to EVS outsourcing. The first is a ratio of purchased services for the security cost center over the total expenses incurred by that cost center. The second is simply the denominator of the ratio, i.e., the total direct expenses incurred over the course of the year for security. These two variables will also be called on for a robustness check, namely, to show that security outsourcing does not drive HAIs the way that EVS outsourcing does.

[——————Insert Table 2 about here.——————]

Descriptive statistics and pairwise correlations for the study sample appear in Table 2. Setting the dependent variable aside for the moment, note that the average hospital is non-profit, non-academic, serves an urban population, and has just under 200 staffed beds. On average, a hospital devotes about a quarter of its annual housekeeping expenses to purchased services. Total direct expenses associated with housekeeping average $3.8 million for the year, though there is great variation about the mean. A deeper analysis of the EVS outsourcing ratio, total EVS expenses, total beds, and the case mix index reveal that they are distributed log-normally, and thus, will be transformed prior to their use in estimation.

Interestingly, neither the focal dependent variable nor its binary transformation appears to be strongly pairwise-correlated with the key explanatory variable. Not surprisingly, all of the control variables except for for-profit status are positively correlated with the number of reported *C. diff.* cases. Furthermore, it appears that urban hospitals and academic hospitals treat a more complex mix of cases. For-profit and urban hospitals are more likely to outsource housekeeping than are other hospitals. And, larger hospitals have larger budgets, of course.

With respect to the final four variables in the table—those to be called on for robustness checks—the pairwise correlations line up as one would expect. For example, the size of the security budget is strongly correlated with the size of the housekeeping budget and with the size of the hospital, measured as the number of beds. It is also worth noting that the mean outsourcing ratio for security is .44, more than 83 percent greater than the outsourcing measure for EVS. The two security variables, like the analogous measures for housekeeping, are distributed log-normally, so they, too, will be transformed prior to their use in estimation.

[————————Insert Figure 1 about here.————————]

We can see from Table 2 that the average hospital reports about 28 cases of *C. diff.* each year and that the standard deviation is about 33 cases. Add to this that the count of *C. diff.* cases must be a non-negative integer, and the result is the distribution of observed *C. diff.* counts that appears in Figure 1—a monotonically decreasing frequency of *C. diff.* cases with two extreme observations.[1]

Methods

Given the nature and the distribution of the dependent variable, our "first cut" at the data should be a simple difference-in-means test in which the sample is split between those hospitals reporting zero *C. diff.* cases and those reporting one or more *C. diff.* cases. We would expect to

[1] The two glaring outliers in the histogram are Stanford University Hospital and Cedars-Sinai Medical Center. Interestingly, both are world-renowned academic medical centers. The removal of these two observations does not impact the strength or precision of any of the estimates in this study.

find that the mean proportion of purchased services is greater in the subsample of hospitals reporting a positive number of *C. diff.* cases. Advancing in our sophistication, the next step is to estimate models that allow us to control for potentially confounding variables. Maintaining the split-sample approach, we will estimate logistic regressions in which the dependent variable is the dummy capturing whether or not the hospital reported one or more *C. diff.* cases in 2012. A positive coefficient estimate for the log purchased services ratio term even in the presence of the vector of control variables would thus support our thesis.

The weakness of both the difference-in-means and the logit estimates is that they treat those hospitals reporting a single *C. diff.* case exactly the same as those reporting 50 or more cases, about 20 percent of the sample. Consequently, we next estimate models that exploit this granularity. Statisticians discourage the use of OLS for estimating count variables like the one we employ claiming that such estimates can result in inefficient, biased, and worst of all, inconsistent estimates (Cameron and Trivedi 1998; Long 1997). Instead, they recommend using one of many models based on the Poisson distribution, the very distribution characterized by Figure 1. In the present case, aside from addressing the challenges associated with count data, we must also acknowledge and address the fact that the dependent variable is "overdispersed"—the conditional variance exceeds the conditional mean—pointing us toward a negative binomial regression model (NBRM) in place of the more parsimonious Poisson regression model. Thus, just as in the logit case, support for our theory would take the form of a positive coefficient on the ratio variable even in the presence of the aforementioned controls.

[------------Insert Figure 2 about here.------------]

Results

Difference-in-Means

Recall from Table 2 that the mean ratio of purchased housekeeping services over total direct housekeeping expenditures is .24. Figure 2 reveals the difference in means when the sample is split between those with zero *C. diff.* cases and those with one or more *C. diff.* cases. The top bar shows that amongst those hospitals reporting one or more *C. diff.* cases, the mean purchased services ratio was .26. For those hospitals not reporting any cases at all, just 7.1 percent of the housekeeping budget went toward purchased services. Thus, *C. diff.*-positive hospitals appear to rely more on outsourcing arrangements for cleaners or EVS than do *C. diff.*-negative hospitals, a difference that is highly statistically significant (p < .001, two-tailed). In sum, the difference-in-means test is consistent with the theorized link between outsourcing and the spread of HAIs.

[——————Insert Table 3 about here.——————]

Logistic Regressions

The next key question is whether or not these results hold up in the presence of the aforementioned control variables. Model 1 in Table 3 provides a starting point by essentially reestablishing the results from the difference-in-means test, albeit in the logit framework rather than the linear one. Thus, in these models, a positive coefficient estimate implies that increases in a given variable are positively associated with the probability that a hospital reports one or more *C. diff.* cases. The second model adds only the control for total housekeeping expenditures, which enters the equation positively. While its inclusion reduces the magnitude of the estimate attached to the outsourcing measure, the latter remains a statistically significant, positive predictor of the likelihood of infection. Model 3 excludes the focal independent variable, allowing us to examine the impact of the control variables in the absence of the outsourcing measure. Not surprisingly, log expenses and log size positively predict the presence of *C. diff.* in a hospital. However, the estimated impact of case mix, for-profit status, urban location, and academic affiliation are insignificantly different from zero.

Model 4 is the first estimate in the paper to reveal the theorized effects of outsourcing in the presence of potential confounders. In Model 4, the outsourcing variable enters the equation with a positive and statistically significant coefficient estimate, providing support for the notion that those hospitals relying more on outsourced cleaners are more apt to report one or more cases of *C. diff.* Thus, the outsourcing of hospital cleaners appears to be positively associated with the spread of this particular HAI, even after we normalize for total housekeeping expenditures, hospital size, and case severity and control for for-profit status, hospital location, and whether or not the hospital has an academic affiliation. Furthermore, relative to the base model that includes only the control variables—Model 3—the differences in BIC statistics provide strong support for Model 4—the model that adds the key predictor of interest (Raftery 1995).

