Physician Agency, Patients' Trust and Institutions Within Physician Groups

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Physician Agency, Patients' Trust and Institutions within Physician Groups

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A Dissertation Submitted to the Faculty of
The Harvard T.H. Chan School of Public Health
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Physician Trust, Patients’ Agency, and Institutions within Physician Groups

Abstract

One of the major challenges of health care contracting is that physicians’ financial and personal interests are often not aligned with patients’ best interests. When this physician agency problem is widespread, patients may lose trust in their physicians, leading to undesirable clinical outcomes. In this dissertation, we explore several means to solve the physician agency problem through institutional arrangements.

Chapters 1 and 2 focus on peer-to-peer institutions within physician groups that can sustain a good group reputation, and this group reputation mechanism can play a role in encouraging physicians to provide appropriate treatments. Chapter 1 investigates the group reputation mechanism from a theoretical perspective. The theory suggests that a physician group’s reputation outperforms each physician’s individual reputation when some kinds of intragroup institutions can minimize an individual physician’s motivation to free-ride on the group reputation. These intragroup institutions have to address the information sharing among physicians and the enforcement of peer sanctions after a misbehaving doctor is detected. We investigate the suspension as an example of such an enforcement.

Chapter 2 further provides empirical evidence on the effects of peer-monitoring institutions on reducing harmful overtreatments in a laboratory setting. The experimental results suggest that information sharing alone does not significantly reduce overtreatment. By contrast, peer-selection enforcement, in which doctors have the freedom to choose their group affiliations and colleagues, significantly reduces overtreatment, nearly eliminating overtreatment in the best physician groups. Furthermore, patients are more likely to see a doctor from the physician group that maintains a low overtreatment rate.

While physicians can adopt vigorous peer-monitoring to mitigate the physician agency prob-
lem, patients may attempt to ensure doctors’ commitment to prioritizing their patients’ best interest when the physician agency problem is perceived. Chapter 3 investigates the informal payment (red-packet) phenomenon in the medical setting using data from China, which can be regarded as an informal gift-exchange institution initiated by patients. We provide supportive evidence that, when patients report low trust in their doctors and indicate poor communication and lack of empathy of their doctors, they tend to offer red packets.
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Chapter 1

Physician Agency, Group Reputation and Institutions for Peer Monitoring

Abstract

Patients’ trust plays a critical role in effective medical services; however, the physician agency problem could damage the trust. Physicians’ group reputation may be an effective means of mitigating the agency problem. This paper investigates, from a theoretical perspective, situations in which physicians’ group reputation outperforms each physician’s individual reputation in motivating physicians’ good practices and bolstering patients’ trust. The model shows that group reputation is not necessarily superior to individual reputation because group reputation may effectively hide individual misconduct. This paper further investigates how peer monitoring institutions regarding sharing information among peers and enforcing punishments for misconduct underpin high group reputations. We find that, in general, it would be better to have institutional arrangements that peers can immediately detect and efficiently sanction a specific physician who jeopardizes the group reputation. Suspending a misbehaving physician’s practice is a more promising peer monitoring enforcement than grim-trigger strategies based on physicians’ copying one another’s behavior.
1.1 Introduction

In a medical setting, physicians are often organized into groups to practice, actively or passively. Famous physician group practices, such as Mayo Clinic, Cleveland Clinic and Massachusetts General Hospital Medical Group are very attractive career options for physicians. Even if a doctor works in a single practice, she or he may participate in partnership (e.g., an Independent Practice Association or IPA) or be affiliated with hospitals. When physicians are affiliated with groups, she or he will share the group reputation. The public will know a physician as “a doctor in Hospital X or Medical Group Y.” The group reputation may influence patients’ care-seeking choices, including both new visits and continuation of care (Dranove and Sfekas, 2008; Dafny and Dranove, 2008; Cutler et al., 2004). Therefore, one important factor for physicians in choosing group affiliations is the group’s reputation. Why do some physicians’ groups have a higher reputation than others? What does a high group reputation mean for both physicians and patients? This paper investigates the role of group reputation in both patient-doctor relationships and peer-to-peer relationships. In our model, group reputation serves as a device to assure physicians’ practicing behavior meet a high standard; a high reputation of a physician group is underpinned by effective intragroup institutional measures that can mitigate affiliates’ agency behavior and ensure commitment to patients’ best interests.

Medical practices feature uncertainty of clinical outcomes and information asymmetry between physicians and patients (Arrow, 1963; McGuire, 2000). In these settings, patients lack sufficient ability to evaluate whether their healthcare needs are met.

When physicians’ own interests conflict with the patients’, physicians could be imperfect agents to patients. The physician agency problem may result in either undertreatment or overtreatment. A physician may not exert herself or himself to consult colleague experts, leading to severe complications. A physician may also recommend unnecessary but profitable procedures, which increases the risk to patients. When physicians practice in a group, the group can agree to peer-to-peer monitoring among physicians, which can overcome information asymmetry between patients and physicians, since physicians, who have similar training, can evaluate the appropriateness of the treatments and clinical outcomes provided by their peers better than patients can. This will help a physician group to maintain a high group reputation. Compared with the individual
reputation, one possible reason for the group reputation to be so important in medical settings may be that the group reputation indicates how effectively the intragroup institutions adopted by a physician group is enforcing peer monitoring and mitigating the physician agency problem. In fact, many medical organizations themselves boast about their reputations for vigorous peer monitoring, which deters member physicians from inappropriate practices. The Mayo Clinic, for example, is often described as a model of medical care delivery that fosters peer accountability; there, physicians are responsible for reviewing each other’s work and collaborating to deliver high-quality, high-value care (McCarthy et al., 2009). Virtually, almost all physician groups have some peer-monitoring institutions, vary by the extent and the procedures. How can these institutions ensure that the physician groups live up to their reputations?

In this paper, we adopt a simple model based on Cai and Obara (2009) to investigate the potential role of group reputation in bolstering patients’ trust and reducing inappropriate overtreatments and undertreatments. The group reputation can be formed and maintained by two main variations in the institutional set-up: information sharing and enforcement based on information sharing. The former mechanism enables physicians in a group to monitor each other’s behavior while the latter mechanism imposes punishment on those who tarnish the group reputation.

In this model, patients demand appropriate care that produces a high value for them, but the appropriateness of their treatments is unobservable to them. At the same time, they are unable to distinguish between valid information about the underlying value of the care they are receiving and the noisy signals from their uncertainty about the clinical outcomes based on their own experience. When physicians have incentives to provide inappropriate care that better rewards them, patients and physicians have to adopt cut-off trigger strategies, with a threshold based on the imperfect value signals, to determine the physician-patient interaction. When the signals are above the threshold, the physician’s reputation is preserved; otherwise, the physician’s reputation is damaged. We extend this model to physician groups. We assume that patients use average signals at the group level instead of individual signals to evaluate the group reputation. If physicians in the group do not share information, an individual physician’s inappropriate behavior cannot be detected; therefore, there is never any ground for peer sanctions. We then compare physicians’ long-run payoffs for providing appropriate care (which is in line with the sum of their patients’ welfare). The model shows that group reputation, when not coupled
with any peer-monitoring structure, is not necessarily superior to the individual reputation in predicting a physician’s long-run payoff. The explanation is that an individual group member has the incentive to free-ride on the group reputation, which decreases the credibility of the group reputation. This result suggests that patients do not necessarily obtain higher value care in a large physician group that has no peer-to-peer monitoring than in an individual physician’s office if we assume the same level of medical technology in both situations.

Using this model, we first examine intragroup information-sharing to facilitate peer monitoring but without a specific institution that enforces peer sanctions. Because the information-sharing could be limited by each member’s attention or by technology constraints, we set up an environment where peer monitoring is restricted within the “neighborhood” of a given physician, based on Saak (2012). The model shows that this intragroup-information structure can facilitate “contagion strategies” (Kandori, 1992; Ellison, 1994). That is, every physician copies the behavior of others. Therefore, one case of inappropriate care would eventually destroy the whole group reputation due to physicians’ successively following suit. The reason that physicians want to follow suit is that they expect that, in the future, more group members will provide inappropriate care, and they themselves are unable to stop the trend. To maximize profit, physicians believe that it would be better to under- or overtreat patients for short term gains. The implementation of the contagion strategies might deter the first misconduct if the scope of the intragroup information-sharing among peers is sufficiently large. However, this form of group reputation is unstable because, in theory, one improper clinical decision will lead to a collapse of the whole group’s reputation. In reality, physicians may want to “quarantine” the inappropriately-performed physician to prevent the deterioration of the group reputation.

Using the same model with local information sharing among peers, we study a particular type of intragroup institution that goes beyond contagion strategies with formal peer-monitoring enforcement —internal suspension based on peers’ reports of inappropriate medical practice. The institutional arrangement of combining peer monitoring with suspension (or even revocation) is common among physician groups. One of the worst situations that can happen to a doctor in her or his career is the physician group’s decision to suspend her or his group affiliation, because a large share of a physician’s practice may be supplied from the group affiliation. Our model suggests that effective sanction using suspension can maintain a high group reputation even if
the group size is large, in which case the threat of contagion strategies fades away. Moreover, a group’s reputation can be maintained after the physicians sanction the inappropriate-performing peer. However, peer monitoring enforced by the internal suspension requires that peer physicians who observe a misbehaving doctor have common expectations about each other’s sanctioning behavior, and it may not be possible to successfully regulate members’ behavior once inappropriate treatments have started to spread widely.

Our paper provides a theoretical foundation to understand various intragroup institutions in medical settings that involve peer monitoring and how they contribute to the buildup of physician group reputation. Recent policy changes have encouraged healthcare providers to consolidate and create larger medical practice groups. This paper models how a large healthcare organization will likely suffer from serious free-rider problems that diminish its reputation, so relevant policy design must pay attention to the effectiveness of intragroup institutions in maintaining group reputation so that they can function as intended and retaining patients’ trust.

Our paper begins by reviewing the relevant literature on group reputation and discusses its application in the medical environment in Section 2. Section 3 describes a simple model featuring the cut-off trigger as an indicator of an individual physician’s reputation when there is imperfect public monitoring, and expands individual reputation to group reputation, comparing the effects of group reputation versus individual reputation. Section 4 discusses how peer-monitoring underpin the group reputation by introducing the information-sharing mechanism and the suspension enforcement. Section 5 discusses the findings and gives the conclusion.

1.2 Literature Review

Arrow (1963) point out that, healthcare is characterized by uncertainty and asymmetric information. In such an environment, many economic institutions, including those that rely on reputation, can only play a limited role in mitigating the physician agency problem if physicians’ incentives or motivations are not aligned with patients’ interests (McGuire, 2000). Physicians themselves, over a long period of time, have attempted to solve the agency problem by forming institutions to assure patients that their interests are being given top priority. Group reputation plays a role in conveying this assurance to patients (Getzen, 1984).
Imperfect observability of individual behavior underlies the phenomenon of group (collective) reputation (Tirole, 1996). In the environment of imperfect signals of individual behavior, group reputation may predict a group member’s behavior better than individual reputation. From an institutional perspective, a high group reputation may serve as an indicator that the group has the capacity to restrain its members from inappropriate practices. In contrast, when patients realize that a group is likely to overlook misbehavior, patients may distrust any member from the group. In contrast, without intragroup institutions to punish misbehavior, the group reputation might not be a reliable indicator. As pointed out by Kandel and Lazear (1992), group reputation has the “public good” feature. In the case of a physician group, the entire group will share the positive reputation effects of the conduct of doctors who properly perform, but free-riders can benefit from the good group reputation without themselves refraining from inappropriate but profitable care. Too many free-riders will override the efficiency brought about practicing in groups, such as an expansion of patient base and bargaining leverage over price (Rob and Fishman, 2005).

Cai and Obara (2009) studies the reputation of firms where customers observed only imperfect signals about the firms’ effort/quality choices. In their model, even when firms choose high effort/quality, there is always a possibility that a bad signal will be observed. The model features a cut-off threshold for public signals. When the signals fall below the cut-off point, the reputation of the firms suffer, and many customers choose never to do business there again. With the model, Cai and Obara discuss group reputation in the context of firms’ horizontal integration. Their insight is that, on the one hand, horizontal integration lead to a larger market base for the merged firm. On the other hand, umbrella branding gives the merged firm more opportunity to conceal its low effort/quality in a specific market. Saak (2012) extends Cai and Obara’s work, analyzing a model of group reputation with imperfect public monitoring and perfect local peer monitoring of effort/quality. Saak finds that even when the peer monitoring is local, firms is able to achieve higher profits based on their high group reputations by decreasing the cost of maintaining their customers’ trust. However, Saak assumes that the exclusion of underperformers either by customers or by the group members is impossible, which limits the discussion of intragroup institutions. In this paper, we will discuss mechanisms that may effectively exclude a physician who provides inappropriate care, which is more relevant to actual medical institutions.

There is emerging empirical evidence on topics related to group reputations in the medical
settings. Most of the literature have focused on identifying the effects of improving the availability of group-level information (such as quality report cards) on the quality indicators of health care (such as risk-adjusted mortality rate) and patients’ healthcare-seeking behavior (Kolstad and Chernew, 2009). Evidence indicates that improving the availability of quality information at the physician-group level (in a way that patients can effectively access) has a positive impact on the quality of care and affects patients’ perceptions of the hospitals’ reputation (Hibbard et al., 2005). However, no strong evidence indicates that merely providing information has changed the pattern of patients’ healthcare choices significantly. Dafny and Dranove (2008) suggest that one reason for the mixed findings on the demand side should be that report-card rankings can only strengthen prior beliefs about the quality of care in a hospital. This paper reinforces this point and provides a theoretical foundation that better explains the formation of patients’ beliefs about a physician group’s reputation. The model in this paper suggests that group reputation may be underpinned by institutions that mitigate the potential agency problem and ensure the quality of care. Improving the availability of information about physician groups could let patients better assess whether a physician group has lived up to its organizational goals, given its intragroup institutional arrangements. However, if patients initially trust the group’s institution, perhaps only extremely negative signals will diminish the reputation of a physician group (Dranove and Sfekas, 2008; Cutler et al., 2004).

In a broad sense, this paper considers physicians to be in a repeated prisoner’s dilemma when players are in a network. Therefore, principles of the general theory may apply because physicians need to cooperate to sustain their group reputation. First of all, institutions that restrain individuals from selfish behavior usually involve the threat of withholding cooperation by others. The group size affects group members’ strategies. In a small group, an individual’s behavior can be observed accurately by other members, and this kind of threat is immediately available as a powerful deterrent (Axelrod, 1986; Fudenberg and Maskin, 1986; Ostrom, 1990). In large groups, information about others’ past behavior is more limited, and cooperation might be supported by contagion strategies, which pose the threat of triggering the spread of non-cooperative behavior following a case of misbehavior (Kandori, 1992; Ellison, 1994; Wolitzky, 2013). Information is a key factor in successfully facilitating such grim-trigger strategies among group members. Saak (2012) takes a similar approach and shows that the deterioration of a group reputation can be caused
by the implementation of the contagion strategies following one case of misbehavior. However, when applied to medical organizations, such grim-trigger strategies come at a cost to patients and result in their loss of trust in the entire physician group. It would be better to have other sanction mechanisms underpinning peer monitoring that would maintain or restore patients’ trust. Suspending or excluding physicians who have performed inappropriately from the physician group is potentially a strong punishment. Enforcing peer monitoring with these sanctions can be related to the ostracism mechanism in a more general setting (Hirshleifer and Rasmusen, 1989; Ali and Miller, 2009, 2012).

In health economics literature, there is limited examination about various information conditions and enforcement institutions underpin physician group reputations. This essay attempts to fill the gap.

1.3 Basic Model

Our model specification parallels Cai and Obara (2009), but we change the framing to apply to a medical setting. The model also uses some structures from Brown and Minor (2012). This model is built to investigate physicians’ reputation at both the individual- and group-level when there is imperfect public monitoring. In order to focus on reputation effects, we assume that healthcare markets are separate and that each physician is a monopolist in her market. Furthermore, we assume there is misalignment between physicians’ incentives and patients’ interests: inappropriate treatment is more rewarding to a doctor but that appropriate treatment benefits a patient more. Inappropriate treatment could be either undertreatment due to a physician’s low effort (hidden action) or overtreatment due to the recommendation of unnecessary but profitable procedures (hidden information). For the sake of convenience, in the following description of the model, the third person pronoun “she” will refer to the physician and “he”: will refer to the patient.

In the game, time is discrete, denoted by \( t = 1, 2, \ldots \), and the time horizon is infinite. There are \( n \) separate healthcare markets, in each of which a risk-neutral physician provides medical services to a number of identical patients. We let \( N \) denote the complete set of physicians across markets. There are \( m \) physicians practice in the same group, denoted by \( M \subset N \); otherwise, they practice individually. In every period, each physician can only accept one randomly-matched patient.
Table 1.1: The stage game of physician-patient interaction

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<th>Inappropriate</th>
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<td>See</td>
<td>((v_R, n_R))</td>
<td>((v_W, n_W))</td>
</tr>
<tr>
<td>Don’t see</td>
<td>((0,0))</td>
<td>((0,0))</td>
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A physician can provide either an appropriate treatment, denoted by “R”, or an inappropriate treatment, denoted by “W”. Patients cannot observe whether the care he has received is appropriate or not. At time \(t\), physician \(i\) will earn a profit of \(\pi_{i,t} \in \{\pi_R, \pi_W\}\) by providing the health service, and a patient of physician \(i\) will obtain a net value of \(v_{i,t} \in \{v_R, v_W\}\). We assume \(\pi_R < \pi_W\) while \(v_R > v_W\). We further assume that \(v_W < 0\) and \(\pi_W + v_W < v_R + \pi_R\).

At the beginning of a period, a patient can make the decision whether or not to see a physician in the market based on the public signals about her most-recent patients. A patient will not choose to see a physician if he expects inappropriate care. If the patient chooses not to see a doctor, the patient’s expected value is zero, and the physician’s profit is zero, too.\(^1\) The stage game is depicted in Table 1.1:

If the patient-doctor interaction is one-shot, the unique Nash equilibrium of the game is (Don’t see, Inappropriate), resulting in payoffs of \((0,0)\). The outcome of (See, Appropriate) is most efficient in terms of total surplus and Pareto-dominates (Don’t see, Inappropriate). However, this efficient outcome is not attainable without considering the effects of the individual physician’s reputation, since the appropriateness of the physician’s recommendation is unknown to the patient.

Since the value of care is a function of its appropriateness, if the value of care that a patient has received can be perfectly observed by a following patient, then it would be straightforward to show that (See, Appropriate) can be achieved by the effects of the individual physician’s reputation, as long as the physician cares sufficiently about her future business. This can be achieved by a trigger strategy when the future patients stop seeing the physician after \(v_W\) was realized in the previous period. if we let \(0 < \delta < 1\) denote the discount factor, it can easily be determined that the first best is attainable when \(\pi_R \geq \frac{(1-\delta)}{\delta} (\pi_W - \pi_R)\).

However, a patient may only be able to observe imperfectly how much value was obtained

---

\(^1\)In reality, patients can choose to delay care until they are more certain about their conditions; they can seek care elsewhere. The value of these options can also be normalized as zero. The interpretation of patients’ outside options is irrelevant to the equilibrium strategies studied in this paper.
by the previous patients. In fact, due to the uncertainty of clinical outcomes, a patient may not
know the value of the treatment he himself has received, much less be able to communicate this
information effectively to patients who follow. If we let \( Q(\cdot) \) denote a monotonous transformation
function for \( v_{i,t} \) (the value of care obtained by physician \( i \)'s patient at time \( t \)), then we can assume
that \( y_{i,t} \) is the observable signal for \( v_{i,t} \), which is generated by the process:

\[
y_{i,t} = Q(v_{i,t}) + \varepsilon_{i,t},
\]

where \( \varepsilon_{i,t} \) represents mean-zero normally-distributed noise with variance \( \sigma^2 \) independent
across physicians and time periods, and \( y_{i,t} \) is a public signal for physician \( i \)' in period \( t \). To
simplify the analysis, We assume that \( Q(v_R) = q > 0 \) and \( Q(v_W) = 0 \). For convenience, we let
\( k_{i,t} = (y_{i,t} - q)/\sigma \) denote the normalized individual signal. \( k_{i,t} \sim N(0,1) \) if the physician always
provides appropriate care.

