Abstract

How does organizational structure affect physician behavior? I investigate this question by studying emergency department (ED) physicians who work in two organizational systems that differ in the extent of physician autonomy to manage work: a “nurse-managed” system in which physicians are assigned patients by a triage nurse “manager,” and a “self-managed” system in which physicians decide among themselves which patients to treat. Taking advantage of several sources of quasi-random variation, I estimate that the self-managed system increases throughput productivity by 10-13%. Essentially all of this net effect can be accounted for by reducing a moral hazard I call “foot-dragging”: Because of asymmetric information between physicians and the triage nurse, physicians prolong patient length of stay in order to appear busier and avoid getting new patients. I show that foot-dragging is sensitive to the presence of and relationship between peers. Finally, I show evidence consistent with theory that predicts more efficient assignment of new patients in the self-managed system.

Keywords: Physician behavior, organizational structure, social incentives, moral hazard

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1 Introduction

There is growing recognition that organizational structure could be responsible for setting high-performing health care institutions apart from the rest (McCarthy and Blumenthal, 2006; Oliver, 2007; Institute of Medicine, 2012; Lee and Mongan, 2009). The popular press has noted large differences in cost and quality across health care institutions (Gawande, 2009), and qualitative case studies of the highest-performing institutions have begun to sketch a pattern of organizational attributes that includes concepts such as teamwork, accountability, transparency, and integration (McCarthy and Mueller, 2009).

More broadly, recent research in economics has shown that management and organization can matter greatly in productivity (e.g., Bloom and Van Reenen, 2007).\(^1\) Still, this literature faces challenges in disentangling sources of the organizational effect on productivity. Organizational differences across firms are often difficult to separate from worker selection or other firm-level exposures. Even changes within firms usually involve multiple features, which complicates isolating behavioral mechanisms. With respect to mechanisms, a gap in understanding remains between the classic prediction that workers in teams should engage in moral hazard (Holmstrom, 1982) and findings in the management literature, largely outside of economics, suggesting that workers perform better with teamwork (e.g., Yeatts and Hyten, 1997).\(^2\)

I study a natural experiment in which emergency department (ED) physicians are observed to work in two different organizational systems that differ in only one respect. In one system, which I call “nurse-managed,” two physician “workers” in the same location (“pod”) are individually assigned patients by a triage nurse “manager.” In the second system, which I call “self-managed,” the triage nurse first assigns patients to a pod that is shared by two physicians, and then these physicians decide between themselves who will care for each arriving patient. These two systems are common in ED settings (Salluzzo et al., 1997; Patel and Vinson, 2005). More generally, this

\(^1\)Other landmark studies include Ichmowski et al. (1997); Bertrand et al. (2004); Bloom et al. (2011); Hamilton et al. (2003).

\(^2\)Teamwork has been most extensively studied in the management and organizational behavior literature, usually with case studies or cross-sectional studies. Explanations have been largely psychological, including concepts such as “cohesion,” “recognition,” and “motivation” (Yeatts and Hyten, 1997). Hamilton et al. (2003), a study in the economics literature, posited complementary skills between team members, found some evidence of selection of high-productivity workers into teams, and concluded that these effects must have outweighed increased moral hazard in teams.
comparison highlights an important organizational dimension: the degree of autonomy workers have to manage and coordinate work among themselves.

Outcomes in the two systems may differ via several mechanisms. In the nurse-managed system, under asymmetric information between physician workers and the triage nurse manager, physicians may want to avoid being assigned more work by appearing busier than they are, keeping patients longer than necessary ("foot-dragging"). In the self-managed system, if physicians have more information on each other’s true workloads and use it in choosing patients, they can reduce foot-dragging relative to the nurse-managed system. However, physicians in the self-managed system may also seek to avoid work by waiting for their peer to pick patients first (another moral hazard that I distinguish with the term "free-riding"). Finally, outcomes may differ through advantageous selection in the self-managed system, as physicians can choose patients according to either skill or availability.

Several features of this empirical design allow for identification both of the overall effect of self-managed teams and of foot-dragging and free-riding as specific mechanisms. First, one of the two pods changed from a nurse-managed system to a self-managed system during the sample period, allowing me to control for time-invariant and unobservable differences between the two pods. Second, I observe the same health care providers – physicians, nurses, and residents – working in both pods. Third, physician schedules are arranged far in advance and do not allow physicians to choose shifts precisely. I construct a measure based on the exogenous flow of work to the ED to isolate foot-dragging, and I use exogenous variation in the assignment of peers to evaluate peer effects on foot-dragging. Fourth, the detailed nature of physician orders allows me to infer when physicians start working on a case and to isolate free-riding.

I focus on the time a physician spends on a patient (i.e., the patient’s length of stay) as my primary outcome measure in the ED. This resembles measures of throughput used in other studies of worker productivity (Mas and Moretti, 2009; Bandiera et al., 2009, 2010). In the ED, throughput is especially relevant because it impacts waiting times, a key determinant of patient satisfaction and outcomes (Bernstein et al., 2008; Thompson et al., 1996). Waiting times are shared by all future patients and depend on aggregate ED throughput, while lengths of stay map each physician’s contribution to this aggregate. Consistent with the health care setting,
I also examine secondary patient-level outputs of quality, revenue, and costs. I do not expect them to differ much if pure foot-dragging moral hazard is the primary mechanism and if the main concern for quality arises from increased waiting times shared by all future patients.

I find that physicians perform 10-13% faster in the self-managed system than in the nurse-managed system. There is no difference in the time physicians take to write their first orders for each patient, which suggests that free-riding is not a significant mechanism. I then examine foot-dragging by testing a prediction that, under this mechanism but not other mechanisms, lengths of stay should increase with expected future work. I find that lengths of stay increase with expected future work in the nurse-managed system but not in the self-managed system. This essentially explains the overall difference between the two systems.

Further, I show that information between peers and social incentives play a crucial role in modifying foot-dragging. To test this, I use the fact that the location of other physicians does not affect total work but could affect the ability of physicians to monitor each other’s work. Thus, if physicians care about being seen engaging in moral hazard, the presence of a peer in the same pod could reduce foot-dragging. I find that the presence of a peer in the same pod – especially a more senior peer – substantially reduces foot-dragging in the nurse-managed system, relative to when there is another physician in the ED but not in the same pod. I also find that foot-dragging in the nurse-managed system depends on the number of patients (the “census”) of both the index physician and the peer, reflecting strategic behavior or social incentives conditional on the distribution of work.

Finally, I study patient assignment to test a prediction reminiscent of Milgrom and Roberts (1988): If the triage nurse knows that physicians are tempted to foot-drag (i.e., distort their censuses upward as signals), then she can be better off by ignoring some information in censuses. That is, she can improve patient assignment ex ante by committing to a policy that ignores informative signals ex post. In contrast, in the self-managed system, if physicians observe and use information about each other’s true workloads, then signals are less likely to be distorted and can be used more efficiently ex post. Consistent with this, I find that patient assignment is more correlated with censuses in the self-managed system than in the nurse-managed system. I also study patient assignment around the transition of the pod switching to a self-managed
system and find evidence of short-term enforcement against foot-dragging, with physicians with higher censuses more likely to be assigned new patients, prior to improving ex post efficiency.

Together, these findings suggest that the self-managed system improves performance because superior information between peers is used to assign work, reducing the moral hazard to avoid work. The remainder of the paper proceeds as follows. The next section describes the ED institutional setting and data. Section 3 outlines a simple model of asymmetric information in the nurse-managed system to explain foot-dragging there and its reduction in the self-managed system; it also discusses conditions for free-riding in the self-managed system. Section 4 reports the overall effect of the self-managed system and shows that free-riding is minimal in the self-managed system. Sections 5 and 6 discuss the main evidence for foot-dragging and its mitigation by organizational structure and the presence of peers. Section 7 explores patient assignment in the two systems over time. Section 8 concludes.

2 Institutional Setting and Data

I study a large, academic, tertiary-care ED with a high frequency of patient visits, greater than 60,000 visits per year (or 165 visits per day), with a total of 380,699 visits over six years. For each visit, I observe times for each point in the process of care – patient arrival at the ED, arrival at the pod, entry of discharge order, and discharge with destination – as well as all physician orders written during the visit (approximately 13 orders on average per visit). Because all actions taken by physicians must be documented and time-stamped as orders, these data provide uniquely detailed process measures of physician effort and patient care.

Patient care in the ED is delivered by an attending physician ("physician"), a nurse (not to be confused with the triage nurse), and sometimes a resident physician ("resident"). The physician is responsible for directing patient care, while the resident, who is still training, may assist the physician with varying levels of autonomy. Nurses execute physician orders and report any concerns to physicians. I observe 92 physicians, 364 nurses, and 986 residents in the data. Among these, 75 physicians, 334 nurses, and 882 residents, comprising 11,865 unique physician-nurse-resident trios, are observed in both organizational systems.\footnote{Essentially all providers who do not work in both systems either are occasional moonlighters or represent...}

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2.1 Systems, Pods, and Shifts

All patients must first enter the ED through a waiting room, also called “triage,” where a triage nurse decides where and when to send them. In the nurse-managed system, the triage nurse directly assigns patients to one of potentially two physicians in the same pod. The triage nurse serves as a manager in the sense that she allocates new patients to physicians whom she thinks are available or able to do the work. In the self-managed system, two physicians in the same pod are jointly responsible for dividing work sent to the pod by the triage nurse. See Figure 1 for a schematic of patient workflow. The assignment of patients to nurses and residents does not differ between the two systems; in both systems, nurses are assigned patients, and residents choose patients.

Basic information about patients cared for by each physician is available to all physicians in the ED and the triage nurse from a computer interface (see Figures 2 and 3). The most important public measure of workload is each physician’s census, or the number of patients being cared for by him. However, censuses can be distorted by prolonging the time to discharge. Physicians may have superior information relative to the triage nurse about the true workloads of their peers, not only from differences in medical knowledge but also because they are in the same room and can directly observe peer behavior and patient status. In the self-managed system, physicians may also use this information to assign patients.

Physicians in the ED work in prescheduled shifts of eight to nine hours. Each shift is in one of two geographic locations, or pods, which I call “Alpha” and “Bravo.” Alpha and Bravo pods are similar in resources, layout, and staffing, and they have remained so over time. The triage nurse can decide to send any patient to either pod, based on bed availability. However, one important difference between Alpha and Bravo is that Alpha pod has always been opened 24 hours, while Bravo pod has always closed at night. As a result, patients who need to stay longer, either because they are sicker or have conditions that might make discharge difficult errors in recording the correct provider. For example, the number of visits corresponding to median resident is 1,525, while this number is 17 for residents who are observed to work in only one system. 4The assignment of patients by nurses or non-medical staff is the predominant system of work assignment in hospital and ED settings. In many of these settings, however, these “managers” have no discretion but merely follow rules. Neither, of course, can they hire or fire nor set financial incentives.
(e.g., psychiatric patients), have tended to be sent to Alpha pod.\textsuperscript{5} Closing Bravo every night may also prompt earlier discharges for patients in the pod as it nears closing.

Alpha pod has always had a self-managed system. In contrast, in March 2010, Bravo pod switched from a nurse-managed system to a self-managed one. The regime change in Bravo pod resulted from a simple intervention in which beds that physicians previously “owned” became shared, so that the physicians were then allowed to choose among patients entering that pod. The reason for this switch, according to the ED administration, was to allow greater flexibility in patient assignment within pod. According to interviews with ED administrators and physicians, the switch was not considered a significant change in organizational structure, and overall implications for efficiency were not apparent.\textsuperscript{6}

Importantly, there was no other official change in either Alpha or Bravo accompanying the above regime change: Schedules and staffing for providers and algorithms for patient assignment to beds, nurses, and residents remained unchanged. Actual assignment choices by the triage nurse between the pods were also relatively stable over time; if anything, Bravo pod received increasingly time-intensive patients over time, as the ED became increasingly busy.\textsuperscript{7} Financial incentives for physicians were unchanged; they have always been paid a salary plus a 10% productivity bonus based on clinical productivity (measured by Relative Value Units, or RVUs, per hour) and modified by research, teaching, and administrative metrics.\textsuperscript{8}

### 2.2 Physician Schedules and Exogenous Variation

In addition to the natural experiment provided by the regime change, this study exploits other

\textsuperscript{5}For example, the average patient age in Alpha was about 50, while the average patient age in Bravo was about 45. The average patient Emergency Severity Index was 0.5 points more severe (on a 5-point scale, with lower numbers being more severe) for patients in Alpha compared to those in Bravo. These and other summary statistics comparing patients in the two pods are shown Appendix Table A-2.1.