[——————Insert Figure 3 about here.——————]

Figure 3 makes sense of these logit coefficients by illustrating the nonlinear impact of outsourcing on the spread of HAIs by using the estimates from Model 4 to show fitted probabilities as a function of the outsourcing measure. More specifically, it plots the probability of a hospital reporting at least one *C. diff* case as a function of the ratio of purchased services to total direct expenses for housekeeping, holding all of the other variables at their sample means. Note that those hospitals that do no outsourcing of housekeeping whatsoever are about 73 percent likely to have one or more *C. diff.* cases. The probability increases with the ratio, steeply at first and then more slowly, reaching .91 by the time purchased services exhausts half of total direct housekeeping expenses. Thus, the plot validates our prediction regarding the relationship between outsourcing and the spread of this particular infection.

[-------------Insert Table 4 about here.-------------]

Negative Binomial Regression Models

While the logit estimates predict the likelihood of there being any cases of *C. diff.*, the count models can exploit the entire range of the dependent variable. These estimates are shown in Table 4, where each of Models 1-4 is analogous to the same numbered logit model in Table 3. That is, once again, the first model can be thought of as a baseline model in the sense that it includes only the key predictor variable and not the control variables. Note that in Model 1, the log ratio or outsourcing variable enters with a positive sign, suggesting that increases in the purchased services ratio correlate positively with increases in the dependent variable, at least in the absence of any controls. The impact of adding a measure of the absolute dollar amount spent on housekeeping, as we do in Model 2, is exactly the same as it was in the second logit model. That is, the estimated impact of outsourcing is weakened, but remains directionally as-predicted and statistically significant.

As with the logit estimates, Model 3 includes only the vector of control variables. Again, Model 3 should become the base model against which to compare Model 4. Model 4 allows us to examine the housekeeping ratio in the presence of control variables, and the results are quite supportive of our theory given the inclusion of the full vector of control variables: increases in the outsourcing measure are associated with an increased predicted case count. Finally, as in the case of the logit estimates, relative to the base model that includes only the control variables—Model 3—the differences in BIC statistics provide strong support for Model 4 (Raftery 1995).

[-------------Insert Figure 4 about here.-------------]

Figure 4 shows predicted counts from Model 4 in Table 4 as a function of the share of the housekeeping budget exhausted by purchased services. Holding all non-focal variables at their sample means, those hospitals that do no outsourcing within the housekeeping function report about 17 *C. diff.* cases. The number increases with the amount of outsourcing, rapidly at first and then more slowly, increasing to about 36 cases once the outsourcing ratio reaches the halfway mark. In sum, our estimates provide strong evidence that outsourcing is, indeed, positively related to the incidence of *C. diff.*

Robustness Checks

A key concern one might have with our logit and NBRM estimates is the potential endogeneity of the outsourcing measure. Since the outsourcing decision cannot be randomly assigned in the cross-section, it is possible that some unobserved variable—call it "managerial quality" or "just being a bad hospital"—drives both the decision to outsource and higher infection rates. Were this the case, it would create a spurious relationship between outsourcing and infections.

We take aim at this potential challenge to our findings by undertaking three sets of robustness checks. The first returns to the estimates we have already run, but adds more fine-grained controls for care quality, seeking to determine whether or not the inclusion of these variables swamps the impact of EVS outsourcing on infection rates. The second shifts each of the two, newly-added quality measures from the right-hand side to the left-hand side, allowing us to determine whether or not the theorized link between outsourced cleaners and HAIs seems to describe the relationship between outsourcing and any proxy for care quality. The third set of robustness checks returns to the central logit and NBRM specifications, but considers the impact of the outsourcing of a hospital's security function as opposed to its housekeeping or EVS function on the incidence of *C. diff.*

Adding More Fine-Grained Controls for Objective and Subjective Care Quality

While our preferred specifications are Model 4 in both Tables 3 and 4, note that each table includes three additional estimates that we have yet to discuss. Indeed, each of these estimates incorporates one or more additional quality variables on the right-hand side. Turning back to the logit estimates in Table 3, Model 5 adds a single regressor—the share of heart attack patients with unscheduled readmissions within 30 days of discharge. This is a standard, commonly-used objective measure of the quality of care delivered by a hospital. Even in the presence of this newly-introduced control variable, the relationship between EVS outsourcing and the probability of one or more *C. diff.* cases remains positive and statistically significant, albeit marginally so, in this case. This reduction in precision, though somewhat mitigated by an increase in the point estimate, is likely the result of the shrinking of the estimation sample. Model 6 replaces the objective measure of care quality with the subjective one—whether or not a patient rates their overall satisfaction with the hospital as "high." Once again, its inclusion does not undermine the relationship between EVS outsourcing and the probability of a facility being *C. diff.*-positive. In fact, in this case, since the sample only shrank by 11 cases relative to Model 4, the focal point estimate maintained its precision. Finally, with respect to the logits, Model 7 in Table 3 includes both of the quality variables simultaneously. Once again, the estimate for the focal independent variable remains positive and even managed to achieve statistically significance.

Models 5-7 in Table 4 undertake the analogous exercise with the NBRMs. The results are quite similar to those arising from the logit estimates. In short, while we cannot dispose of the possibility that some aspects of hospital quality are going unobserved in our analyses, a generally low regard for care quality does not appear to be the invisible driver of a spurious relationship between EVS outsourcing and infection rates.

Predicting Theoretically Unjustified Measures of Care Quality

Were the outsourcing of EVS work just a proxy for the quality of the hospital or of the work of the people managing it and were this proxy to somehow be positively associated with infection rates, it would likely be positively correlated with other, less specific measures of care quality. We test this proposition with respect to both our objective and our subjective measures of care quality.

We first analyze the relationship between EVS outsourcing the objective quality measure, 30-day heart attack readmission rates. Models 1-4 in Table 5 are analogous to Models 1-4 in Tables 3 and 4. However, since this dependent variable is continuous and uncensored, we can estimate it using OLS as opposed to logistic or negative binomial regression. Moreover, in order to view the point estimates at two significant digits, we have multiplied the dependent variable by 100, i.e., to predict a percentage rather than a proportion. In short, in none of the models—including Models 3 and 4 which include all of the controls used in the principal analyses—does the EVS outsourcing variable even approach statistical significance. In Model 2, the absolute amount of money spent on housekeeping is negatively associated with objective care quality, though this effect completely disappears in the presence of the other control variables.

[————————Insert Table 5 about here.————————]

Table 6 shows the results from repeating this exercise, the only difference being the dependent variable. These four estimates come from regressing the subjective quality measure, overall patient satisfaction with the hospital, once again multiplied by 100, on four different sets of right-hand side variables. Again, in absolutely no case can we discern a positive correlation between the outsourcing of a hospital's cleaning services and a patient's overall satisfaction with their hospital. In this case, however, it is interesting the extent to which the structural variables are associated with the dependent variable. For example, patients appear to prefer smaller hospitals to larger ones and non-profit hospitals to for-profit facilities. Nonetheless, there is no evidence that they rate their hospital more highly or more poorly when their cleaners are outsourced. Suffice it to say that the theorized relationship between EVS outsourcing and infection rates does not hold for just any measure—objective or subjective—of care quality.