If physician \( i \in N \setminus M \) practices with individual reputation, \( y_{i,t} \) is the signal that her future
patient can observe.

If physician \( i \in M \) practices with group reputation, a patient can observe the following
group-level information, which averages all previous-round signals among patients who visited
group \( M \). To make a distinction from the individual-level variables, the notation of group-level
variables does not have a subscription of \( i \).

\[
y_t = \frac{1}{m} (\sum_{i=1}^{m} Q(v_{i,t}) + \varepsilon_{i,t}),
\]

It is convenient to let \( k_t = (y_t - q)/\bar{\sigma} \) denote the normalized group-level signal. \( k_t \sim N(0,1) \) when
all doctors provide appropriate care, where \( \bar{\sigma} = \sigma/\sqrt{m} \). We also assume that the group size \( m \) is
public information.

Here, we make the crucial assumption that when group-level information is available, all
patients will ignore individual-level signals. The crude assumption that patients may use only the
group-level signal as a guideline is not wholly implausible. It is widely observed that patients pay
attention to a physician group’s overall performance (such as hospital rankings) when seeking
healthcare. An adverse medical event scandal at a hospital may negatively affect patients’ trust in
the entire medical staff. Nevertheless, since both individual- and group-level signals are noisy,
if equilibrium strategies based on group-level signals minimize physicians’ agency problem,
increasing patients’ welfare, patients may adopt the group reputation as the guideline. It is noteworthy that, in reality, patients may still be able to access a physician’s individual signal. A mixed model of individual and group reputations will dramatically complicate our analysis and make the comparison between individual reputation and group reputation very difficult. Our model in this paper will not deal with this situation.

As a first step, we assume that physicians in group $M$ cannot observe each other’s behavior; therefore, there is no ground to implement any peer monitoring. The structure of the physician group can be understood as independent practices under the umbrella of the same group identity, but physicians have no interactions with each other.

Given the noisy public signals for the value of care, either at the individual- or group-level, there could be multiple equilibria. In this paper, we will focus on a family of perfect public equilibria with the cut-off point of public signals as a dividing line between the high- or low-reputation stages. We define doctors’ and patients’ strategies with two stages for physician $i \in N$:

**High-reputation stage**: The patient who is matched to physician $i$ sees her, and physician $i$ provides appropriate care.

**Low-reputation stage**: The patient who is matched to physician $i$ does not see her, and physician $i$ provides inappropriate care.

The above-mentioned two stages can characterize an equilibrium with cut-off trigger strategies between patients and doctors: Physicians and patients enter the high-reputation stage at the beginning of the game and continue to be in the high-reputation stage as long as $y$ (either $y_{i,t}$ or $y_t$) stays above some threshold $\bar{y}$. Once $y$ falls below $\bar{y}$, both physicians and patients will enter and remain in the low-reputation stage forever.

With the cut-off trigger strategies, if patients cannot perfectly observe the value of care, and, thus, infer the appropriateness of their treatments, they can still set the cut-off point to motivate physicians to give appropriate care as long the appropriateness and value of care are positively correlated. However, there is a probability that a physician who provided appropriate care will permanently lose patients. The choice of the cut-off point reflects the fundamental tradeoff of the game: lowering the cut-off point will increase the chances for physicians and patients to interact,

---

2 A Perfect Public Equilibrium (PPE) is a profile of public strategies that, starting at any time $t$ and given any public history, forms a Nash equilibrium from that point on, see Fudenberg et al. (1994)
but it also makes it more likely that a physician will abuse her patient’s trust. In reality, signals such as a big drop in rankings or adverse medical events may trigger the bad reputation stage.

To see the rationale of the cut-off trigger strategies in supporting equilibria, we let $w$ denote a physician’s average payoffs for providing appropriate care in the equilibrium (hereafter, equilibrium payoffs).\(^3\) $w$ must satisfy the recursive equation:

$$w = (1 - \delta)\pi_R + \delta(1 - \Phi(\bar{k}))w,$$

where $\bar{k} = \frac{q}{\sigma}$. Equation 1.1 demonstrates that the physician’s per-period profit in the equilibrium is the sum of her current-period profit averaged out over time $(1 - \delta)\pi_R$, plus the expected average value from continuation $\delta(1 - \Phi(\bar{k}))w$.

Using Equation 1.1, the physician’s equilibrium payoffs can be re-written as:

$$w = \frac{(1 - \delta)\pi_R}{(1 - \delta(1 - \Phi(\bar{k})))}.$$

Equation 1.2 shows that, ceteris paribus, the physician’s equilibrium payoff $w$ will increase as $\bar{k}$ decreases. Since the patient and the physician earn a fixed pair of payoffs $(v_R, \pi_R)$ for each period in the high-reputation stage, $w$ is in direct proportion to patients’ welfare as well; therefore, we will focus on optimizing $w$ and, thus, minimizing $\bar{k}$, in the comparison of individual reputation and group reputation.

Next, we introduce the incentive-compatible (IC) constraints for physician $i$ to continue to provide appropriate care with individual reputation and with group reputation respectively. This follows the principle of one-shot-deviation.

With individual reputation, the IC constraint can be written as:

$$(\Phi(\bar{k} + q/\sigma) - \Phi(\bar{k}))w \geq \frac{(1 - \delta)}{\delta}(\pi_W - \pi_R).$$

In Equation 1.3, a physician will earn an extra profit of $\pi_W - \pi_R$, if she provides inappropriate care. However, inappropriate care will increase the probability of falling below the cut-off point.

\(^3\)To simplify the notation, we adopt the convention of the repeated-games literature and measure a physician’s payoff as her expected profit averaged over the infinite horizon (that is, the sum of discounted profits multiplied by $1 - \delta$), instead of as its total discounted expected profits. This convention permits an easy comparison between repeated and stage-game payoffs, as they are both measured in the same payoff-per-period units.
by $\Phi(\vec{k} + q/\sigma) - \phi(\vec{k})$.\footnote{When a physician provides inappropriate care, the probability of triggering the low-reputation stage is $P(y_{i,t} < \bar{y}) = P(y_{i,t}/\sigma < \bar{k} + q/\sigma)$.} When the IC constraint of Equation 1.3 is satisfied, a physician will refrain from inappropriate care due to her concern about its impact on her reputation and, consequently, on her ability to attract and retain patients in the future. It should be noted that (Don’t see, Inappropriate) is always an equilibrium strategy; therefore, the threat indicated by Equation 1.3 is credible.

With group reputation but no information-sharing among peers, the IC constraint will change to:

\begin{equation}
(\Phi(\vec{k} + q/\sqrt{m\sigma}) - \Phi(\vec{k}))w \geq \frac{(1 - \delta)}{\delta} (\pi_W - \pi_R).
\end{equation}

Equation 1.4 shows that with group-level signals, one inappropriate treatment increases the probability of triggering the low-reputation stage by $\Phi(\vec{k} + q/\sqrt{m\sigma}) - \phi(\vec{k})$.\footnote{It comes from $\Phi(\vec{k} + q) = \Phi(\vec{k}).$} It is easy to see that, with group-level information, the average signal has better precision with the variance of $\sigma^2/m$, but each case of inappropriate care only reduces the “true” average value by $q/m$. As a result, the sensitivity of the public signal to the individual physician’s treatment choice diminishes with the size at the rate $1/\sqrt{m\sigma}$ with the group reputation, but at rate $1/\sigma$ with the individual reputation.

It can be shown that solutions of $\vec{k}$ can be guaranteed for combination of Equation 1.1/1.3 or Equation 1.1/1.4 if $\delta$ is sufficiently large.\footnote{It is equivalent to finding $\vec{k}$, so that $(\Phi(\vec{k} + \Delta) - \Phi(\vec{k})) - \frac{(\pi_W - \pi_R)}{\pi_R} \Phi(\vec{k}) \geq (1 - \delta)/\delta$, where $\Delta > 0$. See Cai and Obara (2009) for a proof.} In the following analysis, we assume that the solutions of $\vec{k}$ exists, and we are interested in finding the smallest $\vec{k}$, which yields the greatest average on-equilibrium payoffs for the physicians among all cut-off trigger strategy equilibria.\footnote{Cai and Obara (2009) proved that, the smallest $\vec{k}$ is not just among all cut-off trigger-strategy equilibria but among all possible equilibria, since equilibria that yield a physician the greatest average on-equilibrium payoffs must be cut-off trigger strategy equilibria.} If we let $\bar{k}_i$ denote the smallest solution for the combination of Equation 1.1/1.3 with individual reputation, the following rationale shows that Equation 1.3 must be binding with $\bar{k}_i$. One can consider any cut-off trigger-strategy equilibrium with $(w, \bar{k}_i)$ such that Equation 1.3 holds as a strict inequality. We can then decrease $\bar{k}_i$ without affecting the IC constraint. However, this will reduce
physicians’ probability of entering the low-reputation stage, and thus increase \( w \). Therefore, the physician will be better off with a lower cut-off point. If we let \( \bar{k}_M \) denote the smallest solution for the combination of Equation 1.1/1.4 with group reputation, the same binding result applies to Equation 1.4.

We can compare Equation 1.3—the IC constraint with group reputation—with \( \bar{k}_i \) and Equation 1.4—the IC constraint with individual reputation—with \( \bar{k}_M \). Because \( q/\sqrt{m\sigma} < q/\sigma \) when \( m > 1 \), if one substitute \( \bar{k}_i \) with \( \bar{k}_M \) in Equation 1.3, Equation 1.3 is still a strict inequality. Therefore, it is easy to see that \( \bar{k}_i < \bar{k}_M \), which implies that a physician’s best equilibrium payoff with group reputation without peer monitoring is strictly less than her equilibrium payoff with individual reputation.

**Proposition 1.** When a physician practices in the group (\( m > 1 \)) with group-level signals, but there is no peer monitoring, the cut-off point to trigger a low-reputation stage (\( \bar{k}_M \)) must be higher than cut-off point (\( \bar{k}_i \)) when a physician practices with an individual signal.

The intuitive explanation for Proposition 1 is that patients have to be more suspicious with group reputation and increase the cut-off point in order to offset the individual physician’s incentive to free-ride on the group reputation. To use back surgery as an example, when the patient relies on the surgeon’s individual reputation, if one the surgeon’s patient becomes paralyzed, the surgeon’s own reputation may be damaged. However, when a surgeon practices in a group, one paralyzed case may not be to the detriment of the group’s reputation because patients are all pooled together and it is relatively easier to observe some rare occasions. In order to strengthen the group member’s responsibility, patients may still use a single paralyzed case rather than two or more as a cut-off point when they do not trust the physician group. In this case, group reputation will not benefit an individual physician.

### 1.4 Group Reputation with Peer Monitoring

Proposition 1 shows that with group-level signals alone, physicians and patients may not benefit from the group reputation. In this section, we present a more comprehensive model in which each physician has access to some private information regarding the appropriateness of care provided by her peers. To make the analysis manageable, we adopt the specification of intragroup information
structure used by Saak (2012),\(^8\) which assumes that physicians are located around a circle, and that each physician can perfectly observe the patient types chosen by her \(z\) neighbor(s) to the left and \(z\) neighbor(s) to the right, but not more distant neighbors’ treatment choices. To put this in formula form, physician \(i \in M\) observes the patient types of all patients \(j \in \{|i-z|_m, \ldots , |i+z|_m\}\), where \(|x|_m = m - x\) if \(x \leq 0\), \(|x|_m = x - m\) if \(x \geq m + 1\) and \(z \in 1, \ldots , m - 1\) \((m \geq 3)\). This can also be interpreted as physicians’ paying limited attention to their peers. Proposition 1 can apply to \(z = 0\), where there is no information-sharing among doctors.

1.4.1 Peer-monitoring without enforcement

Saak (2012) pointed out that when physicians can observe their peers’ behavior \((z \geq 1)\), physicians may copy their peers’ behavior after they detect an inappropriate treatment, expecting that the group reputation will eventually deteriorate. Therefore, even without any enforcement for the peer monitoring, there may be a credible threat for an individual doctor to trigger peers following suit. Saak’s argument is in line with the so-called contagion strategies in the literature, and the associated equilibrium can be described by the following three stages:

The **high-reputation stage** and the **low-reputation stage** are the same as which we have discussed in the previous section.

**Contagion stage**: While a patient continues to see a doctor from the group, physician \(i\) provides inappropriate treatment when she has detected inappropriate treatment by physician \(j \in \{|i-z|_m, \ldots , |i+z|_m\}\), or she herself has provided inappropriate treatment.

Physicians and patients enter a high-reputation stage at the beginning of the game and continue to be in the high-reputation stage as long as \(k_i\) stays above some threshold \(\tilde{k}\), and no physician provides inappropriate treatment. Some physicians enter the contagion stage when the physician herself or at least of one of her neighbors provides inappropriate treatment, while \(k_i\) stays above some threshold \(\bar{k}\). Once \(k_i\) falls below \(\bar{k}\), physicians and their patients will enter the low-reputation stage forever.

With the contagion strategies available among peers, Saak (2012) showed the cut-off point with group-signals \(\tilde{k}\) could be set to a smaller value than the smallest cut-off point in the case

\(^8\)A generalized model can be found in Wolitzky (2013)
of individual reputation \((\bar{k}_i)\) to trigger the low-reputation stage. We adapt Saak’s results for our model. If we let \(w_{i,m}\) denote a physician’s average payoff of continuation, where the subscript “\(i, m\)” stands for the group size \((m)\) and the observed number of physicians providing inappropriate care \((i)\), then we can restate Equation 1.1 as follows:

\[
w_{0,m} = (1 - \delta)\pi_R + \delta(1 - \Phi(\bar{k}))w_{0,m} \quad .
\] (1.5)

When entering a contagion strategy, for \(i \geq 1\), a physician’s off-equilibrium average payoff after providing an inappropriate treatment can be defined as follows:

\[
w_{i,m} = (1 - \delta)\pi_W + \delta(1 - \Phi(\bar{k} + \frac{iq}{\sqrt{m\sigma}}))w_{\min[m, i+2z], m} \quad .
\] (1.6)

The incentive-compatible condition to prevent the first physician from providing inappropriate care is

\[
(1 - \Phi(\bar{k}))w_{0,m} - (1 - \Phi(\bar{k} + \frac{iq}{\sqrt{m\sigma}}))w_{\min[m, 1+2z], m} \geq \frac{(1 - \delta)}{\delta}(\pi_W - \pi_R) \quad .
\] (1.7)

Next, we need to verify that the threat of triggering the contagion process is credible. Specifically, a physician who have not been involved in providing inappropriate treatments but detected her neighbors’ inappropriate care for the first time should achieve a higher payoff than if she subsequently chooses inappropriate care. For \(i \geq 3\), we have the following constraints:

\[
(1 - \Phi(\bar{k} + \frac{(i-1)q}{\sqrt{m\sigma}}))w_{\min[m, i+2z-1], m} - (1 - \Phi(\bar{k} + \frac{iq}{\sqrt{m\sigma}}))w_{\min[m, i+2z], m} \leq \frac{(1 - \delta)}{\delta}(\pi_W - \pi_R) \quad .
\] (1.8)

Equation 1.8 suggests that a physician may delay the contagion process by 1 step at most by deviating from the contagion stage once. However, it might not be worth doing so because as more and more physicians become infected, the group reputation will be weakened and, finally, destroyed. As a result, the contagion process is irreversible.  

It should be noted that, when Equation 1.7 is binding, the strict inequality of Equation 1.8 must

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9There is another constraint for physicians providing inappropriate: They should continue to provide inappropriate care. Mathematically, just replace \(w_{\min[m, i+2z-1], m}\) with \(w_{\min[m, i+2z], m}\) in Equation 1.8. Since \(w_{\min[m, i+2z-1], m} > w_{\min[m, i+2z], m}\), this constraint is unnecessary when Equation 1.8 is satisfied.

---
hold. When a physician is indifferent about providing either appropriate care or inappropriate care in the reputation stage, she is also indifferent towards postponing the inappropriate care to the future. In this situation, after the first physician provided the inappropriate care, providing inappropriate care becomes immediately profitable. As a result, all peers around the misbehaving doctor will pursue short-term gains and start providing inappropriate care when Equation 1.7 is binding.

In order to satisfy 1.7, the group size cannot be too large when peer monitoring is local. When the group size $m$ is relatively large, the contagion process is slow. The physician who provides early inappropriate treatments may actually want to free-ride on the group reputation, confident that a large share of her peers will not know about her deviation. On the other hand, when $z$ is sizeable, a single inappropriate case can be observed by a large number of peers at the outset and spread out within the group more rapidly.\footnote{In the case of global monitoring in which $z \geq Ceiling((m - 1)/2)$, it can be shown that inappropriate treatment is subject to maximally intensive peer punishment through contagion strategies.}

Based on the above-mentioned discussion, one can proved the following proposition:

**Proposition 2.** When a physician practices in the group $(m \geq 3$ and $z \geq 1)$ and peer-monitoring only involves information sharing, there exists a sufficiently large $\delta$ such that, there is $1 < m < \infty$ so that $\tilde{k} \leq \bar{k}_i$.

Proof. The proof for this is provided in Appendix A.

The cut-off trigger equilibria supported by the contagion strategies have several disadvantages. Most importantly, it requires a commitment from physicians in a group to punish misbehaving peers who provide inappropriate care to the detriment of group reputation and their patients’ welfare. Second, in order to support a good group reputation, the group size cannot be too large when peer monitoring is local. We believe that there are strong practical reasons to explore alternative institutions that can enforce peer monitoring and support the group reputation.

### 1.4.2 Peer-monitoring with enforcement

In this section, we examine how an enforcement mechanism can strengthen peer monitoring and the group reputation. We discuss internal suspension as an example of a mechanism to enforce peer monitoring, in which the properly-performing physician peers can coordinate to suspend a
physician providing inappropriate care for $T$ period. To simplify the expressions and focus on the mechanism, we impose $\pi_R > 2(\pi_W - \pi_R)$, and let $T = 1$. It is simple to generalize our results by dropping the restriction of $\pi_R > 2(\pi_W - \pi_R)$ and by letting $T$ be sufficiently large to make the loss of income over suspension periods salient.

In order to implement the suspension, we assume that, at the beginning of every round, physicians are allowed to report simultaneously their peers’ inappropriate behavior in the previous round. A physician’s practice will be suspended for this round if either of the following criteria is met:

- She was reported by at least one of her neighbors;

- She failed to report the neighbors who were reported by others.

If a doctor is suspended, she cannot take the patient for the current round, but the doctor can still observe the practice of the other physicians. She will return in the next round with the responsibility of reporting any doctor who provided inappropriate care in the previous round. Therefore, the implementation of the suspension mechanism will reduce the overall size of the group without altering the peer-monitoring structure. We further assume that the suspension is implemented internally; therefore, patients will continue to evaluate the group-level signal as if the group size were $m$.

With the sanction mechanism and assumptions mentioned above, we can show that an equilibrium supported by the suspension mechanism consists of the following three stages:

**High-reputation stage**: If there was no inappropriate care detected in the previous round, a physician does not report anyone else, and she provides appropriate care. Patients keep visiting physicians in the group.

**Enforcement stage**: If physician $j \in \{|i - z|m, \ldots, |i + z|m\}$ gave inappropriate care in the previous round, physician $i$ reports physician $j$; physician $j$ does not report anyone else. Physicians who are not suspended provide appropriate care, and physicians who are in suspension do not take patients. Patients continue visiting physicians in the group and know whether their physicians are available on site.

**Low-reputation stage**: Each physician in the group does not report anyone else and provides inappropriate care. Patients do not see physicians in the group.
The strategies mentioned above can characterize the following equilibrium supported by the suspension mechanism. All physicians start in the high-reputation stage. When \( k_t > \bar{k} \) and no doctors provide inappropriate care, they remain in the high-reputation stage; when \( k_t > \bar{k} \) and physician \( j \) provides inappropriate care, physicians in \( j \)'s neighborhood enter the enforcement stage. When \( k_t < \bar{k} \), all doctors will move to the low-reputation stage forever (it should be noted that the low-reputation stage is itself an equilibrium).