\textsuperscript{6}In fact, in May 2011, the ED attempted a redesign that moved both pods to the nurse-managed system, only to discover later that it significantly reduced efficiency. They reversed this organizational change in January 2012.

\textsuperscript{7}In Appendix A-2.1, I calculate the expected length of stay for patients based only on their characteristics. I then average the expected lengths of stay for each pod and each month. In In the first month of the data, patients in Alpha had characteristics that predicted a 14% greater length of stay than those for patients in Bravo; in the last month of the data, this incremental percentage was only 6%. I show this graphically in Figure A-2.1.

\textsuperscript{8}The metric of Relative Value Units (RVUs) per hour encourages physicians to work faster, because RVUs are mostly increased on the extensive margin of seeing more patients and are rarely increased by doing more things for the same patients. I specifically address whether physicians can bill for more RVUs in the self-managed system or when foot-dragging in Sections 4 and 5, respectively.
identifying variation due to physician shift assignment. Physician schedules are determined one year in advance, and physicians are only able to request rare specific shifts off, such as holidays or vacation days.\textsuperscript{9} General preferences, such as whether they would like to work at night, may be voluntarily stated but not honored fully, and all physicians are expected to be open for shifts at all times of the day and days of the week. Once working on a shift, physicians cannot control the volume and types of patients arriving in the ED nor the types of patients assigned by the triage nurse to the pod.\textsuperscript{10}

Conditional on the month-year, day of the week, and hour of the day, I find that physicians are exposed to similar patients types arriving at their pod and patient numbers arriving at the ED. Tables 1 and 2 show this descriptively for physicians with above- and below-median productivity, defined by average lengths of stay. In Appendix A-1, I show similar results for physicians with different preferences for certain patients (defined as the likelihood to choose that patient when in the self-managed system); I formally test and cannot reject the null that physician identities are jointly insignificant in predicting available patient types or ED arrival numbers; and I show that physician types are uncorrelated with those of their peers.\textsuperscript{11}

The observed variation is not only exogenous but also rich for several reasons: First, the numbers and types of patients arriving at the ED are notoriously wide-ranging, even conditional on the time of the day.\textsuperscript{12} Second, physicians work very few shifts per week, usually one to two with the maximum being four, and are expected to work in all types of shifts. As a result, I observe all physicians working in both locations, during all time categories, and with essentially all possible peers. Third, there is substantial variation in the tenure of physicians. While some physicians are observed to remain on staff for the entire six-year period, other physicians are

\textsuperscript{9}Shift trades are also exceedingly rare, about less than one per month, or <1\% of the number of shifts. Results are robust to dropping traded shifts. Per ED administration, shifts are not assigned with peers in mind.

\textsuperscript{10}Physicians may rarely (<1-2\% of operating times) put the ED on “divert” for up to an hour when the flow of patients is unusually high and the entire ED lacks capacity to see more patients. Even when this happens, this only affects some ambulances (which as a whole constitute 15\% of visits) carrying serious emergencies, as opposed to the majority of patients, some of whom walk in. ED flow is largely unaffected.

\textsuperscript{11}Note that I already can control for physician identity across systems. So even if physicians are preferentially assigned certain shifts (even after conditional on rough time categories), estimates of the overall self-managed effect and of foot-dragging across systems will still be unbiased as long as conditions associated with those shift times have the same effect on each physician’s outcomes or foot-dragging, respectively, in both systems. Exogenous physician assignment provides additional robustness allowing for differential effects of unobservable conditions within physicians across systems. Regression specifications are discussed further below.

\textsuperscript{12}At any given hour, the number of patients arriving may range from close to none to the mid-twenties. Patients may require a simple prescription or pregnancy test, or they may have a gunshot wound.
newly hired or leave the hospital during the observation period. I observe physician demographics and employment details, such as the place and date of medical school and residency. I use these data to construct rich descriptors of peer relationships, described in Section 6.2.

2.3 Outcomes

ED length of stay is my primary outcome measure because it directly relates to ED throughput productivity, consistent with other studies of worker productivity (e.g., Mas and Moretti, 2009). Throughput is especially important in the ED, as the focus of both policy papers and a cottage industry of ED management consulting (McHugh et al., 2011). Given ED bed capacity constraints and patients almost always in waiting rooms, lengths of stay determine waiting times, believed to be important for patient satisfaction and health outcomes (Thompson et al., 1996; Bernstein et al., 2008). Lengths of stay measure each physician’s contribution to aggregate waiting times. Measured from the arrival at the pod to entry of the discharge order, they are unaffected by inpatient bed availability, patient home transportation, or clinical care or patient adherence after ED visits.

I consider three secondary outcome measures of quality that have been prominent at the national policy level (Schuur and Venkatesh, 2012; Forster et al., 2003; Lerman and Kobernick, 1987). Thirty-day mortality occurs in about 2% of the sample. Hospital admission represents a resource-intensive option for ED discharge that is believed to substitute sometimes for appropriate care in the ED and occurs in 25% of the sample. Bounce-backs, defined as patients who are discharged home but return to the same ED within 14 days, occur in about 7% of the sample and represent a complementary quality issue.

I also consider patient-level revenue and costs that accrue to the ED and hospital. For revenue, I use Relative Value Units (RVUs), which are units of physician billing for services that scale directly to dollars and reflect the intensity of care provided to a patient.\textsuperscript{13} For costs, I use total direct costs for each patient encounter, including any costs incurred from a resulting hospital admission.\textsuperscript{14} Finally, because I have data on all orders, I consider detailed process

\textsuperscript{13}The current “conversion factor” is $34 per RVU, and the average ED patient is billed for 2.7 RVUs of ED care, resulting in about $6 million in yearly revenue for this particular ED.

\textsuperscript{14}Direct costs are for services that physicians control and are directly related to patient care. Indirect costs
measures that capture all aspects of patient care, including nursing, medication, laboratory, and radiology orders. I do not observe the time that a physician officially signs up for a patient, but as a proxy for this, I use the time that the physician writes his first order.

3 Theoretical Framework

In this section, I outline a simple model of asymmetric information between physicians and the triage nurse. The purpose of this model is to show how the self-managed system reduces foot-dragging and improves assignment efficiency relative to the nurse-managed system, formalizing the conjecture in the management literature that self-managed teams improve productivity by “monitoring and managing work process and progress” (Pallak and Perloff, 1986).

I assume that in the nurse-managed system, the triage nurse cannot observe true physician workloads, although she would like to assign new work according to workloads. Given that physicians prefer to avoid new work, they distort signals of true workload by prolonging patient lengths of stay (i.e., foot-dragging). At the same time, similar to Milgrom and Roberts (1988), I show that a triage nurse who takes this into account can be better off by committing to an ex post inefficient policy of ignoring signals, even though signals remain informative.

In the self-managed system, however, if physician peers sometimes observe each other’s true workloads, then they can also use that information to assign new work. This reduces the threat of foot-dragging and improves ex post assignment efficiency. While physicians may delay choosing patients in the self-managed system (i.e., free-riding) as another moral hazard to avoid work, this is limited with sufficient mutual physician information or commitment. Finally, I contrast self-management with social incentives as another pathway for information between peers to reduce foot-dragging: Social incentives reduce foot-dragging simply because physicians do not want to be seen engaging in it (e.g., Kandel and Lazear, 1992; Mas and Moretti, 2009).

3.1 Stylized Pod Environment

Consider the following simple game of asymmetric information: Two physicians $j \in \{1, 2\}$ include administrative costs (e.g., paying non-clinical staff, rent, depreciation, and overhead).
work in a single pod at the same time. They each have one patient, entailing a low or high workload. In addition to the time that they take on their current patients, physicians also care about new work – a third patient – that might be assigned to one of them. Physician utility is given by

$$u_j^P = \left( t_j - \theta_j \right)^2 - K_P(\theta_j) \mathbb{1}\{J(3) = j\},$$

(3.1)

where $t_j$ is the time that physician $j$ keeps his initial patient, $\theta_j \in \{\theta, \bar{\theta}\}$ is the workload entailed by his initial patient (where $\bar{\theta} > \theta > 0$), $K_P(\theta_j) > 0$ is the cost of getting a potential third patient conditional on $\theta_j$, and $J(3)$ denotes the physician who gets the third patient.

Type $\theta$ occurs with probability $p$, and type $\bar{\theta}$ occur with probability $1 - p$. Types are never observed by the triage nurse, but with probability $\psi$, peers can observe each other’s initial patient types. In contrast, the number of patients of each physician (his census, $c_j \in \{0, 1\}$) is public information at any time. The action that each physician takes is $t_j$. Absent any strategic behavior, each physician would like to discharge his patient at $t_j = \theta_j$, which I also assume is the socially optimal time for treatment and generically captures all concerns of care (e.g., patient health and satisfaction, malpractice concerns, physician effort and boredom). Because patient assignment depends on the organizational system, I discuss the triage nurse and assignment further in the following subsections.

The physician assigned the new patient incurs a cost, which depends on his initial workload, $\theta_j$. I specify this cost as $K_P(\theta) = K_P$ and $K_P(\bar{\theta}) = \bar{K}_P$, where $\bar{K}_P > K_P > 0$. This reflects the idea that neither physician would like to get the new patient, but that it is more costly for a busy physician, either because he must exert more additional effort or because he will have worse outcomes for this new patient.

The timing of the game is as follows:

1. At time $t = 0$ physicians each receive one patient, discovering $\theta_j \in \{\theta, \bar{\theta}\}$.

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15I thus abstract away from any principal-agent problem between physician and patient or between physician and ED in this term, other than the cost incurred by the new patient, discussed below.

16To be precise, a “busy” physician is a physician who starts with a high-workload patient (i.e., his type is $\bar{\theta}$). Merely keeping his patient longer, prolonging $t_j$, does not make a physician busier. This interpretation is supported by evidence that physicians do not provide more care for patients they are foot-dragging on, shown in Section 5.
2. Physicians simultaneously choose how long they will keep their patients, \( t_j \).

3. With probability \( \psi > 0 \), physicians observe each other’s \( \theta_j \).

4. Exactly one patient will arrive with uniform probability distributed across the time interval \( t \in [\theta, \overline{\theta}] \). When the patient arrives, this new patient is assigned to a physician by the triage nurse (in the nurse-managed system) or the physicians themselves (in the self-managed system).

5. Physicians complete their work on the one or two patients under their care and end their shifts. They receive payoffs given in Equation (3.1).

This model highlights the tension between using signals (censuses \( c_j \)) of private information (types \( \theta_j \)) for patient assignment and the fact that these signals can be distorted (through \( t_j \)). Regardless of their type, physicians prefer to avoid new work (through \( K_P(\theta) > 0 \)), but otherwise I assume that physicians have no incentive to keep patients longer than socially optimal. Although the triage nurse never observes the physicians’ types, physicians observe each other’s types with probability \( \psi \). This superior information allows greater efficiency through two separate pathways – self-management and social incentives – discussed below.

3.2 Nurse-managed System

In the nurse-managed system, the triage nurse assigns the new patient to a physician. In my baseline model, I assume that physicians cannot report their types or anything else to the triage nurse, but that the triage nurse can credibly commit to an assignment policy prior to physicians receiving their patients. I believe that this scenario is most realistic: Physicians will find it difficult to describe their workloads in practice, but an assignment policy based on censuses is easily observable, relatively simple, and can be enforced in a repeated game.\(^{17}\)

\(^{17}\)In Appendix B-2, I consider two alternative scenarios: (1) the pure signaling game which allows neither physicians to report their types nor the triage nurse to commit to an assignment policy, and (2) the mechanism design game (without transfers) which allows physicians to report types and the triage nurse to commit to
The triage nurse’s utility is

\[ u^N = -D \sum_{j \in \{1, 2\}} (t_j - \theta_j)^2 - K_N(\theta_{J(3)}) \],

which is similar to but potentially different from that of the physicians. \( D \) is an indicator that allows the triage nurse to care about the treatment times of the first two patients as outcomes (if \( D = 1 \)). Remember that the socially optimal discharge times for patients is \( t_j = \theta_j \), which is universally agreed upon.

The second term, \( K_N(\theta) \), is the cost of assigning the new patient to a physician whose initial patient is of type \( \theta \), specified as \( K_N(\theta) = 0 \) and \( K_N(\overline{\theta}) = \overline{K}_N \), where \( \overline{K}_N > 0 \). As before, this represents some relative cost (now to the triage nurse) in assigning the new patient to a physician with greater workload, because that physician will take more time or provide lower quality of care. I do not restrict the the value of \( \overline{K}_N \) relative to \( K_P - K_P \).