[————————Insert Table 6 about here.————————]

Considering the Impact of Outsourcing Security on Infection Rates

The final way we check for the spuriousness of our findings is by considering the outsourcing of a very different type of hospital work—security—for which there is no theoretical connection to infections.

Table 7 revisits the logit estimates from Table 3. Models 1-4 are analogous to the models in Table 3: the only difference is that these models do not account for the outsourcing of EVS, but instead include identically-constructed variables for the security function. While we must point out that the urban indicator drops out of the model altogether (and is thus not displayed in the table), note that in Model 1, the impact of the logged purchased services share of security has no impact at all on infection rates. This changes in Model 2 which adds the denominator of the security purchased services share as a control. However, it is Models 3-5 that are most compelling for the purposes of a robustness check. Model 3 includes only the controls, and the only variables that are definitively associated with infection rates are the overall size of the security budget and the size of the hospital. However, in contrast to Model 4 in Table 3, the next model—the one that adds the security purchased services share—reveals no association whatsoever between the outsourcing of security and the probability of a facility being *C. diff.*-positive. Thus, Model 4 in Table 7 helps drive home the point that it is the outsourcing of housekeeping, with its tight theoretical connection to infection rates, that matters with respect to infections. Finally, Model 5 supplements Model 4 by adding the two housekeeping variables—

its outsourcing share and the total housekeeping budget. Security outsourcing remains insignificantly different from zero, and the EVS outsourcing variable enters with a positive sign. Once again, its statistical significance has become marginalized due to a loss of efficiency in the estimates: the sample has shrunk by more than 20 percent relative to what it was in Model 4 of Table 3.

[------------Insert Table 7 about here.------------]

Table 8 offers an analogous robustness check of the NBRM estimates from Table 4 with very similar results. The outsourcing of hospital security does not influence the number of *C. diff.* cases at all, let alone with the instrumentality of EVS outsourcing. The security purchased services share is never a statistically significant driver of *C. diff.* counts. Moreover, when the EVS variables are added to the model in the presence of the security variables, the latter remain precise, positive predictors of the incidence of *C. diff.* Thus, were outsourcing just a proxy for poor management or low quality-of-care, to the extent such unobserved constructs were positively correlated with infection rates, then the outsourcing of security would also be positively associated with infection rates. It is not, further bolstering the credibility of the estimates that appear in Tables 3 and 4.

[------------Insert Table 8 about here.------------]

Discussion and Conclusion

The healthcare industry in the United States faces a significant crisis in its ability to deliver high quality and safe patient care on a consistent and affordable basis. Hospitals and other healthcare organizations continue to struggle with the need to meet two pressing, yet often conflicting challenges—improving quality-of-care and surviving in a hypercompetitive environment. In their efforts to meet competitive challenges, healthcare organizations often make strategic decisions that have the potential to undermine the quality-of-care they provide. In particular, decisions regarding the employment models used to manage different segments of the workforce are often a function of an implicit or explicit tradeoff between the cost of delivering care and the quality of the care delivered.

The HAI epidemic plaguing the healthcare system in the U.S. offers a troubling illustration of the difficulties many hospitals have ensuring that their patients are safe and protected from unnecessary and preventable harm during treatment and hospitalization. At the same time, this crisis also allows for an assessment of the effects that different employment models have on hospitals' ability to confront these deadly and costly infections. In particular, this paper examines the relationship between the outsourcing of EVS workers and the incidence of HAIs. Drawing on Zuberi's (2013) qualitative work alongside a review of the literature, we hypothesized that the outsourcing of cleaners—nonclinical workers frequently viewed as noncore—would have a significant, negative effect on a hospital's ability to deliver on its core mission of providing high quality and safe care. Specifically, we proposed that a hospital's reliance on outsourced cleaners would be positively associated with the incidence of hospital-onset cases of one particular HAI, *C. diff.*, that it reports in a given year. Our analysis of HAI rates in California's general acute care hospitals provides strong support for our proposed link between the employment model used to manage EVS workers and reported rates of *C. diff.*, a particularly pernicious type of HAI that has become increasingly prevalent and virulent in North American hospitals (Zuberi 2013).

Our findings have important implications for healthcare scholars, practitioners, and policymakers. As noted above, much of the research examining the causes associated with the spread of HAIs has focused on clinical and technical factors. From a scholarly standpoint, our findings contribute to and extend a stream of research that has examined the link between employment relations and multi-stakeholder outcomes in healthcare (e.g., Avgar et al. 2011; Gittell et al. 2010; Givan et al. 2010; Litwin and Eaton 2016). The past decade has seen a proliferation of research that links work practices and employment relations factors to a host of employee and organizational outcomes. Nevertheless, much of this research has focused on the way in which these factors affect core clinical employees. This study builds on this established stream of research and supports the proposition that the way in which employees are managed has a significant effect on organizational performance, but does so by focusing on what many view as noncore or "peripheral" employees. Our findings, therefore, support the extension of this employment relations research stream to the wide array of nonclinical roles, from housekeeping to security guards, within the healthcare setting. Our findings also support the continued study of other employment practices and their effects on the host of quality and safety challenges that persist in hospitals and other healthcare organizations.

From a healthcare policy standpoint, our findings point to concrete and actionable measures that can be taken in the fight against HAIs. Very little, if any, attention has been given to the less glamorous role that employment relations and work arrangements play in facilitating conditions that can affect the spread of HAIs (Koppel et al. 2012). As such, policy and reform measures have ignored the potential link between the increasing use of flexible work arrangements to manage noncore employees and the difficulties hospitals face in stemming the increased prevalence of deadly and costly HAIs. Our results provide a foundation for a public policy position that encourages hospital use of employment models that are consistent with a high-road strategy for noncore employees.

From a practical standpoint, our findings suggest that hospital administrators have a strong incentive of their own to reevaluate the manner in which they employ and manage their EVS workforce. The outsourcing of this workforce should be carefully reexamined and assessed on the basis of the proposed link to patient care outcomes. For example, one apparent downside to outsourcing EVS—that of poor communication and coordination—could well be mitigated by greater attention to issues associated with the commingling of standard and nonstandard workers (Davis-Blake et al. 2003; Erickcek et al. 2003).