It is a simple matter to demonstrate the three-staged equilibrium with the suspension mechanism. We first examine physician \( i \)'s clinical decision while she is making the clinical decision at \( t \) in the high-reputation stage, given that the reporting strategies on the equilibrium path will be followed in all future rounds. Again, if patients assign a cut-off point \( \bar{k} \) as a cut-off trigger for the low-reputation stage, the physicians’ average equilibrium payoff \( w'_{0,m} \) can be written as follows:

\[
w'_{0,m} = (1 - \delta)\pi_R + (1 - \Phi(\bar{k}))w'_0 \quad . \tag{1.9}
\]

With the suspension enforcement, the incentive-compatible condition for physician \( i \) to continue to provide appropriate care will be

\[
w'_{0,m} \geq (1 - \delta)\pi_W + \delta^2(1 - \Phi(\bar{k} + \frac{q}{\sqrt{m}\sigma}))(1 - \Phi(\frac{\sqrt{m-1}}{\sqrt{m}}\bar{k}))w'_{0,m} \quad . \tag{1.10}
\]

The right-hand side of Equation 1.10 is based on the result that the doctor who deviates will suffer from two kinds of losses: 1) She will lose all income for \( t + 1 \); and 2) She will increase the risk of triggering the low-reputation stage by \( (1 - \Phi(\bar{k} + \frac{q}{\sqrt{m}\sigma}))(1 - \Phi(\frac{\sqrt{m-1}}{\sqrt{m}}\bar{k})) \) for all future periods beyond \( t + 1 \), where the first factor comes from lower average signals due to inappropriate care, and the second factor comes from the increased noise (larger variation) because the group size is reduced by one. In fact, we can focus on the direct loss of income for \( t + 1 \) as a sufficient condition to satisfy Equation 1.10 and ignore the increased risk. By doing so, we will have the following inequation:

\[
\delta(1 - \Phi(\bar{k}))\pi_R \geq (\pi_W - \pi_R) \quad . \tag{1.11}
\]

When \( \delta \to 1 \), for any \( \bar{k} < \bar{k}_i < 0 \), the inequation must hold as \( \pi_R \geq 2(\pi_W - \pi_R) \) and \( 1 - \Phi(\bar{k}) > 1/2 \).

Following a similar logic, in the enforcement stage, when the number of physicians in
suspension is \( s \), the sufficient condition for physician \( i \) to continue to provide appropriate care when she does not expect that anyone else will administer inappropriate care is:

\[
\delta (1 - \Phi(\frac{\sqrt{m - s}}{\sqrt{m}})\bar{k})\pi_R \geq (\pi_W - \pi_R).
\] (1.12)

The inequation also holds because \( \frac{\sqrt{m - s}}{\sqrt{m}}\bar{k} < 0 \). That is, as long as physician \( i \) believe that the doctors who are not in suspension are also providing appropriate care, the loss of income at \( t + 1 \) would be greater than \( 1/2\pi_R \), which is sufficiently large to deter any inappropriate care.

Next, we examine whether other neighboring physicians will report peers who performed inappropriately in the previous rounds. First of all, in this game, no physicians want to report peers who provide appropriate care because doing so will reduce the group size and increase the noise of the group-level signals, and, thus, increase the risk of triggering the low-reputation stage. Moreover, this will not affect the suspension results for those who provided inappropriate care because doctors report simultaneously. For a physician who fails to report a doctor who performed inappropriately, she will be punished immediately by the suspension mechanism, because each doctor has at least two neighbors, and other peers will report the doctor who performed inappropriately. In other words, A physician gains no advantage from failing to report the doctor who preformed inappropriately as others will enforce the sanctions, while the punishment for failing to report inappropriate behavior falls on herself. It should be noted that the physician who provides inappropriate care is indifferent about reporting inappropriate behavior by other doctors. Thus, we assume that she will not report others as her reporting strategy in the enforcement stage, which will not affect the equilibrium.\(^{11}\)

The desirable equilibrium of the game is based on the coordination of properly-performing doctors (peer physicians who are not in suspension are believed to provide appropriate care as well). This result seems to suggest that patients do not need to assign a positive probability in order to stop seeing doctors, even upon observing a low signal from the group, because the physician group can solve any physician agency problems by itself. In other words, the cut-off trigger strategy between patients and doctors appears to be redundant. In fact, doctors in the

\(^{11}\)The game can be modified to motivate those who are about to be suspended to report honestly, which will strengthen the result.
group may find that the peer-monitoring mechanism is not an attractive alternative if patients are not at all sensitive to the group-level signals. Doctors can negotiate to remove the sanction mechanism if providing inappropriate treatment makes everyone in the group better off. In order to prevent this type of collective deviation, patients may want to ensure that at any point of the game the equilibrium of (all inappropriate care, no reports) are Pareto-dominated by the equilibrium supported by the suspension mechanism. Therefore,  \( \bar{k} \) could not be set arbitrarily small, but should satisfy the following condition:

\[
(\Phi(\bar{k} + \sqrt{m\eta/\sigma}) - \Phi(\bar{k}))w_{0,m} \geq \frac{(1 - \delta)}{\delta} (\pi_W - \pi_R).
\]  

Compared with Equation 1.3, because \( \sqrt{m\eta/\sigma} > \frac{q}{\sigma} \) (the collective inappropriate care by all group members is much more salient than an individual inappropriate care), \( \bar{k} < \bar{k}_i \) is still guaranteed.

We summarize our discussion as Proposition 3.

**Proposition 3.** When a physician practices in the group \((m \geq 3 \text{ and } z \geq 1)\) and peer-monitoring can be enforced by the one-period suspension mechanism \((T=1)\), when \( \pi_R > 2(\pi_W - \pi_R) \) and \( \delta \) is sufficiently large, there is \( \bar{k} < \bar{k}_i \) for all \( m \).

Compared with the contagion strategies, one distinctive feature of the suspension mechanism is that the strength of the punishment is relatively independent of the group size. Moreover, the equilibrium supported by the suspension mechanism has the desirable off-equilibrium feature of being able to restore the equilibrium path eventually, while the contagion strategy will immediately lead to further inappropriate care.

It should be noted that the equilibrium is based on the belief that all physicians who are not reported will provide appropriate care, even if they are not observed. If a doctor believes that there are many unobservable doctors providing inappropriate care who have not been suspended, the probability of entering the low-reputation stage is perceived to be high, and the motivation to provide inappropriate care is strong. As a result, the loss of income in the next period may not take place, regardless of whether the suspension is implemented or not. It is essential to achieve the desired equilibrium when all doctors initially provide appropriate care.
1.5 Conclusion

In this paper, we analyze a simple group-reputation model to investigate the link between group reputation and intragroup organizations when clinical outcomes are uncertain and doctors’ incentives and patients’ are not aligned. When group-level average signals are used to evaluate physician groups, the group may not automatically develop collective responsibility for the quality and value of care. On the contrary, the group-level signal is not sensitive to an individual member’s inappropriate care, and free-riding behavior may lead to a decrease in healthcare quality. Therefore, the institutions that can enforce peer monitoring are critical to the survival of physician groups, especially when the group size is large and physicians’ interactions are limited in range.

We summarize the major points of the paper as follows:

1. Without peer monitoring, the group reputation can be inferior to the individual reputation in medical settings if the free-rider problem is thriving when doctors practice in the group name.

2. Grim-trigger among peers can sustain a better group reputation when group size is not too large, but is detrimental when off-equilibrium punishment is implemented.

3. The internal suspension is a better way to support the group reputation when the group size is large, but the mechanism for suspension has to be in place at the outset.

The model suggests that it is not always the best choice for a physician to practice in a group because her peers’ practice of over- and undertreatments may weaken or damage the group reputation and may lead to every group member having a low-reputation. An effective peer-monitoring system could protect a physician’s investment in her relationship to the group from being taken advantage of by irresponsible peers and make a large-scaled practice possible.

The model also suggests that once the peer-monitoring system is ready, the group reputation tends to be less sensitive to occasionally negative public signals. This feature is important to the survival of physician groups in an environment of uncertain clinical outcomes. There may always be some adverse events in spite of every physician practicing properly. A strong group reputation

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12 the institutional variations regarding information sharing and enforcement mechanisms may generate a variety of market structures. In some situations, group practices are more recognized and rewarded than solo practices because it is relatively easy to adopt effective peer-monitoring systems. In other situations, most physicians choose individual practices, perhaps because a physician group has some barriers to organizing peer monitoring. In future research, it would be interesting to examine how variations in the institutional configurations in different regions have led to the variations in the styles and sizes of practices.
to discipline members’ behavior would help to ease these negative effects. Therefore, we can predict that a physician group will adopt the strategy to advertise its internal institutions to the public. For example, Mayo has boasted that “it nurtured a culture of peer collaboration since its earliest days and developed many institutional features that facilitate peer monitoring (McCarthy et al., 2009).”

The major limitation of our model is that we deliberately separate the relationship between the individual reputation mechanism and the group reputation mechanism in order to make a contrast. In reality, the development of trust in a physician may be based on both types of reputation, and individual reputation and group reputation may reinforce each other. On the one side, as pointed out by Hall et al. (2001), trust in the physician groups and healthcare organizations help in establishing the trust when there is no prior knowledge of the clinician. On the other side, the trust-building process may involve “halo effect” (Hall et al., 2001), in which a patient who trusts a particular doctor may extend his trust toward the group with which the doctor is affiliated. This situation is difficult to deal with in our model. In a future study, it would be interesting to model the interplay between individual reputation and group reputation, and examine the overall effects of reputation on equilibrium strategies for patients and physicians in a group.

We may not have discussed adequately in our model how the transaction cost for reporting misbehaving doctors and enforcing sanctions would affect a physician’s participation throughout the peer punishment process, although we have discussed the implicit cost of reducing practice size. In reality, many physicians may have concerns about reporting colleagues due to various expenses, such as extra time, paperwork or even pressure of facing retaliation. A survey by DesRoches et al. (2010) showed that only two-thirds of respondents indicated they were readily to report misbehaving peers. The model shows how minimal transaction costs can facilitate credible peer punishment through the coordination among properly-performing doctors.

We only consider the internal suspension as an example of the enforcement mechanisms for peer monitoring. In the real word, there are many kinds of enforcement mechanisms, which we

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13 Mayo lets clinical records serve as an “open book” means of continual peer review in which clinicians can give one another feedback (McCarthy et al., 2009). Berry and Seltman (2008) reported that physicians at Mayo who did not exhibit collegial behavior to all team members could face suspension without pay or even termination.

14 Perhaps, it may strengthen the incentives for physician peers to implement peer monitoring to prevent other group members from discrediting her name, which is linked with the group reputation.
could not capture with the model we present here. For example, there are a variety of peer selection processes in the physician communities. Physicians may deliberately select group affiliations; physician groups such as hospital staff and group practice can recruit doctors whose behavior is in line with the collective interests of the physicians’ group, and screen out doctors who ignore the patients’ interests and thus harm the group reputation. The recruitment and dismissal of doctors usually involve peer evaluation. In fact, peer selection also occurs in physicians’ daily lives when they refer patients to colleagues. The peer selection mechanisms are dynamic, which are difficult to manage using our stylized model. In Chapter 2, we designed a laboratory experiment to test the effectiveness of the peer selection mechanism in reducing overtreatments specifically.

As a starting point, our model provides avenues for understanding more complex but realistic medical institutions involving group reputation and peer monitoring. Recently, the American healthcare system has produced an accelerated rate of creating larger practice groups. The paper highlights the challenge of the free-rider problem when more and more physicians and providers share common identities. The paper identifies that strengthening peer monitoring is a critical way to cope with the free-rider problem, which will also bolster patients’ trust to a newly-established large physician group.
Appendix
1.A Omitted Proofs

Proof of proposition 2

To simplify notation, we let $\Phi = 1 - \Phi$. For convenience, we assume $m$ is an odd number. It is sufficient to show that there is $m > 1$ and $\tilde{k} = \tilde{k}_i$, so that 1.7 and 1.8 can be satisfied for sufficient large $\delta$.

First, we verify the IC constraint of 1.7. We only need to show the case of $z = 1$, because when $z \geq 2$, the IC constraint will become even easier to satisfy.

For the first doctor who provides inappropriate care, her expected payoffs are

$$w_{1,m} = (1 - \delta)(\pi_W) + \sum_{i=1}^{\infty} \delta^i \prod_{s=0}^t \Phi(\tilde{k} + \min[1 + 2s, m] \frac{q}{\sqrt{m^r}})(1 - \delta)\pi_W$$

(1.1)

$$< (1 - \delta)(\pi_W)(1 + \sum_{i=0}^{m-2} \delta^i \prod_{s=0}^t \Phi(\tilde{k}) + \delta^{(m+1)/2} \prod_{s=0}^t \Phi(\tilde{k})) \Psi(m, \tilde{k})$$

where $\Psi(m, \tilde{k}) = \frac{\delta \Phi(\tilde{k} + \sqrt{m^r})}{1 - \delta \Phi(\tilde{k})}$

Note $\tilde{k}_i < -\frac{q}{2\pi}$, and so we have $\left(\frac{\alpha}{q}\tilde{k}_i\right)^2 > 4$. If we let $m = \left(\frac{\alpha}{q}\tilde{k}_i\right)^2$, and $\tilde{k} = \tilde{k}_i$, then we have $\Phi(\tilde{k}_i + \sqrt{m^r}) = 1/2$ and $\Psi(m, \tilde{k}) = \frac{\delta}{\sqrt{\pi}}$.

Using 1.5,1.7 and 1.1A, the IC constraint must hold if

$$\frac{\pi_g}{\pi_W} > 1 - (\delta \Phi(\tilde{k}_i) \left(\frac{\alpha k_i}{q}\right)^{2+1/2} (1 - \frac{\delta}{\sqrt{\pi}}(1 - \delta \Phi(\tilde{k}_i))))$$

(1.2)

When $\delta \to 1$, we have $\tilde{k}_i \to -\infty$, thus $\lim_{\delta \to 1} \delta \Phi(\tilde{k}_i) = 1$. If we treat $m$ as a continuous variable, we can also verify that $\lim_{\delta \to 1} \delta \Phi(\tilde{k}_i) \left(\frac{\alpha k_i}{q}\right)^{2+1/2} = 1$. To see this

$$\lim_{\delta \to 1} \frac{1}{\sqrt{2z\pi}} \Phi\left(\frac{1/2}{\sqrt{m^r} k_i}\right)$$

$$= \lim_{\delta \to 1} \frac{1}{\sqrt{2z\pi}} \frac{\sqrt{\pi_0} e^{-1/2k_i^2} - e^{-1/2k_i^2}}{\sqrt{k_i^2}}$$

(l’ Hôpital’s rule, using 1.1)

$$= \lim_{\delta \to 1} \frac{1}{\sqrt{2z\pi}} \frac{1}{\sqrt{2z\pi}} \frac{1}{\pi_0} e^{-1/2k_i^2} - e^{-1/2k_i^2} = 0$$

(total differential using 1.2)

We still need to verify that $\tilde{k} = \tilde{k}_i$, $m = \frac{\delta k_i^2}{q}$ can satisfy the constraint of 1.8. For $\iota = \min[3, m], \ldots, m$ as , define

$$f(\iota, m, k, s) = \Phi(k - \frac{1+2s}{\sqrt{m^r}})$$

$$g(\iota, m, k, s) = \Phi(k - \frac{1+2s}{\sqrt{m^r}})$$
Constraint 1.8 can be written as

\[
\sum_{t=0}^{(\frac{d}{q} - 1)/2} \delta^{t+1} (\prod_{s=0}^{t} f_i((\frac{d}{q} \bar{k}_i)^2, \bar{k}_i, s) - \prod_{s=0}^{t} g_i((\frac{d}{q} \bar{k}_i)^2, \bar{k}_i, s)) + \delta^{(\frac{d}{q} - 1)/2 + 1} \prod_{s=0}^{(\frac{d}{q} - 1)/2} f_i((\frac{d}{q} \bar{k}_i)^2, \bar{k}_i, s) - \prod_{s=0}^{(\frac{d}{q} - 1)/2} g_i((\frac{d}{q} \bar{k}_i)^2, \bar{k}_i, s)) \frac{\delta}{s - 0} \leq \frac{\pi \omega - \pi \bar{R}}{\pi \omega}
\]

(1.A3)

The left hand side converge to 0 as \( \delta \to 1 \), for each \( i = \min[3, m], \ldots, m \).

\[ \square \]
Chapter 2

Can Peer Monitoring Reduce Overtreatment? Evidence from a Laboratory Experiment Simulating Medical Care

Abstract

Overtreatment in a medical setting has significant consequences, ranging from financial waste to the potential for complications from treatments that are at best unnecessary. While some recent studies have examined how changes in incentives can reduce overtreatment rates, relatively few studies have considered the role played by institutional arrangements in sustaining a group reputation to avoid overtreatment, in part because of the difficulty of causal identification in observational settings. This paper presents the results of a laboratory experiment based on a credence-good model in a medical framing where high payments for intensive treatment create incentives for overtreatment. We test how overtreatment rates are affected by 1) providing patients with information about group-level outcomes; 2) providing physicians with information about peers’ treatment decisions, and 3) allowing for peer-selection by physicians. We conjecture that peer selection can produce physician groups that sustain reduced rates of overtreatment. The experimental results suggest that peer information does not significantly reduce overtreatment. By contrast, peer selection intervention significantly reduces overtreatment, nearly eliminating

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1 Co-authored with McConnell, Margaret
overtreatment in the best physician groups. Furthermore, patients are more likely to see a doctor from the physician group that maintains a low overtreatment rate. Our results suggest that institutional details can be significant factors in designing health systems that minimize overtreatment and improve patients’ trust.
2.1 Introduction

Overtreatment in a healthcare setting is regarded as patients receiving treatments that are unnecessary and not in the patients’ best interests (Bangma et al., 2007; Korenstein et al., 2012). Overtreatment has significant consequences. In the United States, it is estimated that $200 billion, or 7% of total healthcare expenditures, is spent annually on the overtreatment of patients (Berwick and Hackbarth, 2012). Beyond wasteful spending, patients may experience complications and miss the chance of finding more effective therapies from overtreatment that does not provide clear medical benefits. For example, people with the stable coronary disease will risk developing a blood clot from stent insertion, an invasive procedure that is no more effective than the use of medicine in preventing death (Maisel, 2007).

Misaligned incentives that reward doctors for providing more intensive care have been recognized as a leading cause of overtreatment (Gruber and Owings, 1996; Gruber et al., 1999; Jacobson et al., 2010). For example, fee-for-service reimbursements in many healthcare systems are based on distorted price schedules, leading to widespread overuse of drugs or diagnostic tests (Blumenthal and Hsiao, 2005; Nomura and Nakayama, 2005). This can result in decreased trust between patients and doctors and also result in patients’ forgoing medical treatment, disobeying doctors’ orders or initiating costly medical disputes (Thom et al., 2004). While a number of recent studies have examined how changes in incentives can reduce overtreatment rates (Yip et al., 2014; Brosig-Koch et al., 2015a,b; Hennig-Schmidt et al., 2011), relatively few studies have investigated the role played by institutional settings in contributing to overtreatment, in part because of the difficulty of causal identification in observational studies (Robinson, 2001; Cutler et al., 2013).