18 At \( t = 0 \), the triage nurse commits to an assignment policy function \( \pi(c_1, c_2) \), with censuses \( c_j \in \{0, 1\} \). To simplify the analysis, I impose a symmetric policy function with \( \pi(0, 0) = \pi(1, 1) = \frac{1}{2} \) and \( \pi \equiv \pi(0, 1) = 1 - \pi(1, 0) \). That is, when both physicians have equal censuses, the triage nurse should have no preference to send the new patient to one physician or the other, since she has no other information about who is less busy at that time. Note that \( \pi = 1 \) represents what I mean by ex post efficiency, since the triage nurse can infer that if \( c_j = 0 \) and \( c_{-j} = 1 \), then \( j \) certainly had the lower workload.

I use a Perfect Bayesian Equilibrium as the equilibrium concept. In equilibrium, the triage nurse chooses the optimal assignment policy, summarized by \( \pi^* \equiv \pi^*(0, 1) \), given physician discharge strategies \( t^* \) and \( \overline{t}^* \) for initial patients of type \( \theta \) and \( \overline{\theta} \), respectively. Given \( \pi^* \), physicians choose optimal discharge strategies \( t^* \) and \( \overline{t}^* \).

**Proposition 1.** In the Perfect Bayesian Equilibrium for the nurse-managed system, physicians with \( \theta \) and \( \overline{\theta} \) discharge their patients at \( t^* > \theta \) and \( \overline{t}^* = \overline{\theta} \), respectively, and the triage nurse a policy. Results are similar, but not surprisingly, reporting and commitment as additional capabilities both improve efficiency.

\^Note also that if \( D = 0 \), then it does not matter what value \( \overline{K}_N \) takes, as long as it is some positive number.
assigns the new patient to the physician with census 0, when the other physician has census 1, with some probability \( \pi^* \) between \( \frac{1}{2} \) and 1.

First note that the triage nurse will never want to send the new patient with greater probability to a physician with \( c_j > c_{-j} \). So physicians with high-type patients will never want to mimic those with low-type patients and will choose \( t^* = \vartheta \). But physicians with low-type patients have some reason to mimic having high-type ones. For a given \( \pi \equiv \pi (0, 1) \) previously chosen by the triage nurse, the optimization problem of physicians with \( \theta \),

\[
\max_{t_j} \mathbb{E} \left[ u_j^P (t_j; \pi, \theta) \right],
\]

yields the first-order condition

\[
t^* = \theta + \frac{K_p}{2(\vartheta - \theta)} \left( \pi - \frac{1}{2} \right). \tag{3.3}
\]

For physicians with \( \theta \), there is a first-order gain in temporary mimicry of having \( \vartheta \) relative to a second-order loss, as long as \( \pi > \frac{1}{2} \). In other words, as long as the triage nurse is more likely to send the new patient to a physician she believes is less busy, physicians with \( \theta \) will foot-drag to mimic those with \( \vartheta \).\textsuperscript{19}

The triage nurse commits to \( \pi^* \) that maximizes her expected utility given \( t^* \) and \( \vartheta^* \). Substituting (3.3) into her expected utility and solving the first-order condition yields \( \pi^* \). For simplicity, I present the expression for \( \pi^* \) if \( D = 0 \):

\[
\pi^* = \frac{1}{2} + \frac{(\vartheta - \theta)^2}{K_p} . \tag{3.4}
\]

Equation (3.4) shows that the nurse’s choice of \( \pi \) depends on the cost of getting the new patient for the physician with lower workload, because of his temptation to foot-drag. As this temptation increases, it is optimal for the triage nurse to decrease ex post assignment efficiency, \( \pi^* \). In Appendix B-2.3, I show that \( \pi^* \) is even lower if \( D = 1 \): If the triage nurse also cares about lengths of stay, which is more realistic, then the triage nurse puts even less weight on the physicians’ censuses when assigning the new patient.

\textsuperscript{19}A nice feature of this simple two-type model is that the first-order condition does not depend on what the peer’s type or strategy is, because there is only one patient each and thus one policy parameter \( \pi \). Keeping this initial patient longer by \( dt \) decreases the likelihood of getting the new patient by \( (\pi - \frac{1}{2}) dt / (\vartheta - \theta) \) regardless of the peer’s census. For this reason, parameters like \( p \) do not matter. This is shown in detail in Appendix B-2.1.
The important general point is that the triage nurse may commit to an *ex post* inefficient assignment policy function, $\pi^* < 1$. Even if she wants to optimize only the assignment of the third patient, this policy may improve her expected utility, which is similar to Milgrom and Roberts’ (1988) result that managers can be better off if they commit not to listen to subordinates who could undertake costly “influence activities.” This commitment increases triage-nurse utility by decreasing foot-dragging, shown in Appendix B-2.

The assumption of a single patient arriving in the interval $t \in [\theta, \overline{\theta}]$ is convenient for representing the temptation of moral hazard for physicians with $\theta$. However, in practice there are of course many new patients, and I identify foot-dragging as the response of lengths of stay to the flow of expected future work, defined in terms of *numbers* of patients arriving at the ED triage. To capture this intuition, I can extend the model by changing the interval over which the single patient is expected to arrive, which results in replacing the interval $\overline{\theta} - \theta$ in the denominator of Equation (3.3) with some $\Delta t \leq \overline{\theta} - \theta$, as long as $t^* \approx \overline{\theta} - \theta$ is an interior solution. I show details in Appendix B-2.5, but the intuition is straightforward. With an infinite flow of patients to the ED (as $\Delta t \to 0$), physicians should expect to get a new patient the minute they discharge one. With no expected future patients (as $\Delta t \to \infty$), there is no incentive to foot-drag.

### 3.3 Self-managed System

For the self-managed system, I assume the same physician utilities and information structure as in the nurse-managed system. The only difference is that the two physicians, not a triage nurse, are responsible for deciding who gets the new patient. Physicians choose both $t_j$ and an action that determines the assignment of the new patient. I consider two microfoundations of this assignment action in the self-managed system, both continuing the baseline assumption that physicians cannot report their types.\(^{20}\) In one microfoundation, each physician may only decide whether to choose an unattended patient at each point in time. Alternatively, physicians may commit to an assignment policy that uses not only censuses but also observations of true

\(^{20}\)In Appendix B-3.3, I consider the case in which physicians can report their types to each other. This mirrors the case of physician reporting in the nurse-managed system, in Appendix B-2.4. In both cases, reporting improves efficiency.
workload, which are available with probability $\psi$. I present a brief discussion of results below; details and derivation are in Appendix B-3.

**Proposition 2.** Consider the Perfect Bayesian Equilibrium for the self-managed system. If physicians cannot commit to a policy function, there will be no foot-dragging or ex post inefficient assignment, but some free-riding if $\psi < 1$. If physicians can commit to a policy function, and if $\psi > 0$, $K_P - K_P > K_N$, and $D = 1$, then there will be less foot-dragging and more ex post efficient assignment, relative to the nurse-managed system, and no free-riding.

Without physician commitment to an assignment policy, physicians play a war of attrition (e.g., Bliss and Nalebuff, 1984), both incurring a cost by the new patient remaining unattended after arrival, which I specify in detail in Appendix B-3.1. If types are observed and different, the physician with $\theta$ will choose the new patient immediately upon arrival by subgame-perfect reasoning similar to Rubinstein (1982). There is no point in waiting if he knows that his peer will wait longer (because the peer with $\overline{\theta}$ has a higher cost of accepting the new patient). On the other hand, if they do not observe each other’s types, or if they observe that they have the same type, then they engage in free-riding, inefficiently leaving the new patient unattended with some probability. Physicians with $\overline{\theta}$ refrain from choosing the new patient with any probability if there is a chance their peer has $\theta$. Thus, there is no foot-dragging by physicians with $\overline{\theta}$, because it never reduces the chances of getting the new patient.\(^{21}\)

In the second microfoundation, physicians commit to an assignment policy similar to the triage nurse’s assignment commitment in the nurse-managed system. However, with probability $\psi$, physicians can use each other’s observed types to assign the new patient, and in this event, foot-dragging will have no effect on assignment. This chance, however small, lowers the attractiveness of foot-dragging. With probability $1 - \psi$, physicians follow an assignment policy chosen to maximize their ex ante expected utility with the knowledge that the new patient is more costly for a busy physician but that, upon discovering they are less busy, they will still

\(^{21}\)In Appendix B-3.1.4, I discuss that there is some foot-dragging with continuous types, but that foot-dragging will still be less than in the nurse-managed system with no triage nurse commitment, in Appendix B-2.3.
foot-drag. They can afford to commit to an assignment policy with greater \textit{ex post} efficiency than the triage nurse’s in the nurse-managed system, primarily because foot-dragging is less of a threat with more information on true workloads.\footnote{In Appendix B-3.2, I show that another reason for improved \textit{ex post} assignment inefficiency is that physicians are likely to care relatively more about inefficient assignment than the triage nurse (i.e., $\Delta K_P > \overline{K}_N$), since the cost of inefficient assignment is scaled relative to treating their own patients, while the triage nurse scales this relative to treating all patients.}

In summary, under both microfoundations (with reasonable parameters in the commitment case), physicians foot-drag less, and the new patient is given more often to a physician with lower workload. I consider both microfoundations because the truth likely lies in between: Physicians are not forced to see patients in the self-managed system, but they very likely have a strong cultural norm that quickly assigns patients in order to prevent patients from waiting in the pod unattended for too long. The model also predicts little free-riding with sufficient physician information (high $\psi$), commitment, or costs of leaving patients unattended.

The key point is that information between physicians reduces the usefulness of moral hazard to avoid new work and improves assignment efficiency because physician actions determine assignment. It is useful to contrast this with social incentives, which also reduce moral hazard by information between peers. A growing empirical literature suggests that social incentives operate because peers incur a social cost when seen engaging in moral hazard (Bandiera et al., 2005, 2009; Mas and Moretti, 2009; Jackson and Schneider, 2010).\footnote{Social incentives have also been considered theoretically (Kandel and Lazear, 1992). It is straightforward to modify physician utility in (3.1) such that their expected utility includes a term $\psi S(\cdot)$, where $S(\cdot)$ are social costs incurred conditional on being seen foot-dragging, that reduces foot-dragging.} Note that self-management can improve efficiency without social incentives and that social incentives may operate in the nurse-managed system. Nevertheless, because self-management and social incentives both depend on superior information between peers, peer effects on foot-dragging, examined in Section 6, are a useful test of both social costs and superior information between peers ($\psi > 0$).

\section{Overall Effect of the Self-managed System}

In this section, I estimate the overall effect of the self-managed system on a given team
of providers and on a given patient. I specifically ask the following: If the same patient and providers were assigned to each other in a different organizational system, what would their outcomes be? I can control for pod-specific time-invariant unobservable differences by the fact that I observe one of the two pods (Bravo) switching from a nurse-managed system to a self-managed one. I can also control for providers because I observe essentially all providers – physicians, residents, and nurses – working in both pods over time. Of course, I do not observe the same patient visit in both pods, but I can condition on a rich set of patient characteristics.

As my baseline analysis, I estimate the following equation:

\[ Y_{ijkpt} = \alpha \text{Self}_{pt} + \beta X_{it} + \zeta_p + \eta_t + \nu_{jk} + \varepsilon_{ijkpt}, \]  

where outcome \( Y_{ijkpt} \) is indexed for patient \( i \), physician \( j \), resident-nurse \( k \), pod \( p \), and arrival time \( t \). The variable of interest in Equation (4.1) is \( \text{Self}_{pt} \), which indicates whether pod \( p \) had a self-managed system at time \( t \). It also controls for patient characteristics \( X_{it} \), pod identities \( \zeta_p \), a sum of fixed effects for time categories \( \eta_t \) (for month-year, day of the week, and hour of the day), and physician-resident-nurse trio identities \( \nu_{jk} \). By controlling for observable patient characteristics and provider identities, I only require parallel trends in outcomes conditional on this additional information (Abadie, 2005).\(^{24}\)

Because I cannot control for patient unobservables, I assume that average unobserved characteristics of patients sent to Alpha versus Bravo did not change over time. In Table 3, I estimate several versions of (4.1), including progressively more controls for patient characteristics. The estimate for the effect of self-managed teams on log length of stay remains stable (and slightly increases in magnitude) from -10% to -13% upon adding a progressively rich set of controls. This is consistent with the fact that sicker patients were sent to Bravo pod over time (see Appendix Figure A-2.1) and suggests that unobserved characteristics may follow the same pattern.