Our findings also advance the general study of employment relations and contribute to the established body of research on nonstandard work arrangements and outsourcing in particular. Scholars across disciplines have provided mixed evidence on the consequences of nonstandard work for nonstandard workers (e.g., Barley and Kunda 2004; Kalleberg 2000, 2011; Kalleberg, Rasell, Cassirer, Reskin, Hudson, and Webster 1997; Kalleberg et al. 2000). As reviewed above, this literature has also provided a wealth of empirical evidence linking employer outsourcing decisions to a wide array of negative outcomes. As noted, most of the outcomes examined have centered on employee-related consequences, such as wages and working conditions. Our study, to the contrary, highlights the implications outsourcing has for key measure of organizational performance in the healthcare setting—quality-of-care. In doing so, we advance the longstanding critique of outsourcing as an employment strategy by documenting the negative consequences for the organization, irrespective of any potential negative consequences for employees. Our findings, therefore, shift the debate away from the traditional and often simplistic employer and employee division lines in which outsourcing benefits the former and harms the latter. Set up as a horserace between these stakeholders, the direct, negative impact that externalization has on workers is often assessed against the expected performance improvement for employers. Our findings suggest that these performance improvements are by no means guaranteed and, as such, call for a more nuanced debate around outsourcing practices.

Second, our findings also contribute to the debate regarding the outsourcing of noncore employees. As noted above, some scholars have argued that in making outsourcing decisions, firms distinguish between core employees, who are difficult to replace and add unique value, and peripheral employees, for whom the cost of externalizing the employment relationship is lower (Lepak and Snell 1999, 2002; Thompson 1967). Our findings suggest that, at the very least, this strategic employment approach can come at a significant cost to performance in some organizational settings. We demonstrate that in a setting that is known for a clear demarcation between workforce groups and categories, the outsourcing of what many scholars and practitioners view as one of the least central segments of the workforce has a profound and devastating effect on a crucial outcome and, put bluntly, endangers the lives of patients, not to mention other hospital staff and the community more broadly. This finding suggests that the relationship between noncore employees and the attainment of core organizational objectives may not be as simple and as inconsequential as some scholars have assumed.

Add to this a feature of work in the healthcare sector and many others that exacerbates these issues—task interdependence. In deciding whether workers belong in the core or the periphery, flexibility-related frameworks do not seem to fully account for the social interdependence of work. For example, Kalleberg (2001) maintains that these frameworks do not account for the blending of core and peripheral workers in the production process. In the case of hospital cleaners, it appears that one source of the performance detriment to using contracted cleaners is their social detachment from core members of the care team (Stanwell-Smith 2012). It is not difficult to imagine similar challenges arising elsewhere in the service sector or even in manufacturing.

Our study is, of course, not without limitations. First, we examine the link between flexible staffing arrangement for noncore employees and operational performance in one industry. Thus, our general critique of outsourcing as an employment strategy can be challenged on the basis of its generalizability. To this we respond in four ways. First, we intentionally chose a role that would least arguably be considered peripheral in a setting with many more highly-skilled more highly-paid employees undertaking the "real business" of the organization—healthcare delivery. Second, we also chose a job that exists in many if not most workplaces and is nearly always considered peripheral. Just as patients should be concerned that workers cleaning the hospital are ill-equipped to do their jobs, customers at a restaurant or a dry cleaner should be similarly concerned that "noncore" members of their workforces do not know how to properly clean a counter, scrub a toilet seat, or launder a dirty pair of pantaloons. In short, the factors that influence the centrality of noncore employees in the healthcare industry present themselves in other industries as well. Third, notwithstanding the importance of generalizability, to the extent our intent was to challenge an existing theory, we need not demonstrate that it does not apply in every case. Rather, we must show that we have a found a single exception. And finally, even if this were not the case, our findings have important and practical implications for organizations in the healthcare setting and are therefore important in their own right, irrespective of their generalizability.

In addition to concerns regarding generalizability, to the extent that low pay, high turnover, poor treatment, lack of training, and lack of coordination are driving increases in infections, couldn't the same dynamics play out whether these EVS workers were employees of a contractor or direct employees of the hospital? Put another way, some might argue that our results are a function of the implementation of outsourcing and not of outsourcing in and of itself. Thus, one could further reason that the problem is not outsourcing per se, but outsourcing done poorly. While this remains a possibility that must be explored in future research, given the dominant role that cost savings considerations tend to play in the decision to outsource (Appelbaum et al. 2003; Zuberi 2013), the deployment of a high-road outsourcing approach is likely to be the exception and not the rule. Thus, the dynamics that we theorize probably characterize most of the outsourcing of cleaners in our sample. Nonetheless, to the extent that our proposed mechanisms can play out with internal or external EVS workers and that some of our outsourcing could well be outsourcing "done well," then our estimates suffer from classical measurement error, making it all the more remarkable that we were able to identify a precisely-measured, negative outsourcing effect.

In addition, the usual caveats regarding the use of cross-sectional data certainly apply to this study. Nevertheless, our own qualitative work and exploration of outsourcing data from other years makes clear that due largely to the stability of employment models and of structural features within the hospitals in our sample, longitudinal data would not be an effective means of controlling for time-constant unobservables. In the present case, the most concerning source of simultaneity would arise from some unobserved hospital characteristic that drives both the outsourcing decision and infection rates. While this remains a possibility, we subjected our estimates to a set of robustness checks that we hope puts these concerns to rest.

Finally, with respect to the paper's limitations, we must concede that while our study documents the statistical relationship characterizing the externalization of EVS work and infections, neither our methods nor our findings allow us to definitively pin down the mechanisms driving these results. However, in developing our hypothesis regarding the link between outsourcing and HAIs, we argued that this relationship is the product of control, coordination, and attachment challenges associated with this employment model. Additional research will be needed to establish which of these mechanisms are truly driving the relationships we uncovered.

Having acknowledged these important limitations and the research questions to which they give rise, we remain confident that our findings advance the study of employment relations in general and its application to the healthcare setting, in particular. As healthcare organizations continue to experiment with clinical and technological innovations designed to improve the quality of patient care, our findings serve as a reminder that alongside these innovations, employment decisions play a central role in determining hospital performance.