When patients have suspicions about the appropriateness of care, this distrust may impede beneficial interactions between patients and doctors, leading to a smaller practice. Therefore, physicians may want to establish a reputation for serving patients with treatments that are in the patients’ best interests and avoiding overtreatment. There is a high potential for a reputation mechanism curbing overtreatment. What hinders the reputation mechanism from reducing

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2From an economic perspective, a general definition of overtreatment would be that the marginal benefit of treatment exceeds the marginal cost to the society. However, from the standpoint of medical ethics, it may be argued that even procedures that only weakly benefit patients should be used, regardless of its costs. In this paper, the meaning of overtreatment is more specific than a general economic definition, which involves not only a waste of resources but also suboptimal clinical results. Clearly, we want to prevent this type of overtreatment occurring in a medical setting.
overtreatment in the medical setting is the difficulty patients have in evaluating whether the care they have received fits their underlying clinical needs. Historically, doctors have formed organizations with group reputations to retain and recruit patients. Physicians belong to different groups (such as group practices, hospitals, provider networks, and professional associations) in which group reputations are likely to be relevant. We hypothesize that groups may be able to employ intragroup institutions to uphold their reputations and provide assurance to patients. In this paper, we present the results of a laboratory experiment based on a credence-good model framed in a medical treatment setting, where high payments for intensive treatment create incentives for overtreatment. The objective of the laboratory experiment is to examine, in settings where physicians share a common reputation, which peer institutions can help physician groups minimize overtreatment and bolster patients’ trust in their physicians.

This paper will focus on testing the role of the peer-monitoring system where individual physicians notice and respond to their peers’ performance results, in sustaining the group reputation for proper care and, consequently, in reducing the overtreatment rate. Peer monitoring is known as one of the simplest forms of intragroup institutions, since its implementation does not involve a hierarchical structure or a third-party enforcer (Dixit, 2009). Doctors have the advantage of medical training and thus have more information symmetry among themselves, allowing them to use private information and knowledge to monitor peers’ overtreatment more effectively.

We propose two institutional settings that may bolster a strong peer-monitoring system. First, a peer-monitoring system requires an environment where clinical information can be shared among peers. However, information may not be enough without enforcement and sanction mechanisms in place; otherwise, the free-rider problem would decrease the motivation for peer monitoring (Kandel and Lazear, 1992). This paper investigates institutions that allow an individual physician to deliberately select the colleagues with whom she wishes to work. This selection process creates an enforcement mechanism, since physicians have an incentive not to select colleagues who are observed engaging in overtreatment. For physician organizations like group practices, hospitals, and professional associations, the recruitment and dismissal of doctors usually involve peer evaluation and selection.

We designed a laboratory experiment that simulated patient and doctor decisions regarding overtreatment based on the credence-good model developed by Dulleck and Kerschbamer (2006).
The participants of the experiment are role players who are present in a setting framed with medical language. In the experimental design, while it would be in the best interest of the “patient” to match the intensive treatment only with the severe disease, “doctors” obtain more payoffs when the intensity of treatment is higher. The mismatching between the patient’s interests and the doctor’s incentives creates the potential for harmful overtreatment. We varied the level of information provided to the physicians’ peers and their degree of freedom in selecting future colleagues, thereby varying opportunities for maintaining the physicians’ group reputation through institutional arrangements for peer monitoring. The laboratory approach has the strength of clearly identifying overtreatment, which it is nearly impossible for a researcher to observe directly in a clinical setting, and of isolating, in a well-controlled setting, the peer-monitoring system as the cause of changes in overtreatment rates.

We find that peer monitoring with selection reduces the overtreatment rate by half when the experiment outcomes become stable after the initial stage. Moreover, patients in the peer-selection intervention understood the implications of offering physician selection and were almost 50% more likely to choose to interact with doctors compared to the baseline treatment. Peer information without selection reduced the overtreatment rate and improved the participation rate in contrast to the baseline, but these effects are not statistically significant.

We further find that the driving force of the physician selection is the emergence in the peer-selection intervention of superior physician groups, which most doctors choose to be affiliated with when given the chance to rematch with groups. We observe that such superior groups have an overtreatment rate near zero. By contrast, the relatively inferior groups from which most doctors want to exit perform no better regarding overtreatment than the average rate in the baseline.

Our results help researchers gain a better understanding of how institutional settings influence doctor and patient decisions. We demonstrate that peer institutions involving physician monitoring and selection can reduce overtreatments and improve patients’ trust in their doctors, provided

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3It should be noted that we recruited ordinary people from the community who acted as role players in our experiment, and the medical framing may or may not induce the participants’ other-regarding behavior that is widely observed in the real medical setting. Our primary research goal is to check whether the peer institutions of a physician group can be an independent channel for reducing the overtreatment rates. The medical framing allows us to capture several main features of medical care that have been discussed in the theoretical literature in the experimental design and to present the design to participants in an intuitive way.
that the following institutional conditions can be present and implemented at a low cost: 1) patients have access to group-level information that summarizes the treatment experiences of previous patients; 2) peer-doctors share detailed clinical information; and 3) doctors have a choice of deliberately selecting colleagues. Medical organizations can be designed that incorporate these institutional arrangements to maximize the power of the peer monitoring to curb overtreatment.

The remainder of the paper is arranged in the following fashion. Section II discusses the literature that is related to the experiment’s design. Section III presents the experiment design itself. Section IV provides the conjectures for experimental outcomes based on theories. Section V presents the results. We conclude the paper in Section VI.

2.2 Related Literature

2.2.1 Expert advice and physician-induced demand

In a variety of professional services, the agency problem may arise when the provider is an expert on the type of the goods the customer needs and provides both the diagnosis and the services/goods. Examples can be found in markets such as medical care, car and computer repair, legal or financial consulting, etc., though the complexity and resulting problems may vary. Services/goods of this type are termed “credence goods” in the literature (Darby and Karni, 1973; Emons, 1997; Wolinsky, 1995). Dulleck and Kerschbamer (2006) highlights three types of fraud in the transaction of credence goods: undertreatment, overtreatment, and overcharging, all of which lead to market inefficiency. Overtreatment is a particular concern when the expert is rewarded based on the volume or intensity of the service provided. In a medical setting, fee-for-service, where doctors are paid for each service (like an office visit, test, or procedure), is a dominant approach to pay doctors. This approach gives an incentive for physicians to provide more treatments because payment is dependent on the quantity of care.

In the literature of the physician agency in health economics, there has been a rich body of evidence regarding physician-induced demand (PID) where physicians may influence a patient’s demand for care that is against the best interest of the patient (Evans, 1974; Fuchs, 1978; McGuire, 2006).

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4It is noteworthy that Dulleck and Kerschbamer (2006) used the term “overtreatment” because, in their models, a high-cost treatment could be prescribed to cure a mild disease when a low-cost treatment would have done the job just as well.
Overtreatment could be considered a typical case of PID when the reimbursement is based on a fee-for-service schedule. For example, Gruber and Owings (1996) and Gruber et al. (1999) showed that the relative frequency of cesarean deliveries compared to normal childbirths increased as a reaction to the enlarged fee differentials of health insurance programs and to the decreases in the number of births. A recent study looked into the impact of lowering the reimbursement for overpriced drugs to treat patients with lung cancer, and the authors found that to offset the income reduction associated with the price reduction, oncologists treated more patients with chemotherapy (Jacobson et al., 2010).

The PID literature has focused on changing physicians’ financial incentives as a way of mitigating this physician-agency issue. Economists often suggest adopting prospective payment systems (such as bundled payments and capitation) and applying the pay-for-performance approaches; however, all kinds of payment approaches tend to have unintended consequences (Ellis and McGuire, 1986). It is also challenging for a payer, either the government or a private insurance company, to design and implement a more complicated payment system and to have physicians comply with it (Chernew, 2010). Therefore, it would be useful to provide evidence about other strategies for minimizing overtreatment, rather than relying on the payment approaches alone.

### 2.2.2 Group reputation and peer monitoring

This paper explores a way to curb overtreatment by relying on the design of institutions that foster and strengthen reputation mechanisms. We focus on institutions that facilitate peer monitoring and help physician organizations maintain a reputation for appropriate care, evaluating the extent to which this reputation mechanism can reduce overtreatment.

It is well-known that a reputation mechanism may hold agents accountable because they

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5 Besides the PID literature, overtreatment is also identified in the settings of auto repair, life insurance and the taxi business (Schneider, 2012; Balafoutas et al., 2013; Brown and Minor, 2012).

6 If medical services are paid on a fee-for-service basis, this may lead to misalignment between the doctors’ incentives and the patients’ interests because it usually gives an incentive for physicians to provide more treatments, payment being dependent on the quantity and intensity of care.

7 The small but growing experimental literature on the physician agency has mostly focused on physicians’ reactions regarding the incentives to the financial incentives they face. For instance, Brosig-Koch et al. (2015a,b) and Hennig-Schmidt et al. (2011) studied the effects of different payment systems on doctors treatment choices in the laboratory setting.
fear losing future business and profits if they develop a bad reputation (Fudenberg et al., 1990). However, the reputation mechanism based on an individual seller’s record, which is often discussed in the literature, has two drawbacks in dealing with the overtreatment issue in a market of professional services (Bar-Isaac and Tadelis, 2008). First, the credence-good feature of medical care hinders a reputation mechanism based on clients’ first-hand experience since patients cannot always observe whether they have received appropriate treatment (Tirole, 1996). Second, not all patients have frequent interactions over time with the same doctor. It is common that patients seek care based on the background of a physician, and a large share of a physician’s background is her credentials and affiliations. Therefore, we propose group reputation, rather than individual reputation, as the relevant reputation mechanism for the patient-physician interactions in our design.

Several studies reveal that information about quality provided at the hospital/facility level influence patients’ choice of medical care providers. For example, Cutler et al. (2004) found that the hospital report-card information had a significant impact on the demand for CABG surgery at specific hospitals in New York. They found that patients with lower switching costs and patients with the ability to travel were more likely to switch providers following a change in the reported performance at a hospital. Bjorkman et al. (2014) found that local beneficiaries are sensitive to the summary information at facility levels for primary care providers in Uganda, and that allowing local beneficiaries to monitor primary providers resulted in significant improvements in healthcare delivery and health outcomes in both the short and the longer run.

Since the entire group will share the reputation effects produced by the doctors who act appropriately, free-riders can benefit from a good group reputation without making any effort to maintain it. Too many free-riders will erode the group reputation (Kandel and Lazear, 1992). Group reputation also creates incentives for peer monitoring in order to tackle the free-rider problem. In fact, many professional groups utilize various peer-monitoring mechanisms to restrain their members’ conduct and to protect their own good name (Dixit, 2009). Physicians’ peer monitoring is found in virtually all medical organizations. Mayo Clinic, for example, is described as a model of medical care delivery that fosters team-oriented patient care and peer accountability. Members of care teams have accountability to each other, review each other’s work, and collaborate to deliver high-quality, high-value care (McCarthy et al., 2009).
2.2.3 Enforcement for peer monitoring

Because of the incentives for group members to free-ride on the group reputation, enforcement mechanisms play a crucial role in sustaining a high group reputation. Theoretically, in a peer monitoring system that provides access to peers’ clinical records without any particular mechanism for punishing doctors who engage in misconduct, physicians may not provide overtreatment because of concerns that peers might punish them according to the grim-trigger strategies (Kandori, 1992; Ellison, 1994). Despite this theoretical possibility, no reliable evidence exists on whether grim-trigger strategies among peers can mitigate the physician-agency problem and reduce the overtreatment rate for physicians practicing in groups.

In empirical settings, we sometimes observe formal institutions designed to provide enforcement. For example, most physician groups are organizations in which admission to and exclusion from a practice group is based on peers’ evaluation and selection (Levin and Tadelis, 2005). Physicians denied membership cannot benefit either from the group’s reputation or other shared resources, and may fall into a group with a lower status. Robinson (2001) asserted that a membership system can be established to ensure that physicians who participate in medical groups embrace the organizational goal. In this paper, we evaluate whether, with limited participation of a physician group, peer selection can serve as a supplementary non-price mechanism to restrain physicians from overtreatment through the potential threat of being relegated to the group with a lower reputation.

Although various enforcement mechanisms for peer monitoring have great potential for effectively sustaining a physician group’s reputation and reducing overtreatment, there is little empirical literature to identify the causal effects, perhaps due to the difficulty in finding a benchmark to determine overtreatment and in isolating relevant enforcement mechanisms. Dulleck et al. (2011) use an innovative design of a laboratory experiment to study fraud in an expert market. In their design, both diagnosis and treatment are observable only to the experts who are allowed to post their own prices. Therefore, overcharging, i.e. charging for treatment that was not provided, typically dominates overtreatment when consumers cannot even verify what services they obtain. Nevertheless, Dulleck et al. provide a base to examine the institutional arrangements for physician group in a laboratory setting as a first step. We revised their design by focusing on
overtreatment that was induced by a fixed-price schedule.\footnote{A later study by Mimra et al. (2013) applied a fixed-price schedule and highlighted the role of reputation at the individual level. In their setting, overtreatment was still dominated by overcharging since patients were unable to verify their treatments.}

One piece of evidence that is closely related to this study is Godager et al. (2013). It analyzed the effect of disclosing performance information to peers on physicians’ clinical choices in a laboratory experiment. The researchers invited a handful of medical students (prospective physicians) to prescribe treatments according to a schedule specifying patients’ and physicians’ payoffs from a variety of treatments, and physicians could favor profitable treatments that were not optimal for patients (represented by donations to charity). They investigated whether or not publicly disclosing each physician’s aggregate profits and her patients’ aggregate benefits at the end have an impact on the individual physician’s choice of treatments. They found that disclosing physicians’ performance to their peers increased patients’ benefits in a small but significant magnitude. Their research goal was to identify so-called “intrinsic incentives” of physicians (Kolstad, 2013), as the information disclosure revealed the performance gap among peers. Our study has an entirely different research goal. We focus on testing the effects of institutional arrangement for peer monitoring on the reduction of overtreatment, especially when selection enforcement was possible in addition to information sharing among peers. Compared with Godager et al. (2013), our design is simpler in the payoff structure but more complicated in the institutional structure, involving repeated disclosure of different layers of information (at both group level and intragroup level), and variations of enforcement for peer monitoring. We use group reputation to link these intragroup institutions to patients’ active choices, which, in turn, provide incentives for each group member to monitor peers.

2.3 Study Design

2.3.1 A credence-good model for overtreatment

In order to study the physician-agency problem in a laboratory experiment, we first set up a stage model by modifying the credence-good model developed by Dulleck and Kerschbamer (2006) and Dulleck et al. (2011). For the sake of convenience, in the remaining parts of the paper, the third person pronoun “she” will refer to the physician and “he” will refer to the patient.
In the model, there are two types of possible disease severity for the patient, denoted by $s \in \{s_1, s_0\}$. $s_1$ represents a severe problem that happens with a probability of $h$, and $s_0$ stands for a mild one, which occurs with a probability of $1 - h$. The probability $h$ is public information. Each patient knows that he has a problem, but does not know from which type of problem he suffers. Through a diagnosis, the physician can evaluate the severity of the disease and recommend a single treatment to the patient based on that diagnosis. There are two available treatments proposed by the physician, denoted by $d \in \{d_1, d_0\}$. An intensive treatment, represented by $d_1$, is effective for either the major disease or the minor disease, from which the patient gets a net payoff of $v_1$ and the physician earns a profit $\pi_1$. A non-intensive treatment, represented by $d_0$, is appropriate for a mild disease, from which the patient gets a net payoff of $v_0$ and the physician earns a profit of $\pi_0$. The physician may choose to treat the severe disease with the non-intensive treatment. In this case, the non-intensive treatment is ineffective. The physician earns $\pi_0$ and the patient gets zero payoff. By assumption, $v_0 > v_1$. That is, if the patient only has the minor problem, the non-intensive treatment is in the best interest of the patient. The intensive treatment is optimal for a patient only when the non-intensive treatment cannot do better. $\pi_1 > \pi_0$. That is, the intensive treatment always rewards the physician more; therefore, when the disease is mild, the physician faces the temptation of ordering overtreatment, which is not aligned with the patient’s best interest.

With these specifications, a one-shot game will exclusively reflect the agency problem of overtreatment (a physician provides $d_1$ when a disease is $s_0$). Overtreatment is harmful in terms of a patient’s opportunity cost because the patient benefits more from the more appropriate treatment. Instead of interacting with the physician, the patient can choose to opt out by spending a random searching cost of $r$ for an outside option, which can be understood as a random cost of searching for a perfect agent. The payoff of the outside option will reflect an appropriate treatment based on his need minus the searching cost, denoted by $o$. The expectation of $o$ is $\delta \equiv E(o) = hv_1 + (1 - h)v_0 - E(r)$. Since there is no interaction between the patient and the physician when the patient opts out, the physician will earn a reservation wage of $w$. These payoffs are public information. Figure 1 exhibits the extensive form of the stage game.

The decision-making timeline of the game proceeds with the following four stages:
The patient who is uncertain about his disease severity, either severe ($s_1$) or mild ($s_0$), decides whether to see his currently assigned physician.

If the patient chooses to stay, the physician will proceed with the diagnosis. The uncertainty concerning the severity of the disease is resolved by the physician’s diagnosis of either severe or mild, but the patient is unaware of this diagnosis. The physician gives a treatment, either intensive ($d_1$) or non-intensive ($d_0$), which is revealed to the patient.

If the patient chooses to opt out, the stage game ends. The patient’s expected payoff is $\bar{o}$. The physician gets $w$.

Both the patient and the physician observe their own payoffs from the stage game.

It should be noted that information asymmetry about the severity of an illness exists between the patient and the physician throughout the game. If the patient gets the intensive treatment, he obtains the same payoff regardless of the underlying severity of the disease. Therefore, it is difficult for a patient to identify overtreatment from only a one-time interaction. On the other hand, the treatment for the mild disease with the non-intensive treatment can inform the patient that no overtreatment has occurred, which helps to identify whether the physician is acting in her patients’ best interests, especially when intensive treatment is more profitable for the physician (Frankel and Schwarz, 2014).
The advantage of the stage game is that overtreatment can easily be defined. The patient is clearly better off when he receives the non-intensive treatment for his mild disease. If the physician is acting in the patient’s best interest, the intensive treatment is only given when the physician has no alternative. The model provides a simplified framework for isolating the agency problem from the complexity of medical decisions, which is still relevant to a broad range of medical cases. For example, an unnecessary CABG surgery, which is an intensive procedure, may pose a significant risk for a patient whose problem could actually be controlled by medication alone. Assisted vaginal delivery is far less risky than a cesarean section when the mother does not need the latter intensive procedure. Nonetheless, medical decisions about appropriate treatment are complex, often depending on the patient’s entire medical history and the progress of his disease, making it difficult for observational data to readily identify overtreatment (Chandra et al., 2012).

2.3.2 Experiment Design

Our experimental design is built around the above-mentioned stage game above mentioned. We engage \( k \) pairs of patients and physicians to play the stage game simultaneously for a total of \( T \) rounds. We explicitly use medical language throughout the experimental game, with subjects identified as physicians and patients and groups of subjects named as hospitals. In the actual experiment, we specify \( k=6 \) based on the capacity of the lab. Therefore, 6 patients and 6 doctors are enrolled for each experimental session. \( T \) is set to 20, but participants are not informed about the total number of rounds they are going to play in order to avoid influencing the end-of-game play. At the beginning of each round, a patient and a doctor will be randomly matched. In other words, a patient does not have the opportunity to choose among different physicians. He can only choose between staying with the assigned physician and opting out. In order to represent the situation in which the individual patient and the individual physician do not have frequent

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9It should be noted that the 2 diseases/2 treatments model excludes some medical cases. For example, we leave out cases in which physicians have legitimate treatment choices, involving different benefit/cost ratios. In other words, an expensive intensive treatment may result in an improved clinical result for the patients, while a less-expensive non-intensive treatment may produce a merely acceptable outcome. Thus, the best choice is determined not only by the patient’s condition, but also by financial considerations. In such a situation, a minor treatment may not be a useful signal for proper behavior.

10While we have made the efforts to approximate a medical setting, our subject pool does not represent medical experts, which may limit the external validity of our findings regarding the magnitude of the experimental outcomes.
encounters, we adopt stranger-matching, in which anonymous patients and doctors are randomly matched at the beginning of each round. Stranger-matching precludes any personal-reputation formation by individual physicians. No communication among participants is allowed. We divide 6 physicians into 2 physician groups. Each group has 3 physicians. The initial group affiliation is randomly assigned. We refer to physician groups as hospitals. An identity is randomly assigned to each hospital (named General Hospital and Memorial Hospital). 11 Though an individual physician’s identify is unknown to patients, the patients can see the hospital’s identity. The hospital identity serves as a vehicle for group reputation. A number ID is assigned to a physician, but the ID is only observable to other physicians if peer evaluation is available.