This overall effect represents a significant difference in length of stay due to a simple organizational change in which physicians assign work among themselves, while the physicians

\(^{24}\)As discussed in Section 2, there were secular trends between the two pods. Specifically, more and sicker patients were sent to Bravo pod over time, and new nurses generally spent more time in Bravo pod to fill the need of higher volume. I show unconditional results and discuss this in Appendix A-2.
themselves and financial incentives were held fixed. As a comparison, this effect is roughly equivalent to one standard deviation in physician productivity fixed effects: Physicians who are one standard deviation faster than average have lengths of stay that are about 11% shorter. Given average lengths of stay, the self-managed-system effect is equivalent to a reduction in lengths of stay by 20-25 minutes per patient, and under simple assumptions, it represents a $570,000 yearly savings to this single ED.\textsuperscript{25}

While I find a significant effect of self-managed teams on length of stay, I find no statistically significant effect on quality outcomes (30-day mortality, hospital admissions, 14-day bounce-backs) and financial/utilization outcomes (RVUs and total direct costs), shown in Table 4.\textsuperscript{26} Alternative mechanisms of free-riding and advantageous selection could affect the quality of care and utilization, because they mean that specific patients either are being made to wait for care or are seen by physicians who are better suited (or more available) to see them. In contrast, under pure foot-dragging, only the \textit{discharge} of patients is delayed in order to prevent more work. Foot-dragging should not result in different quality or utilization between the self-managed and nurse-managed systems, because any impact through waiting times would be shared by all patients in the ED. Thus, the lack of effect on quality, revenue, and utilization between the two systems is more consistent with pure foot-dragging than the other mechanisms.

Any statement on quality, however, is limited by relatively imprecise estimates for mortality and bounce-backs. More direct evidence of foot-dragging is shown in the next section. Nevertheless, estimates for RVUs and costs are quite precisely estimated and rule out 2-5% relative changes. For example, given the current dollar conversion of about $34 per RVU, the average ED patient represents about $92 in revenue, while the effect of self-management on revenue is only -$0.51 (95% CI -$2.38 to $1.36). With no change in revenue or costs per patient, delaying the discharge of patients thus unambiguously decreases productivity from a financial perspective.

Table 4 also reports the effect on the time to the first physician order, which I use as a proxy

\textsuperscript{25}For this back-of-the-envelope calculation, I simply assume that ED patient volume is exogenous and that the ED is able to reduce the number of physician-hours, given improved throughput, to meet the volume. By allowing more patients to be seen for a given number of physician-hours, the $570,000 yearly saving to this ED derives from $4.4 million yearly spending in physician hourly salaries (26,280 physician-hours per year at about $167 per physician-hour). This gain ignores reduced waiting times and improved outcomes shared by all ED patients.

\textsuperscript{26}While I can rule out 0.8% increase in mortality, this is relatively large compared to the baseline 2.0% mortality. Effects are more precisely estimated for other outcomes, and I can rule out 4% relative increases in revenue and costs.
for the time between patient arrival at the pod and the patient first being seen by a physician. Significant free-riding would imply a positive coefficient for the self-managed system with respect to this proxy. However, the effect of the self-managed system on this measure is insignificantly different from 0 and slightly negative, indicating no significant free-riding.

The effect on length of stay due to Bravo’s regime change to a self-managed system can also be seen graphically. Figure 4 shows month-year-pod fixed effects over time for the two pods estimated by this equation:

\[
Y_{ijkt} = \sum_{m=1}^{M} \sum_{y=1}^{Y} \alpha_{mym} I_{t \in m} I_{t \in y} + \beta X_{it} + \gamma_{t} + \nu_{jk} + \varepsilon_{ijkt},
\]

where the parameters of interest \( \alpha_{mym} \) are fixed effects for each month, year, and pod interaction; \( I_{t \in m} \) and \( I_{t \in y} \) are indicator functions for \( t \) belonging to month \( m \) and year \( y \), respectively; and \( \gamma_{t} \) is a revised sum of time category fixed effects that only includes day of the week and hour of the day. In Figure 4, there is a persistent discontinuity at the regime change that is consistent with my baseline estimates in Table 3 that self-managed teams in Bravo decreased patient lengths of stay. In addition, Figure 4 shows that trends in log length of stay in the two pods are conditionally parallel, which is the identifying assumption for Equation (4.1).

An issue that arises in difference-in-differences estimation is the construction of appropriate standard errors for inference (Bertrand et al., 2004).27 My baseline specification clusters standard errors by physician, which is equivalent to an experiment sampling at the level of physicians, who are given shifts that translate to pods and organizational systems, before and after the regime change in Bravo. This is the thought experiment I wish to consider, as the same physicians are in both pods before and after the regime change, and as shifts are assigned randomly, conditional on rough time categories.

Still, there is the additional statistical issue of unobserved and potentially correlated pod-level shocks over time. Therefore, I consider two alternative thought experiments for inference, both of which exploit the long time series and can be understood Figure 4. First, I address sampling variation at the pod level across time but with a more parametric form, assuming a

\[\text{Footnote: 27 This issue is largely only relevant to standard errors for the overall effect. Specific mechanisms use additional variation. In particular, foot-dragging relies on the effect of due to exogenous variation in expected future work.}\]
month-year-pod shock that is correlated by a first-order autoregressive process across months within pod. Second, in the spirit of systematic placebo tests (Abadie et al., 2011; Abadie, 2010) and randomization inference (Rosenbaum, 2002), I consider the thought experiment that, under the sharp null of no effect of self-managed teams, there should be no significant difference between my obtained estimates and those I would obtain if I consider placebo regime changes over pod and month. This placebo approach considers randomization at the level of treatment rather than sampling. Detailed in Appendix A-2, both approaches yield a high degree of statistical significance, with $p$-values less than 0.01.

5 Main Evidence of Foot-dragging

This section identifies the mechanism of foot-dragging with the following intuition: The expected gains to physicians by foot-dragging depend on expectations of future work. If no further patients arrive at the ED, then foot-dragging is not needed to prevent new work. But if there is an endless supply of patients waiting to be seen, then discharging a patient directly leads to having to see another one, and the incentive to foot-drag is extremely strong. I thus identify and quantify foot-dragging by increases in lengths of stay as expected future work increases. I measure expectations of future work as a function of the number of patients arriving at the ED.

Conceptually, other than through the moral hazard of foot-dragging, there is no other reason why lengths of stay should increase with expected future work, holding actual work constant.\textsuperscript{28} I therefore interpret increasing length of stay with expected future work as evidence of foot-dragging. I hold this interpretation regardless of organizational system, but I am also interested in comparing foot-dragging between organizational systems. Also, as outlined in Section 3 above, it is important to note that the costs of foot-dragging derive from both direct moral hazard and inefficient assignment that results from this moral hazard. Both of these are directly related to expectations of future work, and both are jointly determined in equilibrium. I do not separately identify these effects here, but I separately address assignment in Section 7.

\textsuperscript{28}When both pods are open, patients that arrive at the ED while the index patient has just arrived at the pod may be sent to either pod. This allows me to separate expectations of future work (the number of patients arriving at the ED) from actual future work (the number of patients who will arrive at the pod). I discuss this further below.
For my baseline estimation of foot-dragging, I use equations of the following form:

\[ Y_{ijkpt} = \alpha_1 EDWork_t + \alpha_2 Self_{pt} \cdot EDWork_t + \alpha_3 Self_{pt} + \beta X_{it} + \zeta_p + \eta_t + \nu_{jk} + \epsilon_{ijkpt}, \]  

(5.1)

for log length of stay \( Y_{ijkpt} \) for patient \( i \), physician \( j \), resident and nurse \( k \), pod \( p \), and time \( t \). As before, \( Self_{pt} \) indicates whether pod \( p \) at time \( t \) was self-managed, \( X_{it} \) controls for patient characteristics, \( \zeta_p \) controls for time-invariant pod unobservables, \( \eta_t \) is a sum of time-category fixed effects (month-year interaction, day of the week, hour of the day), and \( \nu_{jk} \) controls for the provider-trio.

\( EDWork_t \) represents expected future work, defined in two ways. First, I consider ED arrival volume, defined as the number of patients arriving at triage in the hour prior to patient \( i \)'s arrival at the pod. The arrival of these patients is not controlled by physicians. They are seen by physicians via the computer interface, but their ultimate destination is unknown.\(^{29}\) Second, I consider waiting room census, defined as the number of patients (the census) in the waiting room at the time of patient \( i \)'s arrival at the pod. Although physicians presumably can affect the number of patients waiting, this is a more salient measure of expected future work since physicians can readily click on the computer interface to see this census. The coefficients of interest in (5.1) are \( \alpha_1 \), \( \alpha_2 \), and \( \alpha_3 \). A positive \( \alpha_1 \) indicates that physicians increase lengths of stay as expected future work increases (i.e., they foot-drag) in the nurse-managed system, while a negative \( \alpha_2 \) indicates that the self-managed system mitigates foot-dragging. Coefficient \( \alpha_3 \) represents the effect of the self-managed system after controlling for foot-dragging.

Table 5 reports estimates for (5.1), using both measures of expected future work – ED arrival volume and waiting room census. With each additional patient arriving hourly at triage or waiting in triage, lengths of stay increase by 0.6 percentage points in the nurse-managed system. The estimate of foot-dragging in the nurse-managed system is equivalent to a length-of-stay elasticity of 0.10 with respect to expected future work.\(^{30}\) The coefficient for the interaction

\(^{29}\)Given average waiting times and the average length of stay, most patients will not even be assigned until after patient \( i \) is discharged. My results are also robust to alternative time windows for this measure.

\(^{30}\)I estimate this by using log measures of expected future work as \( EDWork_t \). My preferred specification, shown in Table 5, does not take logs of expected future work because it is roughly normally distributed. However, results
between expected future work and the self-managed system suggests that this effect is entirely mitigated in the self-managed system. That is, an additional patient in either measure of expected future work does not affect lengths of stay in the self-managed system. After controlling for foot-dragging, the coefficient representing the effect of the self-managed system is statistically insignificant in all specifications and ranges from -1% to 3%. In addition to the baseline specification in (5.1), I also include a number of controls for physician workload with pod-level volume at the time of patient arrival. Results are robust to including these controls.

These results suggest substantial foot-dragging in nurse-managed teams and equally large mitigation of it in self-managed teams. Estimates are robust under both measures of expected future work – ED arrival volume and waiting room census. Controlling for actual current or future pod-level work does not change results, suggesting that increased patient lengths of stay are due to expectations of future work and insensitive to actual current or future workloads. Again, this distinguishes foot-dragging from other mechanisms of free-riding or advantageous selection. Without the moral hazard of seeking to prevent future work, physicians should not increase lengths of stay as expected future work increases. In contrast, the other mechanisms should only depend on actual work that reaches the pod. \(^{31}\) Finally, the remaining effect of the self-managed system is insignificant, suggesting that foot-dragging is quantitatively large enough to explain the difference in performance between self-managed and nurse-managed systems.

Figures 5 and 6 plot log-length-of-stay coefficients for each decile of expected future work interacted with organizational system, estimated by

\[
Y_{ijkpt} = \sum_{d=2}^{10} \alpha_0^d (1 - \text{Self}_{pt}) D_d (EDWork_t) + \sum_{d=1}^{10} \alpha_1^d \text{Self}_{pt} D_d (EDWork_t) + \beta X_{it} + \zeta_p + \eta_t + \nu_{jk} + \epsilon_{ijkpt},
\]

where \(D_d (EDWork_t)\) equals 1 if \(EDWork_t\) is the \(d\)th decile, measured as ED arrival volume and

\(^{31}\)Actual work is highly pod-specific. Two potential exceptions of spillovers between pods are waiting for a radiology test or a hospital bed. However, I find no difference in foot-dragging between patients based on likelihood, estimated by patient characteristics, to receive radiology tests. Table 6 also shows that radiology testing is unaffected by expected future work. The time spent waiting for a hospital bed is excluded from my measure of length of stay, since I record the time of the discharge order. In contrast, Table 6 shows that outcomes like admission, which are not supposed to be affected by foot-dragging, suggest spillovers from hospital congestion equally in both organizational systems.
waiting room census, respectively. The coefficients \( \{ \alpha_0^2, \ldots, \alpha_{10}^2; \alpha_1^1, \ldots, \alpha_{10}^1 \} \) can be interpreted as the relative expected length of stay for patients in different organizational systems and under different states of expected future work, where the expected length of stay for patients in the nurse-managed system and under the first decile of expected future work is normalized to 0. As shown in Figures 5 and 6, lengths of stay progressively increase in the nurse-managed system as expected future work increases, which is consistent with the intuition that the incentive to foot-drag continues to grow as expected future work increases. The self-managed team has roughly the same expected length of stay as the nurse-managed team at low patient volumes, but its expected length of stay does not change with patient volume.