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Table 1. **Variable Definitions, Construction, and Sources**

Variable	Definition/Survey Item(s)	Construction	Source
C. diff. cases	number of hospital-onset cases of *C. diff.*, i e , positive stool sample obtained on day four or later during the hospital stay, recorded over the reporting period	count variable measured in cases reported	California Department of Public Health Healthcare-Associated Infections (HAIs) report on *Clostridium difficile* (*C. diff.*) infections in California general acute care hospitals
C. diff.-positive	whether or not the hospital recorded at least one hospital onset case of *C. diff.* over the reporting period	binary variable equal to 1 if variable *C. diff.* cases > 0 and 0 if *C. diff.* cases = 0	California Department of Public Health Healthcare-Associated Infections (HAI) report on *Clostridium difficile* (*C. diff.*) infections (CDI) in California general acute care hospitals
housekeeping purchased services share	purchased services as a share of the total direct expenses incurred for housekeeping at the hospital	continuous measure of dollars spent on purchased services for housekeeping divided by the total amount of expenses incurred by the housekeeping cost center	Audited annual financial disclosure report submitted to California Office of Statewide Health Planning and Development
total housekeeping expenses	total direct expenses incurred for housekeeping at the hospital	continuous measure of dollars spent by the housekeeping cost center	Audited annual financial disclosure report submitted to California Office of Statewide Health Planning and Development
total beds	total number of beds set-up and staffed at the hospital at the end of the reporting period	continuous variable measured in number of beds	American Hospital Association (AHA) annual survey database
case mix index	resources needed to treat the hospital's mix of patients during the calendar year	continuous variable measured as weighted sum of the hospital's Medicare Severity-Diagnosis Related Groups (MS-DRG) divided by the total number of discharges over the reporting period	California Department of Public Health, Healthcare Information Division and California Office of Statewide Health Planning and Development
for-profit	whether or not the hospital is operated by a for-profit entity	binary variable in which 1 implies that the hospital is controlled by an investor-owned for-profit individual, partnership, or corporation, and 0 implies the hospital is controlled by the government, the church, or another not-for-profit entity	American Hospital Association (AHA) annual survey database
urban	whether or not the hospital is located in and serves an urban area	binary variable in which 1 implies a CBSA of "metropolitan" or larger and 0 implies a Core-Based Statistical Area (CBSA) defined as "rural" or "micropolitan"	American Hospital Association (AHA) annual survey database
academic	whether or not the hospital is classified as academic	binary variable in which 1 = "yes" and 0 = "no"	American Hospital Association (AHA) annual survey database
readmissions after heart attack	share of heart attack patients readmitted within 30 days of discharge	continuous, risk-adjusted measure of the share of 30-day unplanned patient readmissions for heart attack (acute myocardial infarction) patients—lagged by one year	Centers for Medicare & Medicaid Services' (CMS) Hospital Compare database
patient satisfaction with hospital	share of patients rating their overall satisfaction with the hospital as "high"	continuous measure of the share of respondents over the course of the year that responded to "Using any number from 0 to 10, where 0 is the worst hospital possible and 10 is the best hospital possible, what number would you use to rate this hospital during your stay?" by choosing the numbers 9 or 10—lagged by one year	Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) annual survey of patient's perspectives of hospital care
security purchased services share	purchased services as a share of the total direct expenses incurred for security at the hospital	continuous measure of dollars spent on purchased services for security divided by the total amount of expenses incurred by the security cost center	Audited annual financial disclosure report submitted to California Office of Statewide Health Planning and Development
total security expenses	total direct expenses incurred for security at the hospital	continuous measure of dollars spent by the security cost center	Audited annual financial disclosure report submitted to California Office of Statewide Health Planning and Development

Table 2. Means, Standard Deviations, and Correlations for Study Sample of California General Acute Care Hospitals

#	Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
1	*C. diff.* cases	27.5	32.9	1.00											
2	*C. diff.*-positive	0.86	0.34	.33***	1.00										
3	housekeeping purchased services share	0.24	0.33	.03	.19***	1.00									
4	total housekeeping expenses	3,820,607	4,276,095	.68***	.30***	-.09***	1.00								
5	total beds	195 5	155.0	.67***	.35***	.14**	.70***	1.00							
6	case mix index	1.27	0.30	.34***	.17***	.07	.33***	.22***	1.00						
7	for-profit	0.15	0.36	-.13***	-.03	.29***	-.26***	-.14**	.08	1.00					
8	urban	0.90	0.30	.23***	.30***	.22***	.23***	.33***	.24***	.14**	1.00				
9	academic	0.21	0.41	.32***	.07	-.04	.32***	.37***	.17***	-.10**	.14**	1.00			
10	readmissions after heart attack	0.20	0.01	-.05	.05	.10	-.12*	-.12*	-.08	.11*	.07	-.20***	1.00		
11	patient satisfaction with hospital	0.65	0.07	.07	-.20***	-.11*	.13**	.02	.28***	-.15***	-.18***	.08	-.34***	1.00	
12	security purchased services share	0.44	0.43	-.14**	.01	.24***	-.07	-.07	-.02	.20***	-.08	-.06	-.04	.02	1.00
13	total security expenses	1,467,436	1,763,894	.56***	.17***	-.05	.85***	.61***	.25***	-.26***	.14**	.32***	-.11*	.14**	-.03

* *p*< 10, ***p*< 05, ****p*< 01

Table 3. **Impact of Employment Arrangements on the Spread of Healthcare-Associated Infections (HAIs): Logistic Regression Estimates**

Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
ln(housekeeping purchased services share)	.52***	.26***		.24**	.26*	.29**	.29*
	(5.47)	(2.68)		(2.12)	(1.80)	(2.39)	(1.91)
ln(total housekeeping expenses)		1.64***	1.62***	1.24***	1.78***	1.21***	1.81***
		(5.51)	(4.74)	(3.08)	(2.99)	(3.03)	(3.20)
ln(total beds)			.82**	.88**	.82	.43	.51
			(2.37)	(2.09)	(1.56)	(0.94)	(0.90)
ln(case mix index)			1.32	1.92*	3.11**	2.70**	3.54**
			(1.42)	(1.77)	(2.08)	(2.28)	(2.30)
for-profit			.70	.55	.66	.47	.55
			(1.18)	(0.86)	(0.86)	(0.71)	(0.70)
urban			-.22	-1.00	-1.10	-.94	-1.06
			(-0.37)	(-1.41)	(-1.00)	(-1.25)	(-0.95)
academic			-.83	-.82	.13	-.40	.40
			(-1.30)	(-1.21)	(0.13)	(-0.58)	(0.37)
readmissions after heart attack					47.52		26.57
					(1.64)		(0.79)
patient satisfaction with hospital						-8.02**	-7.20
						(-2.19)	(-1.18)
AIC	192	144	157	136	84	129	84
BIC	199	155	182	165	114	160	117
n	297	297	290	251	204	240	204

Notes: Models are logistic regressions in which the dependent variable is whether or not the facility reported at least one case of *C. diff.* over the course of the year (with z-statistics in parentheses). Based on the difference in BIC statistics, Model 4 is strongly supported over Model 3.

* $p<.10$, ** $p<.05$, *** $p<.01$.