Our experimental interventions vary in information structure and the enforcement of peer-monitoring. The details are as follows:

**Baseline**  In the baseline, there is no opportunity to review the decisions of other physicians or to select peers as co-workers, and physicians’ hospitals are fixed. Public information is shown to both patients and doctors for each hospital in the baseline.12 The information they see consists of:

- The number of patients who saw a doctor in the hospital
- The number of patients who received intensive treatment
- The number of patients who recovered (i.e. did not receive ineffective treatments).

The missing information is how many intensive treatments were actually necessary. In order to ensure that patients concentrate on the information, we ask them to write down the public information for each round. This can also serve as a hospital’s historical record for patients to make reference to when they make decisions about whether or not to see a doctor at that hospital. Figure A1 in the Appendix A exhibits an example screenshot that shows the public information that study participants see.

11The hospital names were Adams and JFK in the initial 6 sessions.

12The hospital-level information can be understood as an aggregate about patients’ individual experience, which can be disseminated efficiently.
Peer Information  In the treatment with peer information, in addition to the public information, doctors can review one another’s clinical records. The following information is provided to doctors but not to patients:

- Each doctor’s ID and hospital affiliation
- Patient’s disease and treatment administered to him
- If a patient decided not to see his doctor, there was a message that said “no patient”.

In order to ensure that physicians review the peer information carefully, physicians are asked to write down the peer information for each round. This can also serve as a peer’s historical record for further reference. It should also be noted that physician groups remain unchanged throughout the experiment for both the baseline and the peer information intervention. Figure A2 in the Appendix A exhibits an example screenshot that shows the peer information.

Peer Selection  In the treatment with peer selection, everything is the same as in the peer information setting, except that every 4 rounds, doctors have the chance to select a hospital and potential partners for the next 4 rounds. A doctor needs to:

- Indicate which hospital she wants to join for the next four rounds
- Rate how much she wants to work with each of the other doctors on a scale of 1 to 5, with 5 the highest score.

Figure A3 in the Appendix A shows an example screenshot of the peer-selection procedure. The following rule determines a physician’s hospital affiliation: if there are three or fewer candidates at the same hospital, all candidates are automatically enrolled in that hospital. If there are more than three candidates at the same hospital, the three candidates with the highest sum of peer ratings are chosen by the hospital, where the sum of peer rating is equal to the total ratings that she has gotten from all other candidates at the same hospital that she has applied to. After the three top-peer-rated candidates have been chosen (in the case of a tie, the enrollment will be determined randomly), the other candidates for that hospital end up at the hospital that they did not choose.

Table 2.1 summarizes the features of each experimental intervention in the study design.
Table 2.1: Summary of experimental interventions

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Patients’ information</th>
<th>Doctors’ information</th>
<th>Intragroup enforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>Aggregate information on patients’ experiences</td>
<td>Aggregate information on patients’ experiences</td>
<td>None</td>
</tr>
<tr>
<td>Peer Information</td>
<td>Aggregate information on patients’ experiences</td>
<td>Clinical information on peers’ practice</td>
<td>None</td>
</tr>
<tr>
<td>Peer Selection</td>
<td>Aggregate information on patients’ experiences</td>
<td>Clinical information on peers’ practice</td>
<td>Selection of colleagues</td>
</tr>
</tbody>
</table>

2.3.3 Implementation and sample

The experiment was conducted at the Harvard Decision Science Lab between August and December in 2014. We invited a combined sample of students and ordinary people to play the roles of doctors and patients in the game. The participants knew that they would earn various amounts of cash, depending on chance, their choices, and other participants’ choices in the game. We recruited participants using the lab’s SONA system (on-line participant management system), with the age restriction ranging from 18 to 65, and the requirement of at least a high-school education. Because the lab is located at Harvard University, the number of student participants might vary considerably across sessions, due to their course schedule. In order to have a similar composition of students across sessions, we restricted the maximum number of student participants in a session to 4.\(^{13}\) It should be noted that although we framed the game in a medical setting, we did not invite experienced doctors or medical students to play the role of doctors. The advantage of involving participants with medical training might enable researchers to identify the effects of medical ethics on clinical decisions (Hennig-Schmidt and Wiesen, 2014; Kesternich et al., 2015).\(^ {14}\) In our study, the primary research question is problem oriented, focusing on which peer-monitoring institutions can effectively reduce the overtreatment rate. Even though we do not deliberately elicit medical ethics, our study results are still relevant for a range of institutional settings where the strength of medical ethical norms varies. In future work, it would be interesting to investigate how a peer-monitoring system plays a role in reducing overtreatment when medical ethics is a

\(^{13}\) Otherwise, it would require an even larger sample to offset that variation. This restriction was not in place during the initial 4 rounds.

\(^{14}\) Kesternich et al. (2015) found that recruiting medical students alone could not elicit medical ethics even though the game was framed in a medical setting. The experimenter still needs to make the Hippocratic Oath salient to medical students and make the experimental outcome link to real patients (through a donation to a medical charity).
Table 2.2: Numerical values for parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>$v_0$</td>
<td>8</td>
</tr>
<tr>
<td>$v_1$</td>
<td>2</td>
</tr>
<tr>
<td>$\pi_0$</td>
<td>4</td>
</tr>
<tr>
<td>$\pi_1$</td>
<td>6</td>
</tr>
<tr>
<td>$h$</td>
<td>0.5</td>
</tr>
<tr>
<td>$w$</td>
<td>2.5</td>
</tr>
<tr>
<td>$\delta$</td>
<td>2.5, 3 and 3.5 with equal probability</td>
</tr>
</tbody>
</table>

more significant factor.\(^{15}\)

The procedures of the experiment are as follows: at the beginning of each experimental session, participants are seated in a cubicle in front of a computer and participate in one session of a game. The instructions presented in the context of medical decision are read aloud (see the online Appendix for the script of instructions). Next, participants answer a short quiz about the payoff matrix in order to ensure that they understand the rules of the game. When all participants answer the quiz correctly, a random device determines the allocation of subjects to their roles. The roles are fixed throughout the entire experiment. After the role assignment, doctors and patients start to play the stage game as described in the previous subsection, with the numerical values for the parameters as shown in Table 2.2. These values are chosen to ensure that patients are willing to see their assigned doctor when they expect that the number of doctors in a hospital will administer appropriate treatments is greater than 1. Under this condition, an individual doctor may have an incentive to provide overtreatment because she can free-ride on the group reputation maintained by the other peers in the baseline.

In order to alleviate the calculation burden to the participants, we distribute the sheet of payoff matrix as shown in Table 2.3 to participants at the beginning of the experiment. We ask participants to refer to this payoff matrix while making decisions throughout the game.

In the end of each experimental session, participants are prompted to answer a questionnaire about demographic features and individual attitudes. Then, the total payoff points earned by participants are converted into cash with the ratio of 4 points = 1 US dollar.

\(^{15}\)We might expect institutions that fostering the group reputation to be even stronger depending on the strength of the norms around medical ethics.
Table 2.3: Payoff matrix for participants

<table>
<thead>
<tr>
<th>Patients’ decisions</th>
<th>Patients’ disease</th>
<th>Doctors’ decisions</th>
<th>Patients’ payoffs</th>
<th>Doctors’ payoffs</th>
</tr>
</thead>
<tbody>
<tr>
<td>To see the doctor</td>
<td>Severe (1/2 chance)</td>
<td>Intensive</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-intensive</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Mild (1/2 chance)</td>
<td>Intensive</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-intensive</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Not to see the doctor</td>
<td>n.a.</td>
<td>n.a.</td>
<td>2.5, 3, or 3.5, with equal probability</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Table 2.4: Summaries of participant allocation

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Number of sessions</th>
<th>Number of participants in each session</th>
<th>Total participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>8</td>
<td>12</td>
<td>96</td>
</tr>
<tr>
<td>Peer Information</td>
<td>8</td>
<td>12</td>
<td>96</td>
</tr>
<tr>
<td>Peer Selection</td>
<td>8</td>
<td>12</td>
<td>96</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>36</td>
<td>288</td>
</tr>
</tbody>
</table>

A total of 288 participants were enrolled for 24 sessions. The participants were equally allocated to the 3 experimental interventions and each experimental intervention contained 8 sessions. Table 2.4 exhibits the allocation of participants. From our initial estimation based on pilots, this sample size guarantees that the study design can detect a relatively large effect of institutional interventions on overtreatment (a standard deviation of 0.8) with 80% power.

2.4 Theoretical Analysis and Conjectures

In this section, we first provide a theoretical analysis of potential experimental outcomes in the baseline. Then, we make some conjectural analyses about the outcomes of experimental interventions. To facilitate these analyses, we assume that all players maximize their pecuniary return and that they are risk-neutral. We will discuss the experimental outcomes under other behavioral assumptions in section 4.3.

2.4.1 Theoretical analysis of baseline

In the baseline, a doctor will administer appropriate care only if the benefit from overtreatment to her is less than the benefit from contributing to the group reputation by providing non-intensive care.

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16 We also conducted 4 pilot sessions with different parameters and periods in July and August of 2014; results from these sessions are not included in the main analysis.
treatment whenever appropriate. However, if a doctor can rely on other doctors’ administration of proper care to maintain her group’s reputation, those doctors may have an incentive to free-ride by overtreating.

To formalize the idea, we let \( g \in \{0, 1, 2, 3\} \) represent the number of doctors who provide appropriate care. Patients’ decisions about whether or not to see a doctor at the assigned hospital are based on \( g' \), the expected number of doctors who will administer the appropriate treatments according to the subjective distribution of \( g \). Patients’ expected payoffs varying by \( g' \) is \( 2 + g' \).\(^{17}\) Since the expected payoff from the outside option is 3, patients will only choose to see a doctor when \( g' > 1 \). The question is whether a doctor will choose to offer appropriate treatment.

To provide an explicit answer, we assume that the patients in round 1 will initially visit their assigned doctors and that the patients in round \( t > 1 \) will form the subjective distribution of \( g \) by inheriting the subjective distribution from the last round and updating it with the previous-round group-level signals following the Bayesian Rule. It is easy to see that as long as not all treatments are intensive in the previous round, \( g' > 1 \) will remain true, because there was at least one doctor who definitely provided appropriate care. When the number of intensive treatments, denoted by \( D \), is 3, the current-round patients’ beliefs may update to \( g' < 1 \) with a positive probability, denoted by \( 0 < q < 1 \). Consequently, all following patients will stop seeing their doctors permanently. The magnitude of \( q \) depends on the entire history of the group. Successive signals of \( D = 3 \) are more likely to lead to all patients opting out. To maintain the group reputation, a doctor should provide nonintensive treatment whenever possible and reduce the chance of \( D = 3 \).

Given the patients’ decisions illustrated above, only a doctor who believes she will make a greater profit in a repeated game by administering appropriate treatment will refrain from administering overtreatment. Defining \( \delta \) as the discount factor, we then look for possible equilibria for baseline with \( \delta = 0.8 \) (Embrey et al., 2013). We find that in order to maintain an equilibrium of \( g = 3 \), \( q \) has to be larger than 1.11 (see Appendix 2B for details) which is impossible. Our interpretation of this result is that even if doctors reasonably focus on long-run profit (\( \delta = 0.8 \)), we may not be able to see an equilibrium of \( g = 3 \) in the baseline, no matter how patients respond.

\(^{17}\)If a physician always provides appropriate care, patients can expect an average of 5 points from interacting with the physician: 8 points if his condition is mild, and 2 points if his condition is severe, with equal probability. Otherwise, if a doctor always administers the intensive treatment, it gives a fixed payoff of 2 points to a patient. \( 2 + g' \) can be derived from \( g'5/3 + (3 - g')2/3 \).
to $D=3$.

In theory, it is possible to evolve into such an equilibrium where some doctors overtreat patients while the remaining doctors keep administering appropriate treatments. The rationale is that, when the probability of triggering the permanent loss of patients sufficiently high, a particular doctor will try to maintain the group reputation by herself even when other peers have started the practice of overtreatment. However, this kind of equilibrium is problematic in the baseline because doctors cannot evaluate whether or not an intensive care administered by a peer is appropriate; and, thus, they have trouble determining their position vis-à-vis their peers due to imperfect monitoring. It would be difficult for member doctors in the same hospital to agree on who should be the doctor with the privilege of overtreating patients and earning more payoffs, and such coordination is likely to fail.

Based on the theoretical analysis of baseline, we are likely to see a high overtreatment rate for physician groups if every doctor wants to be the free-rider on other doctors’ contribution to the group reputation, which also leads to a low participation rate for patients.

### 2.4.2 Conjectures

The theoretical analysis of the baseline clearly shows that, using the public information by itself, it is nearly impossible to sustain the equilibrium in which all doctors administer appropriate treatment. This type of theoretical analysis, however, relies on strong assumptions about the formulation of participants’ beliefs in order to construct equilibrium strategies. When we introduce peer-monitoring systems, it becomes extremely difficult to track those beliefs. In the remaining parts of this section, we provide some conjectures about experimental outcomes for the peer information and selection interventions based on the basic economic rationale (We attempt a theoretical analysis in Appendix 2B).

We organize our conjectures around two outcome measurements of interest: 1) the overtreatment rate at which physicians administer intensive treatments when patients’ conditions are mild, which directly measures the occurrence of physician agency problems; and 2) the participation rate at which patients choose to opt out, which measures patients’ willingness to participate.

In contrast to imperfect monitoring by patients in the baseline, the peer-information intervention exposes a physician’s clinical decision to peers. In theory, an equilibrium of $g = 3$ could be
enforced by grim-trigger strategies among peers: once any peer deviates toward overtreatment, other doctors will themselves begin to consistently overtreat patients. Patients will stop seeing doctors when they perceive that a physician group has been on the off-equilibrium path where all doctors administer overtreatment. However, despite the theoretical possibility, reaching such an equilibrium with patients’ and doctors’ coordination could be challenging in our experimental setting. It is noteworthy that such an equilibrium enforced by grim-trigger strategies among peers has the undesirable feature of leading to a permanent deterioration of the hospital’s reputation after a single overtreatment. If the grim-trigger strategies are effective, we expect that they may give rise to a relatively low overtreatment rate in the peer-information intervention if most doctors administer the appropriate treatment at the beginning.

In the peer-information intervention, although doctors are able to detect overtreatment by peers, the means for sanctioning a misbehaving peer are limited. A more effective peer-monitoring system should allow doctors to screen out those who overtreat patients. In the study design for the peer-selection intervention, we allow two additional choices for doctors at a preset interval of four rounds: 1) choose the hospital they want to enroll in for future rounds; and 2) rate the partners to determine who can enroll in the same hospital. There is a doctor-hospital rematching through peer selection in every 4 rounds so that doctors have time to examine peers’ behavior before rematching with colleagues. The goal of giving doctors these options is to let them enforce peer monitoring by deliberately selecting their hospitals and partners. The enforcement is most effective when there is a superior hospital with a large patient base and an inferior hospital with a shrinking patient base. It should be noted that if both hospital are superior, a particular doctor would have the incentive to provide inappropriate care for the same reason as in the baseline. Therefore, we are more likely to observe that hospitals differentiate into a superior hospital and an inferior hospital.

In summary, we conjecture that the baseline will experience a higher overall rate of overtreatments, because it only relies on public monitoring and every doctor has the incentive to free-ride on the group reputation throughout the experiment. However, we cannot make clear theoretical predictions about which peer-monitoring intervention will have the lowest overtreatment rate. In the peer-information intervention, even if all doctors administer appropriate treatments initially, the result is not stable once some doctors have begun to administer inappropriate care. Therefore,
it is uncertain what the overtreatment rate at the end of the sessions in the peer-information intervention will be. In the peer-selection intervention, we are likely to see that the superior hospital outperforms the inferior hospitals in each session. Since the low overtreatment rate at the superior hospital will be offset by the high overtreatment rate at the inferior hospital, the overall overtreatment rate of the peer-selection intervention is not necessarily different from that of the peer-information intervention. Therefore, we make the following two conjectures.

**Conjecture 1** The baseline will have a higher overall overtreatment rate than the other two interventions.

**Conjecture 2** The peer-selection intervention is more likely to produce a superior hospital, defined as a hospital that approaches the elimination of overtreatments.

Next, we make a theoretical conjecture about patients' participation rates. Patients' participation rates will be determined by two factors: 1) beliefs about the number of doctors in a hospital who provide appropriate treatment; and 2) how frequently negative signals occur (such as 3 intensive treatments out of 3 patients). In the baseline, patients may not be willing to participate in the game if they believe there are an insufficient number of doctors who will administer appropriate treatments. In addition, even for patients who choose to participate, the frequency of negative signals will affect their beliefs. Therefore, we conjecture that the overall patient participation rate will be low in the baseline treatment. For both peer-information and peer-selection interventions, patients may obtain assurance from the existence of the peer monitoring. However, it is uncertain whether the peer-information intervention or the peer-selection intervention will have a higher patients' participation rate overall, since this will depend on whether hospitals can control their doctors' overtreatment and suppress the occurrence of negative public signals. In the peer-selection intervention, when institutions allow physician peers to select hospitals and colleagues, patients will be able to differentiate the superior and inferior hospital by using the public signals. We expect that once the reputation at the superior hospital has been established, patients will be more likely to see doctors from the superior hospital than from the inferior hospital.
Conjecture 3: The baseline will have a lower overall participation rate than the other two interventions.

Conjecture 4: In the peer-selection intervention, the superior hospital will have a higher participation rate than the inferior hospital.

2.4.3 Other behavioral assumptions

The above conjectures are largely based on the assumption of a rational and self-interested player, but they do not consider other behavioral motivations. These motivations include but are not limited to: a) other-regarding preferences as stated by the Hippocratic Oath; b) the pure observer effect, when subjects change behavior if they are observed by others; and c) intrinsic incentives; that is, if doctors are providing appropriate treatments, a single doctor may be less motivated to provide overtreatments because she does not want to perform worse than the majority.

Other-regarding preferences of physicians tend to restrain doctors from overtreatment across all interventions; thus, it will not jeopardize the internal validity of the experimental design, but will instead reduce the variation in experimental outcomes.

The observer effect may predict a reduction in the overtreatment in peer-information and peer-selection interventions in the short-run when doctors’ records are subject to peers’ observation (Levitt and List, 2011), but this effect tends to decline over time (Bjorkman et al., 2014).\textsuperscript{18} Since the game involves 20 periods, we expect that the experimental outcomes obtained from the later stage may contain less pure observer effects. Nevertheless, a comparison between the peer-information and peer-selection interventions will eliminate the observer effect because the peers’ information structure is the same in the two interventions.

As for intrinsic incentives, it is possible that doctors are more likely to follow their peers’ good behavior in the same group (Kolstad, 2013). With information sharing, hospitals with a low initial overtreatment rate tend to automatically maintain its good status. This may reduce the differences in experimental outcomes between the peer-information and peer-selection interventions.

Nevertheless, because we only randomize the institutions but no other things, we can interpret

\textsuperscript{18}For example, Bjorkman et al. (2014) led a team of MDs that observed primary doctors for a short period. They found that quality improved initially but rapidly returned to levels similar to those in the absence of a team of observers.
the differences of the experimental outcomes due to behavioral motivations as a part of the overall effects.

2.5 Results

2.5.1 Summary results of comparing experimental interventions

We first examine the aggregate results across the experimental interventions. Table 2.1 summarizes the average rates for overtreatment, ineffective undertreatment, and patients’ participation. Figure 2.1 displays the evolution of doctors’ overtreatment rates and patients’ participation rates over time for every four rounds. In Table 2.1, we report average outcomes by treatment arms and p-values derived from a permutation of cluster-level means (Young, 2015). As column 1 in Table 2.1 reveals, the overtreatment rate for the baseline is about 44%. The difference in the overtreatment rate between the peer-selection intervention and the baseline is 16.4 percentage points, a difference that is significant at the 5% level (p=0.04). The difference in the overtreatment rate between the peer-information intervention and the baseline is 10 percentage points (p=0.23), which is not statistically significant. The overtreatment rate for the peer-selection intervention is 6.4 percentage points lower than that for peer information, though it is not significant (p=0.25). These results suggest that the peer-selection intervention results in the lowest level of average overtreatment rates.²⁰

Column 3 in Table 2.1 reports the average patient-participation rate. In the baseline, the participation rate is 46.7%; in other words, more than half the time, patients choose not to take advantage of the opportunity to see a doctor. As predicted by the theory, patients are more likely to see doctors in the peer-information and peer-selection interventions, with an increase of 15 percentage points and 20 percentage points (p=0.10 and p=0.035, respectively). In the peer-selection intervention, the participation rate for patients is the highest, as predicted by our

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¹⁹Given prior evidence observed in laboratory experiments, it is not very surprising that many doctors administer the appropriate treatment for the mild disease even in the baseline.