My measures of expected future work are likely to be noisy representations of physicians’ true expectations of future work (e.g., they may expect more patients even when there is no one in the waiting room).\(^32\) Therefore this estimate is a lower bound on true foot-dragging: It is biased downward to the extent that I do not capture true expectations of future work. In addition, I interpret any increase in length of stay with expected future work as foot-dragging. But it may reasonable to think that physicians in the absence of moral hazard should actually work faster, for example if they care about patients waiting too long in the waiting room. This is another sense in which my interpretation is a conservative benchmark: It assumes that, under no foot-dragging, there is either no attention to future work or no reason to work faster when future work increases. Note that since length of stay does not increase with expected future work in the self-managed system, foot-dragging relative to 0 and foot-dragging relative to self-managed teams are roughly the same in magnitude.\(^33\)

I also estimate the baseline equation for foot-dragging, Equation (5.1), for other outcomes and process measures: 30-day mortality, admissions, 14-day bounce-backs, RVUs, total direct costs, and a host of detailed process measures including laboratory, medication, and radiology orders. I show a subset of these outcomes and process measures in Table 6. I find no differential effect

\(^{32}\)Note also that I do not use expectations based on the usual volume for the time of the day or day of the week, which are absorbed by time fixed effects.

\(^{33}\)Another support for this interpretation is the fact, shown in Section 6.1, that length of stay does not respond to expected future work when there is only one physician in the ED. With only one physician in the ED, there is no other physician present to foot-drag against. However, the physician may still foot-drag against future physicians, delaying discharge so that future work goes to physicians who are not yet there, and I technically cannot separate expected future work from actual future work, given that there is only one pod open.
of expected future work between the two systems on any of these outcomes or process measures. Some outcomes do reflect a slight effect of ED arrival volume through hospital congestion for both systems, such as on hospital admissions and total costs, which include costs incurred in admissions. Foot-dragging effects on process measures are tightly estimated and show that the care provided while foot-dragging is not substantively different between the two systems. For example, under typical levels of ED arrival volume, I can rule out that the total order count increases by 0.4 in the nurse-managed system relative to the self-managed system, which represents a 3.3% increase against the average order count of 13. This is also consistent with pure foot-dragging, which delays the time of patient discharge but does not increase the quality or content of medical care.

6 Peer Effects on Foot-dragging

Foot-dragging could be reduced if physicians have more information about each other than the triage nurse has and if they also care about being seen foot-dragging. In this section, I explore peer effects on foot-dragging, as a joint test of more information between peers and social incentives, using three different types of analyses.34

First, I examine foot-dragging when there is a peer in the pod compared to when there is no peer in the pod but a physician working elsewhere in the ED. In the nurse-managed system, without social incentives, foot-dragging should not be affected by the location of other physicians. I use two additional settings – physicians working in a pod that is officially “self-managed” but without a peer, and physicians working alone in the entire ED – as falsification tests for my identification of foot-dragging. Second, I explore whether the type of peer present matters for foot-dragging in nurse-managed and self-managed teams as a test of heterogeneous social incentives across peer types. Third, I examine whether foot-dragging differs depending on a physician’s census and that of his peer, as a test of either strategic behavior or conditional

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34Peer effects on foot-dragging are the effect of a peer interacted with expected future work; it isolates the effect of peers on foot-dragging moral hazard. In contrast, generic peer effects are simply the direct effect of a peer and could act through a variety of mechanisms, such as productivity spillovers. I discuss more generic peer effects in Appendix A-3.1, where I show results similar to Mas and Moretti (2009) (i.e., productive peers increase the productivity of physicians).
social incentives.

6.1 Presence of a Peer

While physicians usually work in pods with a peer, during certain times on shift, physicians find themselves working without a peer. This is because shifts in each pod are staggered and because staffing adjusts upward in the morning when patient volume increases and downward in the night when it decreases. Such scheduling allows me to identify how physicians respond to the presence or absence of a peer.

In the nurse-managed system, only social incentives and more information between peers can explain the dependence of foot-dragging on the location of coworkers. That is, the total amount of future work and the number of physicians among whom to divide the work are sufficient statistics for foot-dragging unless if physicians care about being seen foot-dragging and if more information can be observed by peers working together in the same pod. In addition, two similar analyses can serve as falsification tests for the identification of foot-dragging by increases in length of stay with expected future work. First, when a physician in a self-managed pod is without a peer, he is effectively in a nurse-managed system: Every patient who arrives is in fact assigned to him by the triage nurse. The physician should then exhibit foot-dragging behavior as if working in the nurse-managed system (and without a peer). Second, when there is only one physician in the entire ED, there is essentially no assignment problem. That physician is responsible for all patients who arrive at the ED. With no coworker to foot-drag against, physicians have no incentive for foot-dragging.

In Table 7, I present results for regressions of the form

$$Y_{ijkt} = \alpha_1 EDWork_t + \alpha_2 NoPeer_{jt} \cdot EDWork_t + \alpha_3 NoPeer_{jt} + \beta X_{it} + \zeta_p + \eta_p + \nu_{jk} + \epsilon_{ijkt},$$

(6.1)

for nurse-managed-team and self-managed-team samples separately. \(EDWork_t\) is ED arrival

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35Physicians can still foot-drag against future physicians, but this theoretically is no different at any other time. I cannot control for actual future work in this scenario, because all work that comes to the ED eventually goes to the same pod and physician. However, this would only bias measured foot-dragging upwards if the omitted volume of actual work is positively correlated with expected future work and increases length of stay.
volume, or the number of patients arriving at ED triage in the hour prior to the index patient’s arrival at the pod, and NoPeer\(_{jt}\) is a dummy for whether physician \(j\) has no peer in the same pod. These regressions test behavioral responses by physicians within a system, depending on peer presence. I estimate Equation (6.1) only when there are at least two physicians in the ED, so that foot-dragging always entails a negative externality against a current coworker. I also perform the pooled regression

\[
Y_{ijkpt} = \sum_{s=1}^{4} 1(\text{PeerState}_{jt} = s) (\alpha_s EDWork_t + \delta_s) + \beta X_{it} + \zeta_p + \eta_t + \nu_{jk} + \epsilon_{ijkpt},
\]

which estimates the degree of foot-dragging with coefficient \(\alpha_s\) for each of four peer states \(s \in \{1, \ldots, 4\}\): alone in a pod but not alone in the ED, with a peer in the nurse-managed system, with a peer in the self-managed system, and alone in the ED.

Results in Table 7 are consistent with previously estimated coefficients for the increase in length of stay with expected future work, shown in Table 5, in both systems when a peer is present. When a peer is not present, however, length of stay increases much more quickly with expected future work. Estimates in the first two columns suggest that, without a peer present, the response to expected future work quintuples in the nurse-managed pod and increases in the self-managed pod (but effective nurse-managed system) to almost triple the magnitude as in the nurse-managed system with a peer. Results from the pooled regression in Equation (6.2), shown in the third column of Table 7, confirm this and show that physicians do not increase lengths of stay with expected future work when they are alone in the ED.

These results suggest that physicians reduce their foot-dragging when a peer is present, which is consistent with social incentives and the fact that peers can observe each other’s true workloads better than physicians in different locations. Additionally, results from the two falsification tests, in the second and third columns of Table 7, are consistent with the interpretation of increases in length of stay with expected future work as foot-dragging, a moral hazard reduced by social incentives and self-management. First, physicians working without a peer in an officially self-managed pod (but effectively nurse-managed system) engage in foot-dragging to triple the extent
of those working with a peer in a nurse-managed pod. Second, when a single physician is responsible for all patients entering the ED, I find no evidence of foot-dragging.

It is unlikely that these large effects can be explained by anything other than peer effects on foot-dragging. First, both regressions (6.1) and (6.2) include time dummies for hour of the day. More generally, the coefficients of interest in these regressions (and all other regressions identifying foot-dragging) correspond to responses of length of stay to expected future work, rather than levels of length of stay. Second, essentially all observations with only one physician in a pod occur during transition times of two to three hours during shifts in which the same physician works with a peer. The effect is thus identified by behavior of the same physician in the same shift, but only under different peer conditions. Third, ED conditions are generally unchanged in this short window of time relative to nearby times. One obvious change when a peer leaves is that the ED workload is distributed among physicians who are one fewer. However, results are qualitatively unchanged when normalizing measures of expected future work for the number of physicians in the ED.

6.2 Peer Type

Given that foot-dragging is reduced by the presence of a peer, I next consider different types of social relationships between physicians and their peers. Since social connectedness, driven by demographics or shared history, has been shown to influence peer effects (Bandiera et al., 2010, 2005; Jackson and Schneider, 2010), I first consider peers of the same sex, similar age, or same place of residency training as potentially more connected to each other. Second, I consider peers who are faster (or more productive) than median. The effect of this peer type on foot-dragging may include both social and strategic concerns. To see the strategic concerns, note that slower peers will cause more work to be redirected to physicians unless they slow down as well.36 Third, I consider peers, by their history of time working with each other, who are more familiar with each other’s workplace behavior and more likely to have established reputations with each other.37 Finally, I consider peers who have at least two years greater tenure than the

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36 In addition to these mechanisms for peer effects on foot-dragging, there are other mechanisms for direct peer effects. See footnote 34 and Appendix A-3.1.
37 I use a threshold of at least 60 hours working in the same pod, which is at the 75th percentile, to describe peers
index physician. Social hierarchy is a common feature in many workplaces, particularly those with professionals, long tenures, or strong work cultures. To my knowledge, the peer effects due to hierarchical social relationships has not yet been studied in economics.

For each of these peer types, I estimate regressions of the following form:

\[
Y_{ijkpt} = \alpha_1 EDWork_t + \alpha_2 PeerType_{jt}^m \cdot EDWork_t + \alpha_3 PeerType_{jt}^m + \beta X_{it} + \zeta_p + \eta_t + \nu_{jk} + \varepsilon_{ijkpt},
\]

(6.3)

separately for nurse-managed and self-managed samples. \(PeerType_{jt}^m\) is an indicator that the peer for physician \(j\) at time \(t\) is of type \(m\). I am interested in the coefficient \(\alpha_2\) as the effect of working with a peer type on foot-dragging, again identified by increases in length of stay with respect to expected future work.

Table 8 reports results for three of the peer types.\(^{38}\) Senior peers are the only peer type showing a significant effect on foot-dragging. In the nurse-managed system, working with a senior peer decreases foot-dragging by half, from an increase of 0.8% for each patient arriving at the ED to an increase of 0.4%. In a pooled regression shown in the third column, it also appears that senior peers further reduce foot-dragging in the self-managed system.\(^{39}\) Other peer types – highly productive peers, familiar peers, and connected peers – show no significantly differential effect on foot-dragging. These results suggest that the most important social relationships between peers may be unilateral ones based on hierarchy, as opposed to ones that are based on connectedness or familiarity.

The effect of peer relationships on efficiency may have implications for the construction of teams. Of course, this depends on what relationships are most important. If hierarchical relationships are most important in mitigating foot-dragging, then one possible implementation that are “familiar” with each other. Given physician turnover and a large number of shift times and locations, it is relatively uncommon for two ED physicians to have longer histories working together in the same pod.

\(^{38}\) For brevity, I omit peer types related to social connectedness from Table 8, as they show no effect on foot-dragging.

\(^{39}\) The pooled regression includes interactions with the self-managed system and a direct effect for the self-managed system. I do not write out this equation above, as Equation (6.3) communicates the effect of interest in \(\alpha_2\). Recall that self-management and social incentives may independently reduce foot-dragging, and that there may be some foot-dragging in the nurse-managed system, since the 0 benchmark for no foot-dragging is conservative.
will be to have teams composed of physicians with different tenures. However, this effect appears small relative to the effect of having any peer present or of the self-managed system.

6.3 Physician and Peer Censuses

As physicians in the nurse-managed system both foot-drag and pay attention to the presence and identity of their peers, it follows that foot-dragging may also depend on the relative amount of work peers have (and beliefs about whether they might be foot-dragging). As discussed above, an important summary statistic for the state of work in a pod is the distribution of patients between a physician and his peer.