Table 4. **Impact of Employment Arrangements on the Spread of Healthcare-Associated Infections (HAIs): Negative Binomial Regression Estimates**							
Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
ln(housekeeping purchased services share)	.20***	.13***		.09***	.06**	.09***	.06**
	(4.40)	(4.70)		(3.08)	(2.01)	(3.21)	(2.02)
ln(total housekeeping expenses)		.95***	.68***	.78***	.79***	.76***	.79***
		(18.09)	(7.44)	(7.25)	(7.73)	(6.91)	(7.77)
ln(total beds)			.57***	.43***	.52***	.41***	.53***
			(5.47)	(3.64)	(4.52)	(3.47)	(4.60)
ln(case mix index)			1.43***	1.52***	.77***	1.55***	.84***
			(5.66)	(5.62)	(2.80)	(5.23)	(3.02)
for-profit			.26*	.23	.09	.17	.05
			(1.85)	(1.54)	(0.64)	(1.13)	(0.37)
urban			.61***	.43*	.41	.45*	.40
			(2.61)	(1.70)	(1.48)	(1.74)	(1.45)
academic			-.28**	-.29**	-.13	-.24*	-.12
			(-2.32)	(-2.33)	(-1.05)	(-1.90)	(-0.98)
readmissions after heart attack					13.34***		11.19**
					(3.05)		(2.41)
patient satisfaction with hospital						-.33	-1.19
						(-0.43)	(-1.34)
AIC	2551	2329	2135	1867	1603	1812	1603
BIC	2562	2344	2165	1898	1636	1847	1639
n	297	297	290	251	204	240	204

Notes: Models are negative binomial regressions in which the dependent variable is the number of cases of *C. diff.* reported over the course of the year (with *z*-statistics in parentheses). Based on the difference in BIC statistics, Model 4 is strongly supported over Model 3.

* $p<.10$, ** $p<.05$, *** $p<.01$.

Table 5. **Impact of Employment Arrangements on Hospital Readmissions after Heart Attack: OLS Regression Estimates**				
Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**
ln(housekeeping purchased services share)	.01	.03		.0002
	(0.35)	(0.77)		(0.01)
ln(total housekeeping expenses)		-.13*	.04	-.0003
		(-1.85)	(0.31)	(-0.002)
ln(total beds)			-.06	-.01
			(-0.40)	(-0.04)
ln(case mix index)			-.29	-.56
			(-0.78)	(-1.39)
for-profit			.20	.14
			(0.98)	(0.67)
urban			.45	.47
			(1.20)	(1.22)
academic			-.53***	-.53***
			(-2.80)	(-2.72)
R^2	.001	.01	.07	.07
n	246	246	216	204

Notes: Models are OLS regressions in which the dependent variable is the share of patients readmitted within 30 days after heart attack over the course of the year (with t-statistics in parentheses). The dependent variable has been multiplied by 100 to make the point estimates readable at two significant digits.

* $p<.10$, ** $p<.05$, *** $p<.01$.

Table 6. Impact of Employment Arrangements on Overall Patient Satisfaction with Hospital: OLS Regression Estimates

Variable	Model 1	Model 2	Model 3	Model 4
ln(housekeeping purchased services share)	-.34	-.35		.16
	(-1.57)	(-1.54)		(0.66)
ln(total housekeeping expenses)		.07	1.43***	.57
		(0.16)	(2.12)	(0.72)
ln(total beds)			-3.62***	-3.24***
			(-4.44)	(-3.59)
ln(case mix index)			10.35***	11.54***
			(5.30)	(5.34)
for-profit			-1.99*	-2.65**
			(-1.75)	(-2.21)
urban			-2.49	-2.66
			(-1.42)	(-1.46)
academic			1.87*	2.09*
			(1.87)	(1.92)
R^2	.01	.01	.21	.21
n	284	284	271	240

Notes: Models are OLS regressions in which the dependent variable is the share of patients rating their overall satisfaction with the hospital as "high" over the course of the year (with *t*-statistics in parentheses). The dependent variable has been multiplied by 100 to make the point estimates readable at two significant digits.

* $p<.10$, ** $p<.05$, *** $p<.01$.

Table 7. **Impact of Employment Arrangements on the Spread of Healthcare-Associated Infections (HAIs): Additional Logistic Regression Estimates**					
Variable	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
ln(security purchased services share)	.13	.23**		.09	.02
	(1.22)	(2.11)		(0.70)	(0.16)
ln(total security expenses)		1.50***	.88**	1.08**	.42
		(4.04)	(2.16)	(2.14)	(0.61)
ln(total beds)			1.20***	1.18**	.79
			(2.62)	(2.44)	(1.35)
ln(case mix index)			.39	-.19	.92
			(0.33)	(-0.14)	(0.60)
for-profit			.94	1.60	1.74*
			(1.20)	(1.62)	(1.67)
academic			.03	-.31	-.30
			(0.04)	(-0.34)	(-0.30)
ln(housekeeping purchased services share)					.30*
					(1.75)
ln(total housekeeping expenses)					.86
					(1.14)
AIC	116	95	101	85	81
BIC	123	105	125	108	111
n	249	249	238	196	195

Notes: Models are logistic regressions in which the dependent variable is whether or not the facility reported at least one case of *C. diff.* over the course of the year (with *z*-statistics in parentheses). Since the dummy variable capturing urban vs. rural gets dropped altogether from Models 4 and 5, we omit it from the table entirely.

* $p<.10$, ** $p<.05$, *** $p<.01$.

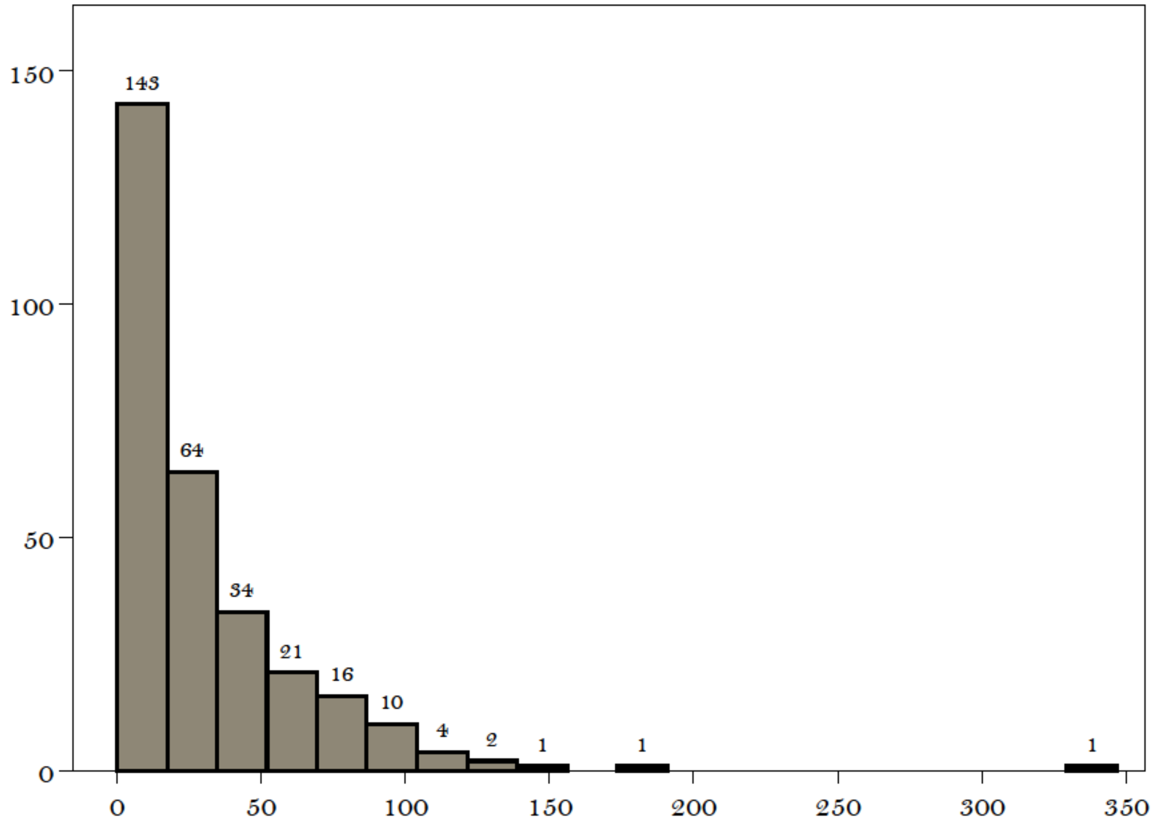
Table 8. Impact of Employment Arrangements on the Spread of Healthcare-Associated Infections (HAIs): Additional Negative Binomial Regression Estimates