²⁰The experimental design also allows doctors to choose undertreatment, and the undertreatment rate can be viewed as an indicator of whether subjects complied with the experimental instructions. If subjects choose treatments randomly, there will be a relatively high undertreatment rate. The overall undertreatment rate is 1.7%. Undertreatment cases occur for the most part at the beginning of the game and distribute evenly across interventions. Because undertreatment cases are rare, we do not consider undertreatment cases in our analysis.
Table 2.1: *Average outcomes by experimental interventions*

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Average rate</th>
<th>Average per-round payoff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overtreatment</td>
<td>Participation</td>
</tr>
<tr>
<td>Baseline</td>
<td>0.441</td>
<td>0.467</td>
</tr>
<tr>
<td></td>
<td>(0.056)</td>
<td>(0.071)</td>
</tr>
<tr>
<td>Peer information</td>
<td>0.341</td>
<td>0.619</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td>(0.039)</td>
</tr>
<tr>
<td>Peer selection</td>
<td>0.277</td>
<td>0.667</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td>(0.040)</td>
</tr>
<tr>
<td>p-value:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peer information = Baseline</td>
<td>0.23</td>
<td>0.10*</td>
</tr>
<tr>
<td>Peer selection = Baseline</td>
<td>0.04**</td>
<td>0.035**</td>
</tr>
<tr>
<td>Peer information = Peer selection</td>
<td>0.25</td>
<td>0.42</td>
</tr>
</tbody>
</table>

Note: 1. Robust standard errors in parentheses are clustered at the session level.
2. P-values are calculated by permutation of cluster-level means.

The last two columns of Table 2.1 list the average payoffs per round for both doctors and patients. We observe that doctors earn about 9.6% and 11.8% more per round regarding average payoffs in the peer-information intervention and in the peer-selection intervention than in the baseline (p=0.152 and p=0.10, respectively). At the same time, patients earn 8.3% and 15.2% more (p=0.11 and p=0.02, respectively) in terms of per-round average payoffs.21

Figure 2.1 shows the evolution of the interaction between doctors and patients for each group of 4 rounds. The figure on the left reveals that the initial overtreatment rate is 45-50% in the baseline and that this rate declines by about 10 percentage points as time goes on. The initial overtreatment rates are below 40% in both the peer-information intervention and the peer-selection intervention. Starting right before the mid-rounds, the overtreatment rates between the peer-information and the peer-selection interventions differ remarkably. Peer-information and peer-selection interventions display similar overtreatment rates at the beginning, which may result from the fact that the peer-selection process has not been fully implemented, and has as yet failed to produce a hospital with a superior status. In addition, given that the selection procedure is relatively complicated, it takes time for doctors to learn how to respond to the mechanism. As a result, the two treatments look similar in the early rounds, but overtreatment declines in the

21 It should be noted that subjects’ actual payoffs in a session do not represent their expected payoffs, since the game is designed to stop unexpectedly and subjects are unaware of when the game will end.

22 This could result from patients’ choices, since patients will avoid hospitals with many negative signals.
Figure 2.1: Evolution of doctor-patient interactions across experimental interventions

Peer-selection intervention relative to the peer-information intervention in the later rounds. The right-hand side of Figure 2.1 shows that after some initial volatility in the patients’ participation, the peer selection intervention earns the highest rate of patients’ participation, up to approximately 70%, while the participation rate plummets in the baseline, especially in the very last stage, where it averages 40%.

We also observe that the participation rate first decreases and then rebounds in both the baseline and the peer-information intervention. It is hard to say exactly why patients’ choices follow this pattern. A possibility is that patients have some confidence in specific hospitals after they observe the hospitals’ histories for a significant amount of time. Another possibility is that patients have a tendency to give doctors a second chance as time goes on. Nevertheless, the participation rate in the baseline does not continue to rise (in fact it declines), and the participation rate in the peer-information intervention remains flat in the last stages of the game.

In order to account for the fact that we collect repeated measures for each experimental subject, we run multilevel mixed-effects linear models comparing the doctors’ overtreatment and patients’ participation across interventions. In each regression, we include random effects at the session and subject-in-session levels. We also include the linear time trend of \( t \), where \( t \) is the number of
rounds left plus 1 (i.e., \(T - t + 1\)) in one of the regression models.\(^{23}\) The regression model can be written as
\[ y_{i,j,t} = \alpha + \beta \times \text{intervention}_{i,j,t} + \gamma t_j + \mu_{i,j} + \rho_{i,j} + \epsilon_{i,j,t}, \]  
(2.1)
where \(y_{i,j,t}\) is the outcome of overtreatment or participation indicator for subject \(i\) of session \(j\) at round \(t\).

The results present the same substantive conclusions as the summary statistics in Table 2.2. Column 1 suggests a significant negative effect of peer selection on overtreatment, which reduces the overtreatment rate by 14.5 percentage points (p-value = 0.01), about 1/3 of the overtreatment rate in the baseline. The peer-information intervention also reduces overtreatment by about 10 percentage points (p-value = 0.07) compared with the baseline, though this difference is only statistically significant at the 10% level. Column 2 includes an interaction between the peer-monitoring interventions and the time trend (measured as the rounds left) in order to consider how the interventions’ impacts change over time. The effects of interaction between interactions and the rounds left are not a significant factor on overtreatment. Due to the complexity of the study design, the effects of experimental interventions in the initial periods are likely to be influenced by variations in individual learning. Column 3 drops the first 8 rounds, thus only including rounds 9-20, by which time we expect that most subjects will understand the experiment and will have chosen a strategy. Focusing on these last rounds, we find that peer-selection reduces the overtreatment rate by 20 percentage points (p-value = 0.01), which is significant at the 1% level. The difference in the overtreatment rate between the peer-selection intervention and the peer-information intervention in these later rounds is 10 percentage points (p-value = 0.09), which is significant at the 10% level. The difference between the peer-information intervention and the baseline is 10 percentage points (p=0.16), similar to the estimated effect across all rounds.

Columns 4-6 in Table 2.2 show that both the peer-information intervention and the peer-selection interaction have a significant effect on patients’ participation. The peer-information intervention increases the participation rate by 15.2 percentage points for all rounds (p-value = 0.06) and 16.8 percentage points for later rounds (p-value = 0.03). The peer-selection intervention

\(^{23}\)We also use the model specification with non-linear time trends such as \(1/t\) and a combination of \(t\) and \(t^2\); the results are similar.
### Table 2.2: Regression estimates of peer-information and peer-selection effects

<table>
<thead>
<tr>
<th>Variables</th>
<th>Doctors' Overtreatments</th>
<th>Patients' Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All rounds 1</td>
<td>All rounds 2</td>
</tr>
<tr>
<td>Peer information</td>
<td>-0.097***</td>
<td>-0.053</td>
</tr>
<tr>
<td></td>
<td>(0.053)</td>
<td>(0.102)</td>
</tr>
<tr>
<td>Peer selection</td>
<td>-0.145***</td>
<td>-0.205*</td>
</tr>
<tr>
<td></td>
<td>(0.056)</td>
<td>(0.120)</td>
</tr>
<tr>
<td>(\tau)</td>
<td>0.002</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Peer information (\times)(\tau)</td>
<td>-0.004</td>
<td>-0.005</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Peer selection (\times)(\tau)</td>
<td>0.006</td>
<td>-0.012**</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.447***</td>
<td>0.415***</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td>(0.083)</td>
</tr>
<tr>
<td>P-value (Wald test)</td>
<td>0.38</td>
<td>0.40</td>
</tr>
<tr>
<td>Peer information = Peer selection</td>
<td>512</td>
<td>2,880</td>
</tr>
<tr>
<td>Observations</td>
<td>853</td>
<td>853</td>
</tr>
</tbody>
</table>

Note: 1. Session-specific and subject-specific random effects are included in the model.
2. Reported standard errors are robust to clustering at the session level.
3. *** \(p <0.01\), ** \(p <0.05\), * \(p <0.1\)

increases the participation rate by 20 percentage points for all rounds (p-value = 0.02) and 25 percentage points for later rounds (p-value<0.001). Column 5 reveals that there is a downward trend of participation for the baseline.\(^{24}\) The peer-information intervention does not offset the trend, but the peer-selection intervention does.

In summary, the results in this section are largely consistent with Conjectures 1 and 3. The baseline produces the highest average overtreatment rate and lowest average participation rate, while, empirically, we observe that the peer-selection intervention outperforms the peer-information intervention in these two measures, especially for the later rounds.

### 2.5.2 Analysis of superior and inferior hospitals

The previous section presents the primary results of this paper based on the randomization of the experimental design. This section examines why the peer-selection intervention has the lowest overtreatment rate and the highest participation rate of patients. We conjecture that the peer selection arm may generate a superior hospital where doctors would compete for enrollment and enjoy a steady flow of patients (Conjectures 2 and 4). In order to identify a superior hospital,

\(^{24}\)The time trend is presented as the rounds left, which is a decreasing measurement; therefore, a positive sign suggests a downward trend.
Table 2.3: Average outcomes for superior and inferior hospitals

<table>
<thead>
<tr>
<th>Interventions</th>
<th>Average rate</th>
<th>Average per-round payoff</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overtreatment</td>
<td>Participation</td>
</tr>
<tr>
<td>Inferior</td>
<td>0.404</td>
<td>0.577</td>
</tr>
<tr>
<td></td>
<td>(0.101)</td>
<td>(0.071)</td>
</tr>
<tr>
<td>Superior</td>
<td>0.055</td>
<td>0.731</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.031)</td>
</tr>
<tr>
<td>P-value</td>
<td>Superior=Inferior 0.00***</td>
<td>0.067*</td>
</tr>
</tbody>
</table>

Note: Robust standard errors in parentheses are clustered at the session level. P-values are calculated by permutation of cluster-level means.

we classify hospitals by doctors’ choices when peer-selection options are available. We label the hospital attracting more than three candidates when partner and hospital re-matching is available as a superior hospital, and the hospital with fewer than 3 doctor candidates as an inferior hospital. When each hospital has exactly three candidates, we continue with the classification of the superior hospital from the previous rematch of colleagues if the classification is available. In early rounds when no more than 3 doctors choose the same hospital, hospitals cannot be classified as superior or inferior, and, thus, classified as undetermined. We observe that undetermined hospitals diminish over time, with a proportion of 100% at Round 1-4, 50% at Round 5-8, 25% at Round 9-12, and zero at the rounds left.

Table 2.3 compared the average overtreatment rates and participation rates of patients between the superior and inferior hospitals as defined above. There are striking differences in the overtreatment rate and the participation rate between the superior and inferior hospitals. The overtreatment rate at the inferior hospital is 40%, while the overtreatment rate at the superior hospital is only about 5%. The difference is 35 percentage points (p<0.001) and significant at 1%. Also, patients’ participation rate at the superior hospital is approximately 15 percentage points (p=0.07) higher than that in the inferior hospitals. At the same time, patients earn about a 0.73 point payoff more per round when they interact with doctors from the superior hospital.

The evolutions of superior and inferior hospitals in regard to overtreatment rates and participation rates are illustrated in Figure 2.2. For comparison, we also include the changing values of the two variables from the peer-information intervention in this figure. Results for the early rounds are somewhat mixed. This may be because it is difficult to differentiate the superior hospital from
the inferior hospital in the initial rounds, in which both patients and physicians are still learning about the game and a large number of hospitals cannot be classified as either superior or inferior. However, overtime the superior hospital clearly emerges. The figure on the left side shows that the overtreatment rate goes to almost zero for the emerged superior hospital that emerges after the initial stage. On the other hand, the inferior hospital has a much higher overtreatment rate, with a rising trend toward the end. The figure on the right side reveals patients’ willingness to interact with their assigned doctors. Similarly to the overtreatment rates, participation rates increase for the superior hospital from 50% to 75% over time; there are positive differences in participation rates, small and large, between superior and inferior hospitals over time.

As can be seen in Figure 2.2, after Round 9-12, the participation rate of patients is similar for the inferior hospital and the peer-information intervention, and overtreatment rates at the inferior hospital are even higher, suggesting that the aggregate differences between the peer-information intervention and the peer-selection intervention are driven by the performance of the superior hospital.

This descriptive analysis cannot establish a causal relationship between the inferior hospital and the superior hospital because the classification for hospitals is endogenous. In other words, it is hard to determine whether the reduction of overtreatment is because of an enforcement effect due to the threat of being relegated to the inferior hospitals, or because of the sorting effect in which
individual doctors who always give appropriate treatment are sorted into the superior hospital. Therefore, we run a mixed-effect linear model that controls for the individual initial overtreatment rate when a hospital’s classification is undetermined, assuming that individual characteristics of doctors that lead to overtreatment are proportional to doctors’ average overtreatment rates in the initial rounds, when the superior hospital cannot be clearly identified (Embrey et al., 2013). The regressions also contain fixed effects for the seasonality within each doctor-hospital match of 4 rounds and for the timing when superior and inferior hospitals can be differentiated (denoted by $\theta_{ij,t}$). The regression model can be written as

$$y_{i,j,t} = \alpha + \beta \times superior_{i,j,t} + \eta \times initial_{overtreatment\_rate} + \gamma \tau_t + \theta_{ij,t} + \mu_j + \rho_{ij} + \epsilon_{i,j,t},$$  \hspace{1cm} (2.2)  

Table 2.4 shows the results of such a model. Compared to the summary in Table 2.3, the gap between the overtreatment rates at the superior hospital and the inferior hospital is significantly reduced. However, there is still a difference of 18 percentage points (p-value = 0.03) between the inferior and superior hospitals for all rounds, which can be considered as the effect produced by the threat of being relegated to the inferior hospital when peer monitoring is enforced; the rest of the differences eliminated by controlling the initial overtreatment (about 13 percentage points) could be accounted for by the sorting effect. When comparing the superior hospital with the inferior hospital in rounds 9-20 in Model 3, we find that the enforcement effects further lead to a 23-percentage-point reduction of the overtreatment rate (p-value = 0.002).

With regard to the regression analysis for participation rates, because patients are randomly assigned to hospitals, a regression analysis for patients does not suffer from the self-sorting bias observed in doctors. We estimate patients’ participation rates directly for the mixed-effect linear models. As shown in column 6, the difference in the patients’ participation rate between the superior hospital and the inferior hospital can be as large as 15 percentage points during rounds 9-20 (p-value = [0.04]). The results show that patients are more likely to visit the superior hospital even if they cannot observe doctors’ choices for partners.

In order to check whether or not, as intended, the selection mechanism in the peer-selection intervention has kept the doctors who overtreat patients from remaining in the hospital with a good reputation as intended, we can simply examine in detail how doctors choose their colleagues. We focus on a subsample of superior hospital candidates because the superior hospital
### Table 2.4: Regression estimates of outcomes for superior and inferior hospitals

<table>
<thead>
<tr>
<th>Variables</th>
<th>Doctors’ Overtreatments</th>
<th>Patients’ Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All rounds 1</td>
<td>All rounds 2</td>
</tr>
<tr>
<td>Superior</td>
<td>-0.175**</td>
<td>-0.218**</td>
</tr>
<tr>
<td></td>
<td>(0.0803)  (0.104)  (0.0761)  (0.0672)  (0.0982)  (0.0711)</td>
<td></td>
</tr>
<tr>
<td>τ</td>
<td>0.00820</td>
<td>(0.0103)</td>
</tr>
<tr>
<td>Superior × τ</td>
<td>0.00424</td>
<td>(0.0141)</td>
</tr>
<tr>
<td>Initial overtreatment rate</td>
<td>0.297**</td>
<td>0.300***</td>
</tr>
<tr>
<td>Seasonality</td>
<td>1</td>
<td>0.0358</td>
</tr>
<tr>
<td></td>
<td>(0.0657)  (0.0617)  (0.0810)  (0.0380)  (0.0413)  (0.0356)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-0.0326</td>
</tr>
<tr>
<td></td>
<td>(0.0660)  (0.0601)  (0.0636)  (0.0600)  (0.0615)  (0.0583)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>-0.0103</td>
</tr>
<tr>
<td></td>
<td>(0.0809)  (0.0847)  (0.0872)  (0.0188)  (0.0172)  (0.0161)</td>
<td></td>
</tr>
<tr>
<td>Order of emergence</td>
<td>1</td>
<td>-0.114</td>
</tr>
<tr>
<td></td>
<td>(0.128)  (0.133)  (0.125)  (0.0897)  (0.0926)  (0.0891)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-0.0992</td>
</tr>
<tr>
<td></td>
<td>(0.115)  (0.126)  (0.121)  (0.0892)  (0.0912)  (0.0892)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.325***</td>
<td>0.298**</td>
</tr>
<tr>
<td></td>
<td>(0.123)  (0.140)  (0.131)  (0.0918)  (0.0916)  (0.0928)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>213</td>
<td>213</td>
</tr>
</tbody>
</table>

Note: 1. Session-specific random effects and subject-specific random effects are included in the model.
2. Reported standard errors are robust to clustering at the session level.
3. *** p<0.01, ** p<0.05, * p<0.1.
is competitive and receives many applicants. Figure 2.3 shows the average rating for doctors who apply to the superior hospital, varying whether or not a doctor has administered one or more overtreatments in the last 4 rounds. It shows that those who ever overtreated patients will receive a much lower rating, with an estimated difference of 1.44 (p<0.001) compared with those who provided appropriate treatments based on a mixed-effect regression model. Therefore, those who overtreated patients are unlikely to gain admission to a superior hospital, even if they apply to it.

In summary, we observed that when the selection mechanism is available, a superior hospital can recruit doctors whose behavior is in line with the collective interests of its members and can screen out doctors who ignore their patients’ interests and thus harm the group reputation. As a result, overtreatment rates decline significantly at the superior hospital, which is the major contributor to lowering the overall overtreatment rate in the peer-selection intervention.

2.5.3 Analysis of patients’ response to signals

Given the complexity of the design, it is important to understand how patients perceive the differences across institutional setups and respond by changing their participation rates. We consider what drives patients’ decisions by examining whether patients are more likely to avoid doctors who are from the hospital with a high rate of intensive treatments, using the regression analysis presented in Table 2.5. In the following analysis, we focus on the marginal effects of the intensive treatment rate of the previous round.
When the same patient is assigned to the same hospital in two successive rounds, the patient’s own experience could influence his interpretation of the previous-round public information. To avoid this complexity, we take a subsample of patients who are assigned to a different hospital from the previous one and run a mixed-effect linear regression to help us to quantify the marginal effect of each intensive treatment rate for a given number of patients in the previous round, excluding patients’ own experiences. We also exclude the observations when there is undertreatment in the previous round, which will be negligible given its rare occurrence.\textsuperscript{25}

As shown in Table 2.5, the coefficients for the rates of intensive treatment in the previous round, given the number of patients, are negative and statistically significant across interventions. In model 4, we consider whether patterns differ in the superior hospital by including an interaction between the rates and being a superior hospital. We find that the intensive-treatment rate in the previous period has a smaller effect on the superior hospital when the patient number is larger than 1. We conclude that patients react to public information in order to decide whether to interact with physicians; however, the reaction to public information is less strong when a superior hospital is available.