Foot-dragging as a policy that depends on own and peer censuses could be influenced by both strategic behavior and conditional social incentives. Strategically, in the nurse-managed system, censuses influence patient assignment by the triage nurse. For example, in the theoretical framework, physicians with high censuses should have less of an incentive to foot-drag because they are already unlikely to receive patients. On the other hand, socially, foot-dragging may be less acceptable to peers at certain joint censuses. In particular, an experimental literature has convincingly shown “reciprocity” in games with public goods (Fehr and Gachter, 2000), which can be explained by a social aversion toward inequity (Fehr and Schmidt, 1999).

For now, I aim to test for either strategic behavior or social incentives that are conditional on the distribution of work by measuring foot-dragging conditional on physician and peer censuses. I consider $C_{jt}$, defined as the number of patients being cared for by physician $j$ at time $t$, and the corresponding $C_{-jt}$ for his peer $-j$. I summarize these censuses into quintiles, with $QU_{jt}^m$ denoting that physician $j$’s census at time $t$ is in the $m^{th}$ quintile, and estimate the following regression:

$$Y_{ijkpt} = \sum_{m=1}^{5} \sum_{n=1}^{5} QU_{jt}^m QU_{-jt}^n (\alpha_{1}^{m,n} EDWork_t + \alpha_{2}^{m,n}) + \beta X_{it} + \zeta_p + \eta_t + \nu_{vk} + \varepsilon_{ijkpt}. \quad (6.4)$$

I assume that patients appear on physician $j$’s census once they arrive at the pod. This is certainly true in the nurse-managed system. In the self-managed system, it abstracts away from the fact that physician $j$ has to choose patients on his census when working in self-managed teams.
EDWork is again measured as ED arrival volume and represents expected future work. The general coefficient of interest, $\alpha_{1}^{m,n}$, represents the degree of foot-dragging by physician $j$ when his census is in the $m$th quintile and his peer’s census is in the $n$th quintile. As before, I interpret foot-dragging as increases in length of stay with expected future work. I estimate this model separately for nurse-managed and self-managed teams; I am interested in testing for heterogeneity in foot-dragging in the nurse-managed system, while I am mostly using the self-managed system as a falsification test for heterogeneity, as I do not expect and have not found significant foot-dragging in the self-managed system.

Table 9 presents estimated foot-dragging coefficients $\alpha_{1}^{m,n}$ from (6.4). These estimates reveal several features in the two organizational systems. First, using 0 as the benchmark for no foot-dragging, there is virtually no foot-dragging in the self-managed system, regardless of censuses. This is consistent with previously discussed findings of little to no foot-dragging in the self-managed system. Second, foot-dragging in the nurse-managed system shows remarkable dependency and predictability according to the exact joint-census state (also shown in Appendix Figure A-4.1). As predicted by strategic behavior, physicians foot-drag more when they have lower censuses. Although I do not separate strategic behavior from social incentives in this reduced-form analysis, physicians notably refrain from foot-dragging when both censuses are “normal” (i.e., in the third quintile), which suggests conditional cooperation. On the whole, however, physicians fail to refrain from foot-dragging in the nurse-managed system.

### 7 Patient Assignment and Equilibrium Building

I have shown that the self-managed system improves throughput productivity by reducing foot-dragging and that physician peers in the same pod observe more information about each other’s true workloads. In this section, I test a prediction related to the use of this information by physicians in the self-managed system to assign patients.

According to the management literature, self-managed teams improve efficiency by both “monitoring and managing work” (Pallak and Perloff, 1986). As formalized in the model discussed in Section 3, if physicians use more information about true relative workloads to choose
patients in the self-managed system, foot-dragging should not only decrease, but the \textit{ex post} assignment efficiency should also increase. That is, patients should be assigned \textit{more} often in the self-managed system than in the nurse-managed system according to censuses as signals of workload.

In addition to studying patient assignment in steady state, a related but distinct issue is how physicians built the new equilibrium after Bravo pod switched from a nurse-managed to a self-managed system.\footnote{As discussed in Gibbons and Henderson (2012), equilibria may not be immediate or obvious, and they instead might need to be “built.” They categorize reasons for this under needs to establish “credibility” and “clarity,” and they review theoretical, experimental, and case-study literature on this (e.g., Greif, 1993; Fudenberg and Levine, 1993; Weber and Camerer, 2003). I discuss this issue – of why the equilibrium in Bravo after its regime change is not immediate – more specifically later in this section.} In Figure 7, I show that foot-dragging does not immediately disappear after the switch in Bravo, by estimating the effect of expected future work, interacted with four-month interval dummies, on length of stay. Rather, it takes at least five months to disappear. Therefore, a second question relates to the assignment of patients during this transition period, and in particular whether foot-dragging physicians are more likely to get new patients.\footnote{For more discussion of how patients are assigned in the self-managed system, see Section 3.3 and Appendix B-3. Regardless of whether physicians can commit to an assignment policy and of the amount of information they observe, patients should be assigned to physicians who foot-drag with greater probability if they have lower true workloads.}

To address these questions, I study the relationship between censuses and patient assignment. Censuses are a public measure of workload, but they are signals that can be distorted by foot-dragging. A testable implication of the prediction of \textit{ex post} assignment inefficiency is that physician censuses should be \textit{less} related to new patient assignment in the nurse-managed system than in the self-managed system in equilibrium. Stated another way, this tests the theory that signals are used more efficiently in the self-managed system. Assignment during the off-equilibrium transition of Bravo pod sheds light on how the equilibrium with no foot-dragging is eventually achieved in the self-managed system. Specifically, patient assignment to physicians who foot-drag should result in a positive correlation between assignment and censuses.

I measure the correlation between censuses and new patient assignment for both pods over time. For my baseline specification, I estimate the linear probability model

\begin{equation}
I_{ijt} = \alpha \text{Census}_{jt} + \beta \text{Shift}_{jt} + \eta_j + \nu_t + \varepsilon_{ijt},
\end{equation}

(7.1)
where the outcome $I_{ijt}$ is an indicator variable for whether patient $i$, who arrives on the pod at time $t$, is assigned to physician $j$. $Census_{jt}$ denotes the number of patients under the care of physician $j$ at time $t$ and is the variable of interest. $Shift_{jt}$ includes time indicators of physician $j$’s shift at time $t$, since physicians are less likely to be assigned new patients as they near the end of their shift, regardless of their censuses. The fixed effect $\eta_j$ controls for physician identities and allows for some physicians being more likely to take new patients regardless of census or observed behavior by their peers. The fixed effect $\nu_{it}$, controlling for patient $i$ at visit $t$, ensures that two physicians could have been assigned the patient. It implies that this linear probability model is equivalent to estimating a differenced model in which the variable of interest is $Census_{jt} - Census_{jt-1}$, the difference in censuses between a physician and his peer, with a coefficient algebraically equal to $\alpha$. The coefficient $\alpha$ represents the incremental likelihood, averaged over different shift times, with which a physician is to receive a new patient for each additional patient on his census relative to his peer’s census.

Figure 8 shows a plot of coefficients $\alpha$ in (7.1) over time and in both pods. I estimate $\alpha$ over each month by using triangular kernels with 45 days on each side of the first of the month; for months immediately before and after the regime change, I only use 45 days on the side away from the regime change. Prior to the Bravo regime change, Figure 8 shows relatively stable assignment in both pods. In both systems, physicians with lower censuses are more likely to be assigned patients, but this likelihood is consistently greater in the self-managed system (Alpha) than in the nurse-managed system (Bravo). Immediately after the regime change in March 2010, assignment in Bravo shows a jump in which physicians with higher censuses are actually more likely to receive new patients. After three months, the spike reverses, and patients are again more likely to be assigned to physicians with lower censuses, even more so than prior to the regime change. Finally, Bravo’s correlation between assignment and censuses after the spike settles to the same level as Alpha’s. The qualitative features of these assignment policy functions are robust to a number of different specifications, including logit estimation, omission of physician fixed effects $\eta_j$, alternative kernel bandwidths, and controlling for other workload observables such as average patient severity.

43See Appendix Figures A-4.2 and A-4.3 for a set of plots representing the same estimates with confidence intervals.
These results show that, in equilibrium, the self-managed system improves the \textit{ex post} assignment efficiency according to publicly observable signals of workload. By measuring assignment in both pods over time, I also show that assignment is not specific to pods, but rather to the organizational systems. This is consistent with the theory in Section 3: As the threat of foot-dragging is reduced in the self-managed system by the use of more information between peers, new patients can be more readily assigned to physicians with lower censuses.\textsuperscript{44} Stated differently, foot-dragging is not reduced in the self-managed system by a trivial mechanism that ignores relative workloads.

Answering the second question – of how the new equilibrium is built during the transition period after the Bravo regime change – is admittedly more speculative. Most standard models, including mine, are silent on building new equilibria, since behavior is considered already \textit{in equilibrium}. Nonetheless, a well-known experimental regularity is that players do not usually settle immediately on equilibria. Experiments have shown that people are influenced by the mere name of a game (Liberman et al., 2004) or irrelevant past experiences that could lead to “institutional afterglow” (Bohnet and Huck, 2004). Specific to this study, although physicians had worked in self-managed teams in Alpha, the regime change in Bravo was not announced as a move to replicate the organizational system in Alpha, but rather as a simple merger of bed ownership between peers with nothing else changed (e.g., Bravo was still closed at night). Additionally, as mentioned in Section 2, most ED physicians work sporadically, and so some would have been new to the regime change in Bravo even after a few weeks after implementation. Finally, the self-managed system requires physicians to work more as a team, and therefore outcomes are more dependent on the beliefs and strategies of both peers.

Given that full cooperation is not immediate, the question is how full cooperation is eventually established. Again, some insight can be gained from the experimental literature. Enforcement in public goods games has been studied in seminal research by Ostrom et al. (1992) and Fehr and Gachter (2000). They have found that full cooperation is possible only when players are allowed to enforce it by punishment. In other words, the rules of the game, akin to

\textsuperscript{44}Although many triage nurses are not aware that they are optimizing \textit{ex ante} assignment by ignoring censuses under the threat of foot-dragging, they are given management “rules of thumb” to alternate assignment unless censuses are sufficiently out of balance.
the organizational environment, determine the degree of cooperation even with the same players and same information. Unlike laboratory experiments, this study cannot definitively show punishment. I do however see that, during the transitional period of residual foot-dragging in Bravo, physicians with higher censuses were more likely to be assigned new patients, reflected in the spike in Figure 8. This is consistent with foot-dragging physicians being made to take new patients, possibly because their foot-dragging was observed by peers who decided not to take new patients upon observing that they already bore higher true workloads. Such an assignment policy is consistent with eventually building a new equilibrium with no foot-dragging.

8 Conclusion

This paper sheds light on how organizational structure improves physician worker productivity. In particular, this study draws a contrast between two systems in which physicians have different managerial authority: In the nurse-managed system, physicians are assigned work by a triage nurse “manager”, while in the other self-managed system they are responsible for assigning work among themselves. The self-managed system produces significantly shorter patient lengths of stay than the nurse-managed system, primarily via the reduction of a moral hazard I call foot-dragging, in which physicians delay patient discharge to forestall new work. Even in the nurse-managed system, the presence of peers reduces foot-dragging, suggesting both social incentives and more information between peers. The self-managed system appears to use this information between peers further to improve patient assignment and reduce foot-dragging.

Although I find that foot-dragging essentially explains the overall effect of self-managed systems, I do find preliminary evidence that physicians choose patients differentially and that there may be distributional effects across patient types, depending on desirability to physicians. This is beyond the scope of this paper and is an area of further research. For practical reasons, I focus on observable measures of productivity, but there may be a host of other considerations, such as conflict among physicians, that could arise from self-management but would be more difficult to measure in this study. However, many of these issues have been addressed extensively in literature outside of economics and point quite favorably toward self-management (Yeatts and
This study examines a precise but relatively minor experiment in the arrangement of ED physician teams that followed from a simple, discrete change in the ownership of beds. In practice, however, self-managed teams and organizations in general differ in a wide variety of ways, including for example the number of workers in the same team and the nature of work relationships among team members. Indeed, there is substantial variation in organizational structure even within health care. Other arrangements, particularly those with a more obvious focus on teamwork, may have significantly different effects on the behavior of workers and should be further studied.