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
ln(security purchased services share)	-.04	.01		.002	-.03
	(-1.19)	(0.27)		(0.08)	(-1.17)
ln(total security expenses)		.73***	.29***	.37***	.12
		(13.42)	(3.64)	(4.00)	(1.10)
ln(total beds)			.74***	.64***	.37***
			(7.24)	(5.52)	(3.05)
ln(case mix index)			1.36***	1.39***	1.33***
			(5.11)	(4.79)	(4.85)
for-profit			-.06	.01	.18
			(-0.44)	(0.07)	(1.20)
urban			.23	.61	.65*
			(0.73)	(1.51)	(1.65)
academic			-.08	-.11	-.19
			(-0.70)	(-0.86)	(-1.56)
ln(housekeeping purchased services share)					.08***
					(2.73)
ln(total housekeeping expenses)					.55***
					(3.88)
AIC	2267	2128	1955	1683	1657
BIC	2278	2142	1983	1712	1694
n	249	249	238	203	202

Notes: Models are negative binomial regressions in which the dependent variable is the number of cases of *C. diff.* reported over the course of the year (with z-statistics in parentheses).

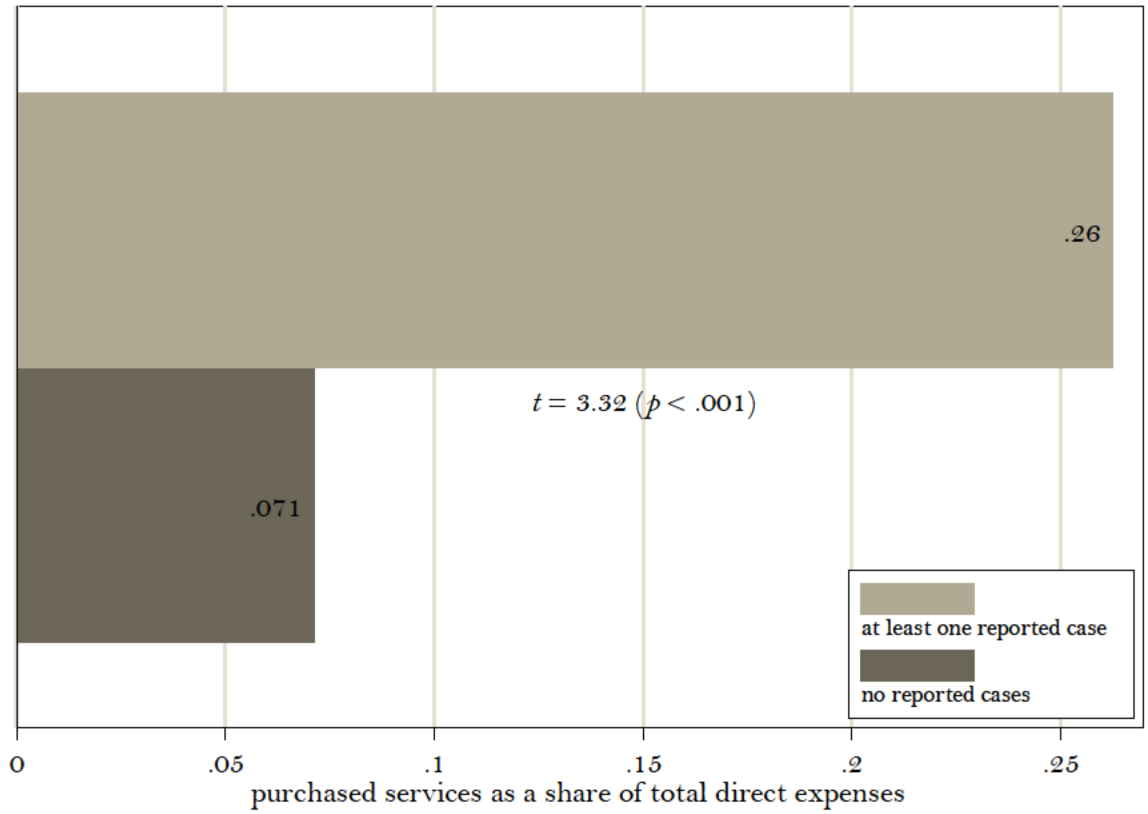
* $p<.10$, ** $p<.05$, *** $p<.01$.

Figure 1. **Frequency Distribution of Reported Cases of *Clostridium Difficile (C. Diff.)* in California's General Acute Care Hospitals**