### 2.6 Conclusion

While there are clear theoretical reasons to believe that institutional arrangements which foster group reputation may help to reduce medical overtreatment, evaluating the role of these institutional features using observational data faces many challenges. This paper presents the results of a laboratory experiment that simulates decisions made by doctors and patients. Doctors must decide whether to overtreat, and patients in turn must decide whether to visit study doctors or opt out of medical care. The game features 2 diseases and 2 treatments and studies how to maximize appropriate treatments when there are financial incentives for doctors to overtreat. We compare three institutional structures, highlighting the asymmetry between patients’ and doctors’ information, as well as the relative symmetry of information among peer doctors. In the baseline condition, patients are only provided with information about the performance of physician groups. In the peer-information intervention, physicians are also provided with information about the

\textsuperscript{25}The regression model can be written as $y_{i,j,t} = \alpha + \text{public information}_{i,j,t-1} \beta + \gamma t + \mu_j + \rho_{i,j} + \epsilon_{i,j,t}$. 
Table 2.5: Regression estimates of outcomes for superior and inferior hospitals

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Baseline</th>
<th>Peer Information</th>
<th>Peer Selection</th>
<th>Peer Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous-round patients (PRPs)=1</td>
<td>0.324***</td>
<td>0.176***</td>
<td>0.135*</td>
<td>0.113</td>
</tr>
<tr>
<td></td>
<td>(0.0869)</td>
<td>(0.0176)</td>
<td>(0.0706)</td>
<td>(0.0863)</td>
</tr>
<tr>
<td>PRPs=2</td>
<td>0.603***</td>
<td>0.420***</td>
<td>0.207***</td>
<td>0.284***</td>
</tr>
<tr>
<td></td>
<td>(0.140)</td>
<td>(0.0594)</td>
<td>(0.0763)</td>
<td>(0.0694)</td>
</tr>
<tr>
<td>PRPs=3</td>
<td>0.489***</td>
<td>0.512***</td>
<td>0.361***</td>
<td>0.426***</td>
</tr>
<tr>
<td></td>
<td>(0.151)</td>
<td>(0.0734)</td>
<td>(0.0970)</td>
<td>(0.110)</td>
</tr>
<tr>
<td>PRPs=1*Intensive treatment rate</td>
<td>-0.265***</td>
<td>-0.104**</td>
<td>-0.196***</td>
<td>-0.130</td>
</tr>
<tr>
<td></td>
<td>(0.102)</td>
<td>(0.0513)</td>
<td>(0.0997)</td>
<td>(0.0948)</td>
</tr>
<tr>
<td>PRPs=2*Intensive treatment rate</td>
<td>-0.369***</td>
<td>-0.350***</td>
<td>-0.191***</td>
<td>-0.263***</td>
</tr>
<tr>
<td></td>
<td>(0.108)</td>
<td>(0.0774)</td>
<td>(0.0365)</td>
<td>(0.0710)</td>
</tr>
<tr>
<td>PRPs=3*Intensive treatment rate</td>
<td>-0.216</td>
<td>-0.449***</td>
<td>-0.349***</td>
<td>-0.454***</td>
</tr>
<tr>
<td></td>
<td>(0.228)</td>
<td>(0.0709)</td>
<td>(0.0788)</td>
<td>(0.0678)</td>
</tr>
<tr>
<td>Superior</td>
<td>0.281***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0410)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superior* PRPs=1</td>
<td>-0.145</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.104)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superior* PRPs=2</td>
<td>-0.393***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.146)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superior* PRPs=3</td>
<td>-0.366***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.129)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superior* PRPs=1*Intensive treatment rate</td>
<td>-0.171</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.153)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superior* PRPs=2*Intensive treatment rate</td>
<td>0.231</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.185)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superior* PRPs=3*Intensive treatment rate</td>
<td>0.276**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.125)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \tau )</td>
<td>-0.00161</td>
<td>0.00470*</td>
<td>-0.00461</td>
<td>-0.00268</td>
</tr>
<tr>
<td></td>
<td>(0.00549)</td>
<td>(0.00261)</td>
<td>(0.00360)</td>
<td>(0.00468)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.289***</td>
<td>0.414***</td>
<td>0.623***</td>
<td>0.570***</td>
</tr>
<tr>
<td></td>
<td>(0.0488)</td>
<td>(0.0605)</td>
<td>(0.0823)</td>
<td>(0.0611)</td>
</tr>
<tr>
<td>Observations</td>
<td>463</td>
<td>468</td>
<td>478</td>
<td>478</td>
</tr>
</tbody>
</table>

Note: 1. Session-specific and subject-specific random effects are included in the model.
2. Reported standard errors are robust to clustering at the session level.
3. *** p <0.01,** p <0.05,* p <0.1
treatment decisions of their peers, allowing them to observe over-treatment. Finally, we create a peer-selection institution where physicians are provided with information about the treatment decisions of their peers and choose who is allowed to become a member of their physician group by rating their peers.

We find that the peer-information intervention, compared with the baseline, does not yield a statistically significant difference in the overtreatment rate. By contrast, institutions that foster peer selection reduce overtreatments relatively effectively. The driving force behind this difference is the formation of superior hospitals, to which most doctors apply when peer-partner rematching is an available option, where overtreatment rates approach zero. On the other hand, overtreatment rates at inferior hospitals, where lower-rated doctors end up, provide overtreatment at similar rates to the average in the baseline. Patients’ participation rates have an inverse correlation to the overtreatment rate across experimental interventions. In theory, when detailed clinical records are shared among physician peers, if a physician believes her overtreatment behavior will trigger peers to follow suit, she will refrain from overtreatment. This will lead to a low overtreatment rates at hospitals in the peer-information intervention. The results of our experiment demonstrate, however, that peer selection is significantly more reliable than peer-information sharing alone in reducing overtreatments because, compared with the trigger strategies, peer-selection institutions provide sanctions for doctors at the superior hospital that are easier to implement and lower in cost. Moreover, despite the complexity of the games, patients do seek to avoid hospitals with high levels of intensive treatments and hospitals that few other patients are choosing, and patients in the peer-selection intervention are able to successfully identify hospitals with high group reputations.

The external validity of generalizing our results to overtreatment in empirical medical settings is limited because our data was collected in a laboratory where people playing roles participated in a carefully-controlled game. However, we have empirically demonstrated that peer-doctor monitoring can reduce overtreatments and improve patients’ trust in their doctors, provided that the following conditions are present: 1) patients have access to group-level information that summarizes the treatment experiences of previous patients; 2) peer doctors share detailed clinical information; 3) the costs to doctors of selecting partners and forming groups are low. This simple experiment provides insight into how these institutional features can restrain physicians from
overtreatment and increase patients’ trust. Factors like professional ethics are likely to reinforce the mechanisms. The strength of the experimental approach is that it generates explicit and replicable results, as long as our methodology and laboratory conditions are followed. Our study design allows us to make ceteris paribus changes in the institutional conditions for peer monitoring and observe outcomes like overtreatment, which is not easy to identify in a real medical setting.

Our results are consistent with the fact that health systems that allow physicians greater freedom in choosing their colleagues will exhibit better standards of professional contact, especially in prestigious physician groups. In the US system, physicians are free to choose their group affiliation; however, the enrollment and dismissal of a group member usually involve peer evaluation and selection. We observe that prestigious physician groups such as Mayo Clinic and the Massachusetts General Hospital Medical Group typically outperform the regional/national average in measurements of unnecessary services. In contrast, countries that have rigid physician-allocation systems may experience breakdowns in patient trust. For example, China nationalized the health system during the era of planned economy. After China changed from central planning to market-based economy for most industries in the 1980s, the medical care has been run state-owned corporations with rigid personal policies managed by the government. Consequently, the mechanism of peer evaluation and selection is ineffective (Eggleston et al., 2008). Not coincidentally, the Chinese healthcare system has suffered from a trust crisis. Patients have over time come to believe that physicians are responsible for widespread overprescription and unnecessary procedures that they order for their personal gain alone (Blumenthal and Hsiao, 2005). When patients do not observe immediate clinical effects, they tend to switch providers all by themselves (Garfield et al., 2013). Moreover, there are frequent cases in which patients insult or even injure physicians when their physicians’ practice standards are open to suspicion (Hesketh et al., 2012).

Our results concerning superior and inferior hospitals are also consistent with the small-area-variation phenomenon in medical care delivery. A small area usually refers to a town or a spatial area represented by a zip code within a region (such as a state). For example, women in one New England town undergo hysterectomies at more than twice the rate of another New England town.

Data from Centers for Medicare and Medicaid Services show that these hospitals exhibit lower rates of various imaging tests for outpatients than the national average, even though they are tertiary hospitals, which tend to accept patients in high demand. These data can be accessed at https://www.medicare.gov/hospitalcompare/
(Wennberg and Gittelsohn, 1973; McPherson et al., 1982). From the peer-selection perspective, doctors with similar practice patterns are likely to form a practice group covering the same area. Epstein and Nicholson (2009) found that peers within the hospital where she practices as well as in the other hospitals in the same small area strongly influence a physician’s style of practice. In fact, even in the same county/city, the quality of care would show significant variations among hospitals. For example, Data from the Leapfrog group show that at one community hospital in Middlesex county in Massachusetts, the rate for first-time mothers with low-risk deliveries receiving C-section is 18.5, while the rate at another community hospital in the county is 33% . (The Leapfrog Group, 2015).

In recent years, health policies have increasingly encouraged the utilization of hospital performance indicators as a guideline for patients’ healthcare seeking and the adoption of information systems for information-sharing within and across health care organizations. This trend has already strengthened an open flow of information in the framework as we illustrated for designing the information-sharing intervention. We can expect that the more open information environment will facilitate more vigorous peer selection at the physician-organization level. Moreover, the restructuring of American providers into Accountable Care Organizations (ACOs), defined as a group of providers that work together voluntarily to coordinate care and share Medicare’s payment incentives, has created an environment in which peer selection could be implemented at not just intragroup, but also intergroup level. There is a great probability that the voluntary alliance mechanism can improve the efficiency of healthcare delivery and reduce the waste of unnecessary care if ACO’s organizational design incorporates these institutional arrangements to maximize the power of peer monitoring.

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27Their study’s indicator of OB/GYN practice style was the portion of deliveries conducted by caesarian section. By controlling for patient and physician characteristics, they found that the practice of physician peers was important in making the choice for caesarian birth procedures.

28At the same time, the government has to play the role of watchdog in monitoring the “inferior” group and taking appropriate measures to protect patients.
Appendix
2.A Screenshots

The following **public information** is provided to all doctors and patients.

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Number of patients who saw a doctor</th>
<th>Number of patients who received intensive treatment</th>
<th>Number of patients who recovered (i.e. payoff&gt;0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Memorial</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

Patients should write down the **public information** on the corresponding form for future reference, while doctors should just read it!

**Figure 2.A.1:** Example screenshot of public information

The following **clinical information** is provided to all doctors *but not* patients.

<table>
<thead>
<tr>
<th>ID</th>
<th>Hospital</th>
<th>Patient's disease</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General</td>
<td>No patient</td>
<td>No patient</td>
</tr>
<tr>
<td>2</td>
<td>General</td>
<td>Severe</td>
<td>Intensive</td>
</tr>
<tr>
<td>3</td>
<td>Memorial</td>
<td>Severe</td>
<td>Intensive</td>
</tr>
<tr>
<td>4</td>
<td>Memorial</td>
<td>Mild</td>
<td>Intensive</td>
</tr>
<tr>
<td>5</td>
<td>General</td>
<td>Severe</td>
<td>Non-intensive</td>
</tr>
<tr>
<td>6</td>
<td>Memorial</td>
<td>Mild</td>
<td>Non-intensive</td>
</tr>
</tbody>
</table>

Doctors should write down the **clinical information** on the corresponding form for future reference!

**Figure 2.A.2:** Example screenshot of peer information
Figure 2.A.3: *Example screenshot of peer selection procedure*
2.B  Detailed Theoretical Analysis

In this section, we provide a theoretical analysis of the study design to illustrate the potential experimental outcomes. We assume that all players maximize their pecuniary return, and that they are risk-neutral, who are considered as rational players in standard game theory. We will discuss the experimental outcomes under other behavioral hypotheses after we make initial predictions based on standard game theory.

In this game, anonymous patients are randomly matched with doctors in round $t \in \{1, 2, \ldots \}$. Patients observe the number of previous patients ($N_{t-1}$) and the number of previous intensive treatments ($D_{t-1}$) in the past rounds at a hospital. It is noteworthy that they do not know which intensive treatments are necessary, because patients cannot observe each other’s disease condition. Nevertheless, the relative ratio of $D_{t-1}$ and $N_{t-1}$ partially reflects the number of doctors who administered appropriate treatments in the previous round, represented by $g_{t-1}$. The statistical relationship between $D_{t-1}$ and underlying $g_{t-1}$ given $N_{t-1} = 3$ is shown in Table 2.B.1. Specifically, when $g_{t-1} = 0$, the probability for patients to observe three intensive treatments at round $t - 1$ is 100%, which is 8 times higher than when $g_{t-1} = 3$. To simplify the notation, in the following analysis, we omit the subscripts of $N_{t-1}, D_{t-1}, g_{t-1}$ for the previous round. We drop the subscripts of $t - 1$ when there is no confusion.

| $g$   | $P(D = 0|g)$ | $P(D = 1|g)$ | $P(D = 2|g)$ | $P(D = 3|g)$ |
|-------|--------------|--------------|--------------|--------------|
| 0     | 0            | 0            | 0            | 1            |
| 1     | 0            | 0            | 1/2          | 1/2          |
| 2     | 0            | 1/4          | 1/2          | 1/4          |
| 3     | 1/8          | 3/8          | 3/8          | 1/8          |

Table 2.B.1: Conditional distribution of $D$ over $g$ (when $N = 3$)

A patient’s only decision is whether or not to see a doctor from the assigned hospital. Patients’ decisions are based on $g'$—the perceived number of doctors who will administer the appropriate

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29 Technically, such a patient can be replaced by an identical short-run player in round $t + 1$ (Fudenberg et al., 1990).

30 Patients can also learn the number of ineffective undertreatments, denoted by $U_{t-1}$. Because it is not rational for a doctor to administer any undertreatment, in the following analysis, we assume $U_{t-1} = 0$ and is thus irrelevant to the patients’ decision-making.
treatments according to the hospital’s past history. To simplify the analysis, we assume \( g' \) can only be an integer. Patients can expect an average of 5 points from a doctor who provides appropriate treatment; 8 points if the patient has the mild condition, and 2 if he has the severe condition with equal probability. Otherwise, if a doctor always administers the intensive treatment, it gives a fixed payoff of 2 points to a patient. Thus, the expected payoff varying by the number of good doctors is \( 2 + g' \).\(^{31}\) Since the expected payoff from the outside option is 3, patients will only choose to see a doctor when \( g' > 1 \). Clearly, patients are more likely to conclude \( g' > 1 \) if \( D \) is small relative to \( N \).\(^{32}\) Specifically, when \( N - D > 0 \), patients are sure that at least \( N-D \) doctors have administered the appropriate treatment for the mild condition. Therefore, the likelihood for a patient to see the assigned doctor would increase as \( N - D \) increases.\(^{33}\)

A doctor’s choice of the appropriate treatment contributes to the group reputation by reducing \( D \) and can potentially help other peers to retain patients. However, a doctor driven solely by profit motivation may benefit from free-riding on other peers’ efforts to maintain the group reputation. Only a doctor who believes she will not make a greater profit in the long run by administering inappropriate intensive treatment will be likely to provide appropriate treatment. To simplify the calculation of doctors’ expected value of future payoffs or continuation value, we use a physician’s profit margin in the following analysis by subtracting the reservation wage from the potential payoff of each round. The margins for a non-intensive and intensive treatment are 1.5 and 3.5 respectively. For doctors who always give the appropriate treatment, the expected margin for a future patient is thus 2.5. Defining \( \delta \) as the discount factor, we then calculate the predictions with \( \delta = 0.8 \) (Embrey et al., 2013).

Across interventions, to maintain the correct incentives for doctors, patients need to punish physicians by opting out when bad public signals occur. We assume that patients may adopt a mixed strategy, in which, with a probability \( q > 0 \), they will not see a doctor if they observe

\(^{31}\)This can be derived from \( 5g'/3 + 2(3 - g')/3 \).

\(^{32}\)According to the Bayes’ rule, \( P(g > 1|D') > P(g > 1|D'') \) if \( D' < D'' \), given a patient’s prior belief of the distribution of \( g \).

\(^{33}\)\( N \) is also relevant to patients’ choices. On the one hand, a small \( N \) suggests that patients in the previous round did not trust their doctor, which will affects the judgment of the current-round patients. On the other hand, a small \( N \) makes the public information even noisier because doctors without patients have no chance to reveal their willingness to administer appropriate care. Specifically, when \( N = 0 \), there will be no further information about a hospital’s treatment pattern.
$N = D = 3$ (i.e., the worst public information), because they cannot ascertain that there will be an adequate number of doctors who treat patients appropriately based on the public information. $q$ can be chosen to maximize a patient’s payoff ex-ante. To make the model manageable, we assume patients’ choices are synchronized (i.e., patients assigned to the same hospital see doctors altogether or not at all). To implement this strategy, patients only need to observe the public information of the most recent round when $N > 0$. Allowing patients to observe a longer history would improve their ability to monitor doctors, but the underlying mechanism is very much the same.

Given the patients’ strategy, in the following analysis, we focus on the existence of equilibria where $g$ doctors always administer appropriate treatments. In such an equilibrium, a doctor’s expected continuation value can be written as $V^g_n$, where the superscript $g$ is the equilibrium number of good doctors in her hospital and $n$ is the number of patients her hospital can expect for the current round. When a doctor administers a treatment based on her observation of her patient’s disease condition, her expected continuation value can be written as $V^g_n(d)$. In the case when all doctors always administer appropriate treatments, four equations follow:

$$V^g_{n=3} (d_0) = 1.5 + \delta V^g_{n=3}$$

$$V^g_{n=3} (d_1) = 3.5 + (1 - q/4) \delta V^g_{n=3} + q/4 \delta V^g_{n=0}$$

$$V^g_{n=3} = 1/2 V^g_{n=3} (d_0) + 1/2 V^g_{n=3} (d_1)$$

$$V^g_{n=0} = (1 - q) \delta V^g_{n=3} + q \delta V^g_{n=0}$$

Equation 2.3 is the expected payoff if the doctor concerned administers a non-intensive treatment for a mild condition. Because the hospital-level information for the next round must contain a non-intensive treatment, subsequent patients will continue to see doctors from this
hospital. Equation 2.4 is the expected payoff from an intensive treatment. If the doctor concerned has administered an intensive treatment, the chance that all patients get intensive treatments would increase to 1/4 if the other doctors also provide intensive treatments when necessary. Equation 2.5 means that, for a doctor who always administers appropriate treatment, her continuation value independent of her patient’s conditions is only determined by chance. Equation 2.6 means that if there are no patients in the current round, doctors expect that patients will see assigned doctors with a probability of \( q \) next round as there is no update of \( D \) and \( N \).

**Baseline**

In the baseline, a hospital’s group reputation can only be sustained by patients’ imperfect monitoring. If \( g = 3 \) is a possible equilibrium, according to the one-stage deviation principle, a doctor must not gain by intentionally overtreating for one period and then return to the appropriate treatment in all future periods. To achieve this equilibrium, the following condition must be satisfied.

\[
V_{g=3}^{n=3}(d_0) \geq V_{g=3}^{n=3}(d_1)
\]  

(2.7)

Given \( \delta = 0.8 \), \( q \) has to be 1.11 from Equation 1-4 when Equation 2.7 is binding. Our interpretation of the theoretical solution is that even if doctors reasonably focus on long-run profit, we may not be able to see an equilibrium of \( g = 3 \) in the baseline.

Except for \( g = 3 \), patients may also be interested in sustaining \( g = 2 \), where one doctor overtreats patients while the remaining two doctors keep administering appropriate treatments. The cut-off value of \( q \), in this case, might fall below 1 because the probability of triggering three intensive treatments is higher for those who keep administering appropriate treatments. In this case, it seems to be easier to sustain \( g = 2 \). However, this kind of equilibrium is problematic since doctors move simultaneously and will thus have trouble determining their position vis-à-vis their peers due to imperfect information about peers. It would be difficult for member doctors in the same hospital to agree on who should be the doctor with the privilege of overtreating patients and earning more payoffs than the others. Such a coordination is likely to fail.