References


Figure 1: Patient-to-physician Assignment Algorithm

Patient arrives in ED triage

Nurse-managed

Triage nurse decides on pod

Triage nurse decides on bed

Patient arrives in pod bed

Physicians own beds

Physician assigned

Self-managed

Triage nurse decides on pod

Triage nurse decides on bed

Patient arrives in pod bed

Physicians decide on assignment

Physician assigned

Note: This figure shows the patient assignment algorithm, starting with patient arrival at ED triage and ending with assignment to a physician. In ED triage, the triage nurse decides which pod and bed to send the patient. If the triage nurse decides to send the patient to a pod with a nurse-managed system (if one exists), then she also makes the decision on which physician will be assigned the patient because physicians own beds. If she decides to send the patient to a pod with a self-managed system, then she does not assign the physician. The physicians currently working in the self-managed pod will decide among themselves on that assignment. Although not shown in the figure, the triage nurse always assigns the bed and the nurse; she never assigns the resident, since residents in either pod choose their own patients or are told by physicians to see patients.
Figure 2: Computer Schematic of Alpha Pod

Note: This figure shows a computer screen layout of Alpha pod, which is both a geographic representation of the physical pod and the interface for physicians to select patients, examine the electronic medical record, and enter orders. Slots represent beds, with two beds per room, and filled beds are represented by slots with information. Colors represent various patient states, for example, whether an order needs to be taken off or whether the patient has been ordered for discharge. Identifying patient information has been removed here, but when displayed, such information includes patient last name, chief complaint, age, sex, physician, resident, nurse, emergency severity index, and minutes in ED (including triage) and in pod. Alpha is always self-managed.
Figure 3: Computer Schematic of Bravo Pod

Note: This figure shows a computer screen layout of Bravo pod, which is both a geographic representation of the physical pod and the interface for physicians to select patients (when applicable under the self-managed system), examine the electronic medical record, and enter orders. Information represented is the same as for Alpha pod, shown and explained in Figure 2. Bravo was a nurse-managed system then changed to a self-managed system in March 2010. When Bravo pod was under the nurse-managed system, the geographic layout and the screen was simply divided in half, generally with one physician occupying each half. The image above was taken with Bravo under the self-managed system.
Figure 4: Overall Effect of Self-managed System on Log Length of Stay

Note: This figure shows month-year-pod fixed effects estimated in a regression of log length of stay, as in Equation (4.2). Alpha pod fixed effects are plotted with hollow blue circles; Bravo pod fixed effects are plotted with solid red circles. The vertical red line indicates the month of the regime change of Bravo from a nurse-managed system to a self-managed system, in March 2010. Alpha was always self-managed. The fixed effect for Bravo in the first month is normalized to 0. The regression controls for uninteracted ED arrival volume, time categories (dummies for month-year, hour of the day, and day of the week), pod, patient demographics (age, sex, race, and language), patient clinical information (Elixhauser comorbidity indices, emergency severity index), triage time, and physician-resident-nurse interactions.
Figure 5: Foot-dragging as Expected Future Work (ED Arrival Volume) Increases by Deciles

Note: This figure shows relative expected log length of stay as a function of expected future work, as measured in deciles of ED arrival volume, or the number of patients arriving at triage in the hour prior to the patient’s arrival at the pod. Expected log length of stay is normalized to 0 in the nurse-managed system and with the first decile of ED arrival volume. Coefficients for these decile-pod dummies are plotted from the regression of (5.2). Hollow blue circles indicate coefficients for the nurse-managed system; solid red circles indicate coefficients for the self-managed system. Vertical brackets show 95% confidence intervals. All models control for time categories (dummies for month-year, hour of the day, and day of the week), pod, patient demographics (age, sex, race, and language), patient clinical information (Elixhauser comorbidity indices, emergency severity index), and physician-resident-nurse interactions. Results are insensitive to controlling for pod-level patient volume.
Figure 6: Foot-dragging as Expected Future Work (Waiting Room Census) Increases by Deciles

Note: This figure shows relative expected log length of stay as a function of expected future work, as measured in deciles of waiting room census at the time of the patient’s arrival at the pod. Expected log length of stay is normalized to 0 in the nurse-managed system and with the first decile of waiting room census. Coefficients for these decile-pod dummies are plotted from the regression of (5.2). Hollow blue circles indicate coefficients for the nurse-managed system; solid red circles indicate coefficients for the self-managed system. Vertical brackets show 95% confidence intervals. All models control for time categories (dummies for month-year, hour of the day, and day of the week), pod, patient demographics (age, sex, race, and language), patient clinical information (Elixhauser comorbidity indices, emergency severity index), and physician-resident-nurse interactions. Results are insensitive to controlling for pod-level patient volume.
Figure 7: Event Study of Foot-dragging in Bravo

Note: This figure shows foot-dragging in Bravo pod, as estimated by the log-length-of-stay coefficient for expected future work (measured by ED arrival volume, defined as the hourly rate of patients arriving at triage when the index patient arrives at the pod) interacted with four-month interval dummies. These coefficients are plotted as an event study before and after the regime change of Bravo pod from a nurse-managed system to a self-managed system in March 2010, shown with a vertical red line. The solid dots plot the coefficient estimates, and the dotted lines plot the 95% confidence intervals.
Figure 8: Effect of Additional Census Patient on New-patient Assignment Probability

Note: This figure shows the new-patient assignment probability, as a function of relative censuses for physicians within each pod. The plotted coefficient estimates represent the average effect on assignment probability of each additional patient on a physician’s census relative to his peer’s census. Hollow blue circles show coefficient estimates for Alpha pod, which was always self-managed. Solid red dots show the coefficient estimates for Bravo pod, which switched to a self-managed system in March 2010, shown with a vertical red line. Coefficients are estimated in a kernel regression using a triangular kernel with 45 days on each side; estimates for February and March 2010 in Bravo pod are estimated by a kernel with 45 days only on the same side of the regime change. For simplicity, 95% confidence intervals are not plotted; see Appendix Figures A-4.2 and A-4.3 for plots with confidence intervals.
Table 1: Patient Characteristics Available for Physicians with Above- or Below-median Productivity

<table>
<thead>
<tr>
<th>Patient characteristic</th>
<th>Physicians with above-median productivity</th>
<th>Physicians with below-median productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>48.7 (19.6)</td>
<td>48.7 (19.6)</td>
</tr>
<tr>
<td>Emergency severity index</td>
<td>2.74 (0.78)</td>
<td>2.74 (0.78)</td>
</tr>
<tr>
<td>White</td>
<td>0.508 (0.500)</td>
<td>0.509 (0.500)</td>
</tr>
<tr>
<td>Black or African-American</td>
<td>0.233 (0.423)</td>
<td>0.234 (0.423)</td>
</tr>
<tr>
<td>Spanish speaking</td>
<td>0.098 (0.297)</td>
<td>0.097 (0.296)</td>
</tr>
<tr>
<td>Female and age &lt; 35 years</td>
<td>0.187 (0.390)</td>
<td>0.185 (0.388)</td>
</tr>
</tbody>
</table>

Note: This table reports averages and standard deviations (in parentheses) for each characteristic of patients available to physicians with above-median and below-median productivity. “Available” means available to choose from in the self-managed system or assigned to in the nurse-managed system. Physician productivity is estimated by fixed effects in a regression of length of stay, controlling for all possible interactions of team members (physician assistant or resident and nurse), coworker, and pod; patient characteristics (age, sex, emergency severity index, Elixhauser comorbidity indices); ED arrival volume; and time categories (month-year, day of the week, and hour of the day dummies). The average difference in productivity between physicians of above- and below-median productivity is 0.28, meaning that physicians with above-average productivity have 28% shorter lengths of stay than those with below-average productivity.
Table 2: ED Conditions for Physicians with Above- or Below-median Productivity

<table>
<thead>
<tr>
<th>Prior patient volume for entire ED</th>
<th>Physicians with above-median productivity</th>
<th>Physicians with below-median productivity</th>
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<tbody>
<tr>
<td><strong>During any shift</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within last hour</td>
<td>6.06</td>
<td>5.97</td>
</tr>
<tr>
<td></td>
<td>(3.87)</td>
<td>(3.86)</td>
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<tr>
<td>Within last 6 hours</td>
<td>34.90</td>
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</tr>
<tr>
<td></td>
<td>(19.11)</td>
<td>(18.95)</td>
</tr>
<tr>
<td><strong>While in self-managed team</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within last hour</td>
<td>5.63</td>
<td>5.42</td>
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<tr>
<td></td>
<td>(3.77)</td>
<td>(3.73)</td>
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<tr>
<td>Within last 6 hours</td>
<td>34.46</td>
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</tr>
<tr>
<td></td>
<td>(17.98)</td>
<td>(17.63)</td>
</tr>
<tr>
<td><strong>While in nurse-managed team</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within last hour</td>
<td>6.40</td>
<td>6.40</td>
</tr>
<tr>
<td></td>
<td>(3.92)</td>
<td>(3.90)</td>
</tr>
<tr>
<td>Within last 6 hours</td>
<td>35.25</td>
<td>35.77</td>
</tr>
<tr>
<td></td>
<td>(19.96)</td>
<td>(19.87)</td>
</tr>
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</table>

**Note:** This table reports ED patient arrival volume for physicians with above-median and below-median productivity. Physician productivity is estimated by fixed effects in a regression of length of stay, controlling for all possible interactions of team members (physician assistant or resident and nurse), coworker, and pod; patient characteristics (age, sex, emergency severity index, Elixhauser comorbidity indices); ED arrival volume; and time categories (month-year, day of the week, and hour of the day dummies). The average difference in productivity between physicians of above- and below-median productivity is 0.28, meaning that physicians with above-average productivity have 28% shorter lengths of stay than those with below-average productivity.
Table 3: Overall Effect of Self-managed Teams on Log Length of Stay

<table>
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<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
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</thead>
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<tr>
<td>Log length of stay</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-managed system</td>
<td>-0.095***</td>
<td>-0.108**</td>
<td>-0.113***</td>
<td>-0.120***</td>
<td>-0.133***</td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.042)</td>
<td>(0.042)</td>
<td>(0.042)</td>
<td>(0.041)</td>
</tr>
<tr>
<td>ED arrival volume and</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>time controls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pod dummies</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Patient demographics</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Patient clinical</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>information</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient triage time</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Resident-nurse</td>
<td>Y</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>dummies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physician-resident-nurse</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>dummies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of observations</td>
<td>309,840</td>
<td>310,535</td>
<td>310,535</td>
<td>310,535</td>
<td>310,535</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.340</td>
<td>0.362</td>
<td>0.368</td>
<td>0.374</td>
<td>0.390</td>
</tr>
<tr>
<td>Sample mean log length</td>
<td>1.099</td>
<td>1.099</td>
<td>1.099</td>
<td>1.099</td>
<td>1.099</td>
</tr>
<tr>
<td>of stay (log hours)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: This table reports the effect of the self-managed system on log length of stay, in Equation (4.1), while controlling for various observables. All columns control for ED patient arrival volume, time categories (month-year, day of the week, and hour of the day dummies), pod, and patient demographics (age, sex, race, and language). Various models may control for patient clinical information (Elixhauser comorbidity indices, emergency severity index); the time spent in triage, which reflects the triage nurse’s subjective belief about patient severity; and resident-nurse interactions or physician-resident-nurse interactions. All models are also clustered by physician. * significant at 10%; ** significant at 5%; *** significant at 1%.
Table 4: Overall Effect of Self-managed Teams on Other Outcomes

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30-day mortality</td>
<td>Hospital admissions</td>
<td>14-day bounce-backs</td>
<td>Relative Value Units (RVUs)</td>
<td>Log total costs</td>
<td>Log time to first order</td>
</tr>
<tr>
<td>Self-managed system</td>
<td>0.0019 (0.0029)</td>
<td>0.011 (0.008)</td>
<td>0.0097 (0.0064)</td>
<td>-0.015 (0.028)</td>
<td>-0.016 (0.030)</td>
<td>-0.026 (0.024)</td>
</tr>
<tr>
<td>Number of observations</td>
<td>311,281</td>
<td>311,281</td>
<td>311,281</td>
<td>251,273</td>
<td>280,997</td>
<td>297,693</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.309</td>
<td>0.464</td>
<td>0.024</td>
<td>0.404</td>
<td>0.529</td>
<td>0.161</td>
</tr>
<tr>
<td>Sample mean outcome</td>
<td>0.020</td>
<td>0.272</td>
<td>0.067</td>
<td>2.701</td>
<td>6.724</td>
<td>-0.624</td>
</tr>
</tbody>
</table>

**Note:** This table reports the effect of the self-managed system on outcomes other than length of stay, estimated by Equation (4.1). Fourteen-day bounce-backs are defined as patients who return to the ED within 14 days of being discharged home. Relative Value Units (RVUs) represent intensity of care and are directly scalable to dollar amounts of clinical revenue. Total costs include direct costs for the entire visit, which may include hospital admission. Time to first order is the time between patient arrival at the pod and the first physician order, measured in log hours. All models control for ED patient arrival volume, time categories (hour of the day, day of the week, and month-year dummies), pod, patient demographics (age, sex, race, and language), patient clinical information (Elixhauser comorbidity indices, emergency severity index), triage time, and physician-resident-nurse interactions. All models are clustered by physician. * significant at 10%; ** significant at 5%; *** significant at 1%.
Table 5: Foot-dragging as Expected Future Work Increases