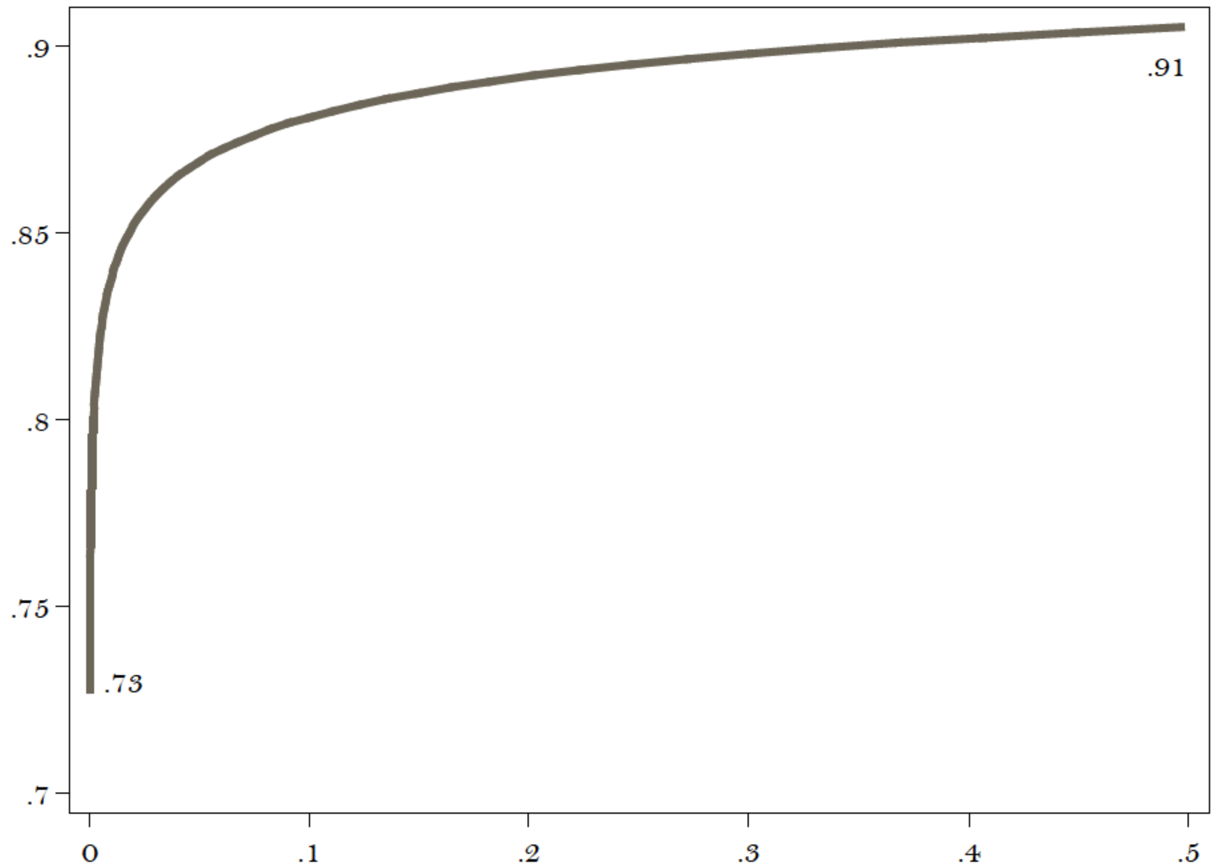
Notes: The study sample encompasses 8,667 reported *C. diff.* cases across 297 hospitals.

Figure 2. Observed Mean Share of Housekeeping Expenses Categorized as Purchased Services by Whether or Not the Hospital Reported at Least One Case of _Clostridium Difficile (C. Diff.)_



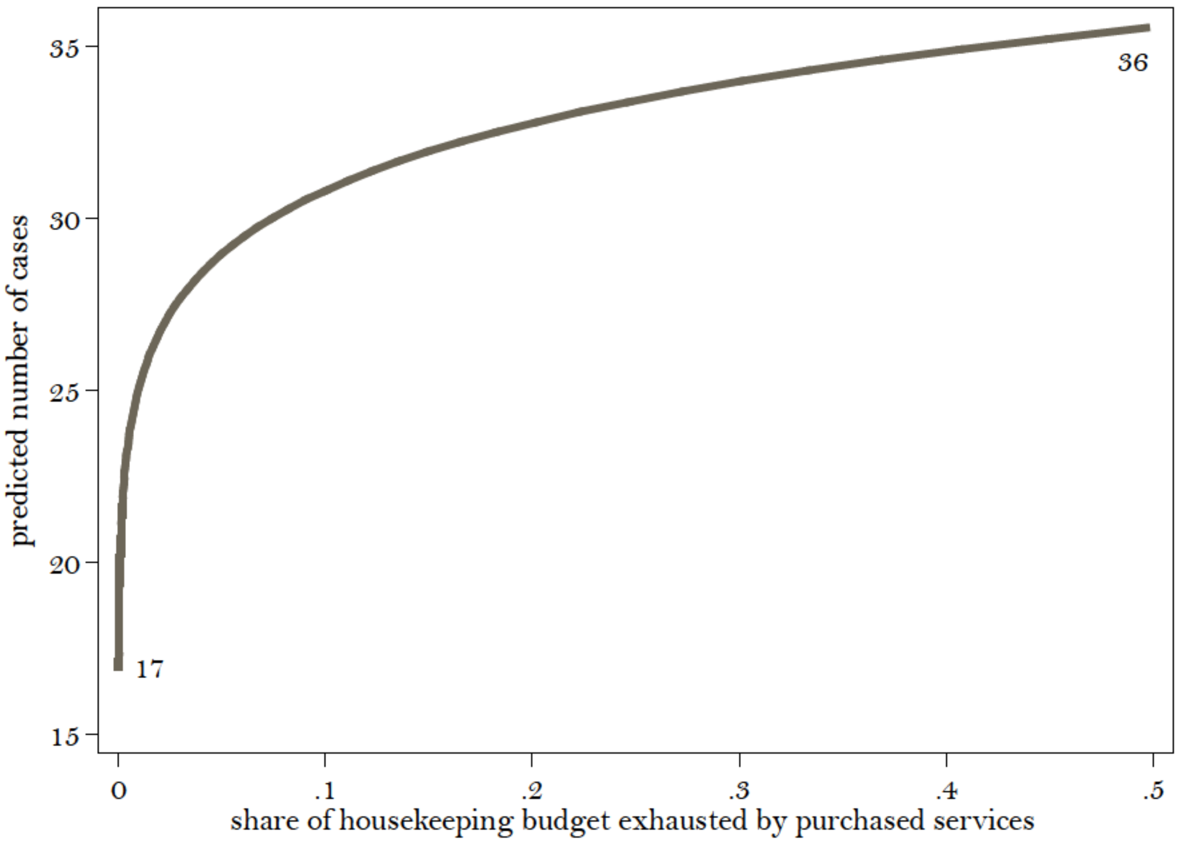
Notes: Bars represent observed means. Also reports the results of simple *t*-test of the difference-in-means, with the *t*-statistic and *p*-value.

Figure 3. **Probability of One or More Cases of *Clostridium Difficile (C. Diff.)* Reported in California's General Acute Care Hospitals as a Function of the Share of Housekeeping Expenses Exhausted by Purchased Services**



Notes: Plots show fitted probabilities derived from Model 4 in Table 3, with all non-focal independent variables held at their sample means.

Figure 4. **Predicted Cases of *Clostridium Difficile* (*C. Diff.*) in California's General Acute Care Hospitals as a Function of the Share of Housekeeping Expenses Exhausted by Purchased Services**



Notes: Plot shows fitted probabilities derived from Model 4 in Table 4, with all non-focal independent variables held at their sample means.