<table>
<thead>
<tr>
<th>Measure of expected future work</th>
<th>Log length of stay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>ED arrival volume</td>
<td>0.006*** (0.001)</td>
</tr>
<tr>
<td>Waiting census</td>
<td>0.006*** (0.001)</td>
</tr>
<tr>
<td>Expected future work × self-managed system</td>
<td>-0.006*** (0.001)</td>
</tr>
<tr>
<td>Self-managed system</td>
<td>0.037 (0.044)</td>
</tr>
<tr>
<td>Pod-specific volume control</td>
<td>N</td>
</tr>
<tr>
<td>Number of observations</td>
<td>282,105</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.439</td>
</tr>
<tr>
<td>Sample mean log length of stay (log hours)</td>
<td>1.179</td>
</tr>
<tr>
<td>Sample mean patient volume measure</td>
<td>15.58</td>
</tr>
</tbody>
</table>

Note: This table shows the effect of expected future work on log length of stay, estimated by Equation (5.1). Expected future work is measured either as the number of patients arriving at ED triage during the hour prior to the index patient’s arrival at the pod (“ED arrival volume”) or as the number of patients in the waiting room during that time (“waiting census”). Models (1) and (3) do not control for pod-level prior patient volume, defined as the number of patients arriving in the pod of the index patient one, three, and six hours prior to the index patient’s arrival, while models (2) and (4) do. All models control for time categories (month-year, day of the week, and hour of the day dummies), pod, patient demographics (age, sex, race, and language), patient clinical information (Elixhauser comorbidity indices, emergency severity index), and physician-resident-nurse interactions. All models are clustered by physician. * significant at 10%; ** significant at 5%; *** significant at 1%.
Table 6: Effect of Expected Future Work on Other Outcome and Process Measures

<table>
<thead>
<tr>
<th></th>
<th>Outcomes</th>
<th>Process Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>30-day</td>
<td>Hospital</td>
</tr>
<tr>
<td></td>
<td>mortality</td>
<td>Admissions</td>
</tr>
<tr>
<td>ED volume</td>
<td>-0.0001</td>
<td>-0.0006*</td>
</tr>
<tr>
<td></td>
<td>(0.0001)</td>
<td>(0.0004)</td>
</tr>
<tr>
<td>ED volume ×</td>
<td>0.0002</td>
<td>-0.0006</td>
</tr>
<tr>
<td>self-managed</td>
<td>(0.0003)</td>
<td>(0.0004)</td>
</tr>
<tr>
<td>Self-managed</td>
<td>-0.001</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.012)</td>
</tr>
<tr>
<td>Adjusted</td>
<td>0.338</td>
<td>0.461</td>
</tr>
<tr>
<td>R-squared</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample mean</td>
<td>0.019</td>
<td>0.265</td>
</tr>
<tr>
<td>outcome</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: This table shows the effect of expected future work on other outcomes and process measures, estimated by Equation (5.1). Log total costs include all direct costs incurred from the encounter, including any from admissions. Expected future work is measured by ED arrival volume (“ED volume” for brevity), defined as the number of patients arriving at ED triage during the hour prior to the index patient’s arrival at the pod. Models do not include pod-level prior patient volume; results are unchanged when including this. All models control for time categories (month-year, day of the week, and hour of the day dummies), pod, patient demographics (age, sex, race, and language), patient clinical information (Elixhauser comorbidity indices, emergency severity index), triage time, and physician-resident-nurse interactions. Results are insensitive to controlling for pod-level patient volume. All models are clustered by physician. All models have 289,132 observations, except for model (4), which has 269,905 observations. The sample mean patient volume is 15.53 for all models, except for the model (4), for which it is 15.48. * significant at 10%; ** significant at 5%; *** significant at 1%.
Table 7: Effect of Peer Presence on Foot-dragging

<table>
<thead>
<tr>
<th>Sample</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nurse-managed</td>
<td>Self-managed</td>
<td>Pooled</td>
</tr>
<tr>
<td>Log length of stay</td>
<td>0.006***</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td></td>
</tr>
<tr>
<td>ED volume</td>
<td>0.024***</td>
<td>0.017***</td>
<td>0.018***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.002)</td>
</tr>
<tr>
<td>ED volume × no peer present</td>
<td>0.009***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED volume × peer present</td>
<td></td>
<td>-0.002**</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.001)</td>
<td></td>
</tr>
<tr>
<td>ED volume × peer present, nurse-managed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>ED volume × peer present, self-managed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED volume × only physician in ED</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of observations</td>
<td>130,581</td>
<td>157,419</td>
<td>296,177</td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.441</td>
<td>0.352</td>
<td>0.365</td>
</tr>
<tr>
<td>Sample mean log length of stay (log hours)</td>
<td>0.926</td>
<td>1.179</td>
<td>1.061</td>
</tr>
<tr>
<td>Sample mean ED volume</td>
<td>17.118</td>
<td>14.217</td>
<td>15.517</td>
</tr>
</tbody>
</table>

Note: This table reports the effect of expected future work, interacted with peer presence, on log lengths of stay. Expected future work is measured by ED arrival volume ("ED volume" for brevity), defined as the number of patients arriving at ED triage during the hour prior to the index patient’s arrival at the pod. Equation (6.1) estimates models (1) and (2). Model (1) is estimated with observations of patients seen by nurse-managed teams; model (2) is estimated with self-managed teams. Both of these models use observations with at least one other physician in the ED, so that foot-dragging entails a negative externality against a current coworker, who may or may not be a peer. Model (3) is estimated by Equation (6.2) and includes the full sample. Main effects are included but omitted from the table for brevity. In all columns, the phrase “no peer present” means no other physician in same pod but another physician in ED, while “only physician in ED” means no other physician in entire ED. All models control for time categories (month-year, day of the week, and hour of the day dummies), pod (when applicable), patient demographics (age, sex, race, and language), patient clinical information (Elixhauser comorbidity indices, emergency severity index), triage time, and physician-resident-nurse interactions. All models are clustered by physician. * significant at 10%; ** significant at 5%; *** significant at 1%. 
Table 8: Effect of Peer Relationships on Foot-dragging

<table>
<thead>
<tr>
<th>Type of peer</th>
<th>Log length of stay</th>
<th>Log length of stay</th>
<th>Log length of stay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>ED volume</td>
<td>0.008***</td>
<td>0.003***</td>
<td>0.009***</td>
</tr>
<tr>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td></td>
</tr>
<tr>
<td>ED volume × peer type</td>
<td>-0.004***</td>
<td>0.000</td>
<td>-0.003***</td>
</tr>
<tr>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td></td>
</tr>
<tr>
<td>Self-managed × ED volume</td>
<td>-0.008***</td>
<td>-0.007***</td>
<td>-0.005***</td>
</tr>
<tr>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.001)</td>
<td></td>
</tr>
<tr>
<td>ED volume × peer type</td>
<td>0.002</td>
<td>0.001</td>
<td>-0.004*</td>
</tr>
<tr>
<td>(0.002)</td>
<td>(0.002)</td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>Self-managed × peer type</td>
<td>-0.031**</td>
<td>-0.027**</td>
<td>0.005</td>
</tr>
<tr>
<td>(0.014)</td>
<td>(0.013)</td>
<td>(0.014)</td>
<td></td>
</tr>
<tr>
<td>Sample</td>
<td>Nurse-managed</td>
<td>Self-managed</td>
<td>Nurse-managed</td>
</tr>
<tr>
<td></td>
<td>Adjusted</td>
<td>Pooled</td>
<td>Adjusted</td>
</tr>
<tr>
<td></td>
<td>R-squared</td>
<td>0.445</td>
<td>0.364</td>
</tr>
<tr>
<td></td>
<td>Sample mean log</td>
<td>0.936</td>
<td>1.251</td>
</tr>
<tr>
<td></td>
<td>length of stay</td>
<td>0.926</td>
<td>1.179</td>
</tr>
<tr>
<td></td>
<td>(log hours)</td>
<td>17.30</td>
<td>15.08</td>
</tr>
<tr>
<td></td>
<td>Sample mean ED</td>
<td>17.12</td>
<td>14.22</td>
</tr>
<tr>
<td></td>
<td>volume</td>
<td>17.12</td>
<td>14.22</td>
</tr>
<tr>
<td></td>
<td>15.33</td>
<td>15.33</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15.33</td>
<td>15.33</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** This table reports effect of expected future work, interacted with a peer type, as by Equation (6.3). Expected future work is measured by ED arrival volume (“ED volume” for brevity), defined as the number of patients arriving at ED triage during the hour prior to the index patient’s arrival at the pod. All observations require the presence of a peer. Peers with greater tenure, those with high productivity (faster-than-median fixed effect for lengths of stay), and familiar peers (peers with at least 60 hours of history, approximately the 75th percentile, working with the index physician) are considered. ED volume is demeaned. Coefficients for the direct effect of the peer type and pooled coefficients for self-managed are omitted for brevity. All models control for time categories (month-year, day of the week, and hour of the day dummies), pod (when applicable), patient demographics (age, sex, race, and language), patient clinical information (Elixhauser comorbidity indices, emergency severity index), triage time, and physician-resident-nurse interactions. The nurse-managed, self-managed, and pooled samples had 121,024, 126,264, and 247,288 observations, respectively. All models are clustered by physician. * significant at 10%; ** significant at 5%; *** significant at 1%.
Table 9: Foot-dragging Depending on Physician and Peer Censuses

<table>
<thead>
<tr>
<th>Peer census quintile</th>
<th>Nurse-managed</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Self-managed</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Index physician census quintile</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
<td>Index physician census quintile</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>0.040***</td>
<td>0.030***</td>
<td>0.024***</td>
<td>0.019***</td>
<td>0.009</td>
<td></td>
<td></td>
<td>0.008</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.005)</td>
<td>(0.004)</td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.006)</td>
<td></td>
<td></td>
<td>(0.008)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>0.023***</td>
<td>0.020***</td>
<td>0.018***</td>
<td>0.017***</td>
<td>0.005</td>
<td></td>
<td></td>
<td>0.007</td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.006)</td>
<td>(0.006)</td>
<td>(0.004)</td>
<td>(0.003)</td>
<td>(0.004)</td>
<td></td>
<td></td>
<td>(0.012)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>0.023***</td>
<td>0.009</td>
<td>0.001</td>
<td>0.009**</td>
<td>0.002</td>
<td></td>
<td></td>
<td>0.006</td>
<td>0.010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.006)</td>
<td>(0.007)</td>
<td>(0.006)</td>
<td>(0.004)</td>
<td>(0.005)</td>
<td></td>
<td></td>
<td>(0.008)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>0.022***</td>
<td>0.010**</td>
<td>0.001</td>
<td>0.002</td>
<td>-0.006</td>
<td></td>
<td></td>
<td>0.003</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.004)</td>
<td></td>
<td></td>
<td>(0.007)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>0.010**</td>
<td>0.002</td>
<td>-0.007*</td>
<td>0.002</td>
<td>0.000</td>
<td></td>
<td></td>
<td>-0.002</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.004)</td>
<td>(0.005)</td>
<td>(0.004)</td>
<td>(0.005)</td>
<td>(0.009)</td>
<td></td>
<td></td>
<td>(0.007)</td>
<td>(0.009)</td>
</tr>
</tbody>
</table>

Note: This table reports the effect of expected future work, for each cell of physician and peer quintile interaction and for each organizational structure. Expected future work is measured by ED arrival volume, defined as number of patients arriving at ED triage during the hour prior to the index patient’s arrival at the pod. All observations involve at least one peer present. On the left are coefficients $a_{1,m}^{n}$ from Equation (6.4) for physician-census quintile $m$ and peer-census quintile $n$ using nurse-managed-team observations (adjusted $R$-squared 0.428, 121,024 observations). On the right are the same coefficients using self-managed-team observations (adjusted $R$-squared 0.329, 126,264 observations). All models control for time categories (month-year, day of the week, and hour of the day dummies), pod (when applicable), patient demographics (age, sex, race, and language), patient clinical information (Elixhauser comorbidity indices, emergency severity index), triage time, and physician-resident-nurse interactions. All models are clustered by physician. Coefficients for the nurse-managed team are also shown in Appendix Figure A-4.1. * significant at 10%; ** significant at 5%; *** significant at 1%.