**Peer Information**

In the case of peer information sharing, in contrast to imperfect monitoring by patients, doctors
have perfect information about one another. Thus, an equilibrium of $g = 3$ could be enforced by trigger strategies among peers. To illustrate this idea, we focus on the following “grim-trigger” strategy: once any peer deviates toward overtreatment, other doctors will themselves begin to consistently overtreat patients. With the grim trigger strategy in mind, we primarily focus on checking whether or not a doctor who previously administered appropriate treatment would be likely to deviate toward overtreatment or not. With the trigger strategy in mind, the condition to make a doctor administer a non-intensive treatment for the mild condition would be

$$V_{n=3}^{g=3}(d_0) \geq 3.5 + \delta(1 - q/4)V_{n=3}^{g=0} + \delta q/4V_{n=0}^{g=0}$$  \hspace{1cm} (2.8)$$

where $V_{n=3}^{g=0} = 3.5 + \delta(1 - q)V_{n=3}^{g=0} + \delta qV_{n=0}^{g=0}$. That is, when patients choose to see doctors, all doctors will overtreat patients and hope for future patients merely by chance as determined by $q$. However, the trigger strategy will be delayed for one round, and thus the probability of having $D = 3$ after the current round is $1/4$ since the other two doctors will have not adjusted their strategies.

In addition to Equation 2.8, we need to verify whether or not the threat of the peer sanction is credible, which requires that $g = 0$ would be in equilibrium, too. Otherwise, there will always be at least one doctor who will choose not to invoke it in time on the doctor providing overtreatment. According to the one-stage deviation principle, the condition can be written as

$$V_{n=3}^{g=0} \geq 1.5 + \delta V_{n=3}^{g=0}$$  \hspace{1cm} (2.9)$$

Conditions 2.8 and 2.9 can be met when $0.6 \leq q \leq 0.71$. Thus the minimum $q$ that patients can choose is 0.6. However, in spite of the theoretical possibility, reaching $g = 3$ with patients’ and doctors’ coordination according to our explanation could be challenging in our experimental setting. Moreover, such an equilibrium of $g = 3$ has the undesirable feature of leading to a permanent deterioration of the hospital’s reputation after a single overtreatment.

**Peer Selection**

In the peer-information intervention, doctors are able to detect overtreatment by peers, but the way to punish a misbehaving peer is limited to the trigger strategy. A more effective peer monitoring system should allow doctors to screen out those who overtreat patients. In the study
design for the peer-selection intervention, we allow two additional choices for doctors at a pre-set interval of four rounds: 1) choose the hospital they want to enroll in for future rounds, and 2) rate the partners to determine who can enroll in the same hospital. The goal of giving doctors these options is to let them enforce peer monitoring by deliberately selecting their hospitals and partners. The equilibrium strategy of this game is complicated and is not entirely explicable by standard game theory. Thus, we discuss a case in which the patients’ strategy is fixed as follows: assign $q'$ for the hospital where a negative signal of three intensive treatment comes first, and continue to visit the other hospital with $q''$. We refer to the former hospital as an inferior hospital and to the hospital that patients still visit as a superior hospital. For purposes of illustration purpose, we let $q' = 1$ and $q'' = q < 1$. Thus, when inferior and superior hospitals are distinguishable, the value of continuation for staying in the inferior hospital will be zero. In the following analysis, we focus on a doctor who is in the superior hospital.

According to the experimental design, there is a doctor-hospital rematching through peer selection in every 4 rounds. When every doctor believes the mechanism can meet its goal by excluding the doctors who overtreat patients from their existing hospital and replacing them with potentially well-behaved doctors, a doctor in the superior hospital who overtreats patients will clearly continue to do so until she is screened out by peers. The biggest temptation for a doctor to overtreat would be present at the beginning of the 4 rounds. The incentive-compatible condition for the doctor to refrain from overtreatment would be

\[ V_{\delta=3}(d_0) \geq 3.5[1 + \delta(1 - q/4) + \delta^2Q_1 + \delta^3Q_2] \]  

(2.10)

The right-hand side is the expected value for a doctor in the superior hospital to overtreat patients throughout the time interval of four rounds and then to be sorted into the inferior hospital where $Q_1 = (1 - q/4)^2 + (q/4)(1 - q)$ and $Q_2 = (1 - q/4)^2 + 2(1 - q/4)(q/4)(1 - q) + (q^2/4)(1 - q)$. In fact, condition 2.10 can always be satisfied with $q \leq 1$. Equation 2.10 suggests that the doctor concerned believes other doctors will keep administering appropriate care, thus making it unprofitable to leave the current hospital. This is credible because the remaining doctors would themselves face the same threat of being sorted into the inferior hospital, and the short-run incentive to overtreat would thus be offset if they expect the superior hospital to re-establish $g = 3$
after screening out the doctor who has overtreated. It is important to note that the doctor drawn from the inferior hospital to the superior hospital has incentives to give appropriate treatment regardless of her history once since the equilibrium of the superior hospital has been reestablished. Therefore, $g = 3$ in the superior hospital is likely to remain stable because a one-time deviation by a doctor is unlikely to affect it in the long run.

The remaining question is what the strategies of doctors in the selection process would be, so that the selection mechanism can play its role as we intended. Supposing that after one physician in the superior hospital administered overtreatment, the remaining two doctors will cooperate to maintain the group reputation, we propose the following strategies, which are largely consistent with the profit-maximization motivation of each individual doctor:

- Remain in the original hospital before the hospitals have been classified as superior and inferior, and later choose the superior hospital later;

- Rate peers according to the following schedule:  1) A doctor who chooses to stay in the same hospital and who did not overtreat patients in the previous time interval will rate any doctors in the same hospital with a score of 5, and assign a score of 1 to those who are outside it, when no overtreatment has occurred in the last four rounds at her hospital. When at least one doctor at her hospital overtreated patient in the last four rounds, she will give 1 to the ones who overtreated, and give an arbitrary score between 1 and 5 to the outsiders she thinks are most likely to treat patients appropriately.  2) A doctor who chooses to stay in the same hospital and who overtreated patients in the last four rounds will give everyone 1 in order to maximize her opportunity to stay.  3) A doctor who intends to leave her hospital will rate any other doctors with a score of 1 in order to maximize her opportunity to enroll in the superior hospital.

There may well be effective strategies other than those listed above to enforce process of the peer selection. In general, as long as the majority of doctors would choose if they could to work with peers who treat patients appropriately, either due to self-interest or other behavioral preferences like indirect reciprocity, the threat of being sorted into the inferior hospital will make the selection mechanism play its role as intended.
Chapter 3

Informal Payments and Patients’ Perceptions of the Physician Agency Problem: Evidence from Rural China

Abstract

Informal payments for medical services refer to additional cash payments or gifts that patients pay to physicians for services in addition to official charges. This phenomenon is widespread in transitional economies. Papers have been published on different causes for such payments, but few have explored the potential for theories from behavioral science to shed light on the practice of informal payments. This paper explores the role of informal payments in maintaining trust between doctors and patients. Using the data from rural household surveys in China, we find evidence consistent with the hypothesis that patients’ concern about physician agency problems is a significant driver for informal payments. With the data showing that patients are more likely to make informal payments when they trust their physicians less or give low ratings to their doctors’ communication performance. We provide an explanation for this finding: patients may be willing to make informal payments to physicians to induce direct reciprocity and thus mitigate the physician agency problem.
3.1 Introduction

Informal payments are known to be widespread in the health systems of transition economies, such as China, the former Soviet Union and Eastern bloc countries of Europe (Bloom et al., 2000; Gaal and McKee, 2005; Rechel and McKee, 2009; Stepurko et al., 2013). Patients make informal payments, in cash or in kind, to physicians in addition to official charges billed for medical services, particularly surgeries and inpatient services (Lewis, 2007; Gaal et al., 2006a).\(^1\) Although these payments could be viewed as a means to supplement physician income in underfunded healthcare systems,\(^2\) they give rise to serious welfare concerns. Such payments impose heavy financial burdens on patients (in particular for the poor),\(^3\) impede public confidence in the standards of care and create negative attitudes towards the medical system (Lewis, 2007; Stepurko et al., 2013). Moreover, researchers have observed that once informal payments become prevalent, they tend to persist, even if governments take vigorous measures to fight against them (Rechel and McKee, 2009; Vian, 2008). Currently, many countries have put the elimination of informal payments into their health reform agendas; however, few countries have successfully eradicated informal payments from their health systems. As noted by Gaal and McKee (2004), an effective policy response is handicapped by the absence about an adequate understanding of the causes of the phenomenon (Stepurko et al., 2010). Using the household survey data from China, we provide descriptive evidence about the determinants of informal payments. We pay particular attention to the role of informal payments in addressing patients’ concerns about the physician agency problem.

Some early studies argued that informal payments were a supply-side issue. It could be

\(^{1}\)Lewis (2007) showed around the year 2000 that the proportion of inpatients who made informal payments was about 60% in selected former communist countries such as Albania, Poland and Romania. In addition, Bloom et al. (2000) noted that 50% to 70% of inpatients made informal payments in some major urban hospitals of China in early 2000. Recent data from the Transparency International’s Global Corruption Barometer suggest that this pattern still prevails in many transitional countries.

\(^{2}\)Informal payments have constituted a significant income source for physicians. In transitional countries like Poland and Hungary, informal payments can double the salary of physicians (Chawla et al., 1998; Gaal et al., 2006b). There is an argument that the informal payments could allow providers to cross-subsidize the poor by extracting more from the rich. However, this is merely a hypothesis without any evidence (Ensor, 2004).

\(^{3}\)Studies of informal payments paid to physicians in different countries show that payments amount to roughly between 25% and 100% of the patients’ monthly median income per hospital visit, depending on the disease severity and the type of the hospital involved (Lewis, 2007; Bloom et al., 2000).
understood as physicians’ “rent-seeking” behavior when physicians were not adequately regulated (Lewis, 2000; Ensor, 2004). However, there is evidence from other studies that in the vast majority of cases, informal payments appear to reflect patients’ expectations that are independent of physicians’ “rent-seeking” (Gaal et al., 2006a; Vian and Burak, 2006; Stepurko et al., 2010). A better understanding about the reasons for informal payments has important policy implications. If informal payments merely result from providers’ rent seeking, raising salaries and enforcing applicable laws more strictly may eliminate this issue. If the patients’ motivations drive informal payments primarily, then valid policies to address these payments must address the patients’ concerns.

The literature has offered several explanations for patients’ motivations for making informal payments. The two most popular explanations are to express gratitude and to fulfill consumer choices (see next section for details). In this paper, we consider an alternative explanation from the perspective of the patient-doctor relationship. That is, when physicians are perceived as imperfect agents, patients may initiate informal payments to mitigate their physicians’ agency behavior and, thus, ensure that their physicians will exert the best efforts and choose procedures according to the patients’ best interests. Since patients and doctors cannot construct a complete contract in advance due to the uncertainty of medical outcomes, the issue arises of how a physician can make a commitment to a patient after receiving the payment. One possibility is that informal payments might trigger an obligation to reciprocate with high efforts and appropriate care on the part of a physician, which would provide assurance to her patients. This explanation can be applied to healthcare systems where the misalignment between doctors’ incentives/motivations and patients’ interests is great and widespread. Many health systems in transition economics suffer from serious physician agency problems due to low physician salaries or misaligned provider incentives when prices for physician services are set below the equilibrium level (Hsiao and Heller, 2007; Rozenfeld, 1996).

With two household survey datasets from China, we describe some associations between patients’ perceptions of the physician agency problem and informal payments. Specifically, with

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4We would expect that the informal-payment phenomenon can also be observed in countries with similar physician agency problems as those in the transitional countries. In fact, the literature also reported informal payments in Greek, Israel and Taiwan (Liaropoulos et al., 2008; Cohen, 2012; Chiu et al., 2007). We thank the outside reader for raising this point.
cross-sectional data of rural inpatients from 8 Chinese provinces, we find that both patients’ trust levels and ratings of doctors’ communication performance are associated with the informal payment behavior, where a low trust level and communication rating correspond to a high informal payment rate. If these two explanatory variables indicate patients’ concerns about the physician agency problem, this association suggests a significant reason for patients to send informal payments is to mitigate the agency problem of doctors. With data collected from surveys in 5 rural counties in Ningxia province that included detailed questions about patients’ motives for making informal payments, we find that 70% of the respondents provided answers regarding concerns about physician agency behavior, which supplements the findings from the large-scale survey. One possible explanation for the correlation is that patients consider informal payments as a way to induce direct reciprocity and, thus, to mitigate the physician agency problem. Although our empirical findings cannot completely identify the reciprocity channels, which would require the data confirming the physicians’ response after receiving the payments, alternative mechanisms cannot explain why the doctors’ commitment that relies on the condition of accepting informal payments is credible. Our findings shed light on the potential behavioral factors in explaining informal payments, on which the current literature has put an insufficient attention.

The paper will proceed as follows: In section 2, we review the literature that provides explanations for the patients’ motives for making informal payments. In Section 3, we discuss the rationale of mitigating the physician agency problem by informal payments via the channel of reciprocity. In Section 4, we present some findings from the large-scale survey and the Ningxia survey. Section 5 discusses the limitations of the paper. The conclusion and policy implications are included in Section 6.

3.2 Related Literature

Informal payments in the medical settings are cash, favors and gifts from patients to physicians for services that have already been covered by official payments. In the literature, authors have used many terms to refer to informal payments, such as “under-the-table” payments, “bribes”

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5There are cash payments or indirect favors from pharmaceutical companies based on the number of drugs prescribed, but those are not within the scope of this paper.
and “gratitude” money (Kornai and Eggleston, 2001). In particular cultural settings, there are euphemisms for informal payments. For example, in China, the payments are called red packets (hongbao). These names reflect the complex nature of the phenomenon, and, obviously, they are not mutually exclusive.

Early studies considered the origin of informal payments as the providers’ rent-seeking behavior. That is, physicians use their resources to obtain an economic gain from patients. Typically, some authors considered informal payments as equivalent to corruption (Lewis, 2000), with doctors making illegitimate use of their power to force patients to make informal payments or suffer the consequences of inadequate or improper care (Lindkvist, 2013). However, if we restrict the definition of corruption to “abuse of public office for private gain”—a widely-used definition by the World Bank—it is problematic to equate informal payments with corruption because doctors’ authority does not necessarily come from their official positions. Physicians’ power is better understood as monopolistic market power based on the physicians’ informational advantage. Because it is not necessarily corrupt to exert market power, many authors argue that taking informal payments is a “gray” area for physicians, although there is no doubt that taking bribes is illegal (Ensor, 2004). Nevertheless, there is only anecdotal evidence showing physicians soliciting bribes, and much of the recent literature has documented that a substantial proportion of informal payments are voluntary (Gaal et al., 2006a; Vian and Burak, 2006).

More and more researchers have started to pay attention to the motives for patients to make informal payments, and provided various explanations. These explanations can be divided into two categories.

The first category considers informal payments as gifts through which the patient can express gratitude (Kornai, 2000; Gaal et al., 2006a; Stepurko et al., 2013). If this is the case, we might expect that, for the most part, informal payments will occur after the treatment is successfully provided. However, the literature shows that pre-treatment payments are far more frequent (Gaal et al., 2006a; Vian and Burak, 2006). Many people make informal payments before the physician perform major treatments (Yang, 2008; Vian et al., 2006). Gratitude money should occur only after

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6In fact, red packets are monetary gifts given to children by their relatives during the New Year period or on special occasions such as weddings, graduations or the birth of a baby.

7This may also create a pay-for-performance incentive for doctors.
a successful treatment.

The second category of explanations regards informal payments as a way to acquire high levels of consumption of medical services (Ensor, 2004; Gaal and McKee, 2005), reflecting the choice of patients. There are three basic means for a patient to fulfill their consumer choices: 1) pay for (immediate) access 2) pay for extra services, and 3) pay for being attended by senior or capable doctors. As for the first means, a typical case would involve patients making informal payments to jump a long line in a health system burdened by service shortage.\(^8\) Possibly, some informal payments are made to gain priority in obtaining healthcare access; however, there are many cases in which patients make payments after medical procedures have been scheduled in a timely manner. As for the second means, it may occur when the health system rations care strictly; therefore, patients want to bypass the rationing rules and receive specific medical tests or procedures. In this situation, patients may believe they themselves best understand their medical needs. However, in medical settings, patients, who themselves typically lack the relevant information, have to depend on physicians to determine their healthcare needs. The scope of healthcare services that patients can order on their own is limited, and sometimes only peripheral (such as a private ward or one-to-one nursing care). As for the third means, some patients would like to ensure that senior physicians are providing the patients’ medical care because senior physicians can best perform treatments that require extensive experience and skills (Liu and Sun, 2007; Yang, 2008). However, even the best available doctor may face conflicts of interest, and perform under- or overtreatments. Why do patients have trust in them?

Both gratuity and consumer-choice explanations mentioned above neglect the physician agency problem, which is rooted in the uncertainty and information asymmetry of healthcare (Arrow, 1963; McGuire, 2000). When physicians’ goals and patients’ interests are misaligned, patients may have serious concerns about whether physicians will exert themselves or deliver appropriate services that are in the patients’ best interests, particularly for complicated procedures, for which patients cannot observe physician efforts or evaluate the appropriateness of treatments. Patients concerns about the physician agency problem in the transition period may become acute. In

\(^8\)In this case, we would expect that the informal payment phenomenon would involve anyone who can influence the patients’ waiting list, such as hospital managers and even officials of the Department of Health. In that case, public discontent should not target the physicians.
many transition economies, the reform of health systems lagged behind economic reforms in the post-transition era (Hsiao and Heller, 2007). While health systems still followed conventions of “Semashko” or the centrally planned model, the public funding was withdrawn by the government. On the one hand, many physicians officially worked in rigid state-run organizations with low fixed salaries, but earned sums several times than their salaries by moonlighting (Kornai and Eggleston, 2001). On the other hand, many high-end services were paid out-of-pocket, and physicians could then charge patients at the market price. Moreover, the unregulated pharmaceutical industry offered kickbacks (Yu et al., 2010; Vian, 2008), and physicians who were dissatisfied with their incomes accept these kickbacks (Hsiao and Heller, 2007). In this situation, physicians either tend to undertreat patients due to low official payments or overtreat patients due to certain services that are more profitable or involve kickbacks. Perceiving this, patients may try to minimize the risk of the agency behavior through informal channels. The literature that put emphasis on the socio-economic background of informal payment phenomenon focused on how it influenced the providers’ rent-seeking behavior. Patients’ concerns about the physician agency problem and the measures they took to curb the agency problem in such a context were overlooked (Gaal et al., 2006a).

This paper proposes that patients may use informal payments as a means to ensure doctors’ commitment to prioritizing their patients’ best interests, when the physician’s motivation is open to suspicion. In fact, the literature sheds light on this point. When reporting their motivations for making such payments, people often mentioned that the payments were made for “a feeling of security” or “peace of mind” (Yang, 2008; Vian et al., 2006). However, these findings were usually categorized as a “psychological effect” (Stepurko et al., 2010). If patients are often convinced that making informal payments can shield them from sub-standard services, there must be some economic rationale for patients to hold that belief. The existing hypotheses, including expressing gratitude and fulfilling consumer choices, may not have addressed one of the most important points in explaining patients’ motives for making informal payments, namely, to avoid

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9 For example, in a field study conducted in Albania by Vian et al. (2006), patients mentioned that the payments were made for “a feeling of security”. They were worried that substandard care would be provided if they did not pay. Correspondingly, Yang (2008) also found that the majority of participants believed that patients intended the red packets as incentives to motivate doctors to provide high-quality care. As one interviewee put it: “Patients do not trust doctors completely; patients feel that only red packets demonstrate that they care about their doctors, and that doctors will reciprocate by caring about their patients.”
the physician agency problem.

### 3.3 Rationale

How can informal payments curb the physician agency problem? In this section, we show a possible rationale that informal payments can achieve this goal based on reciprocity. Reciprocity is defined as a contingent preference. Specifically, if the agent perceives the actions of the principal as benevolent, the agent values the principal’s benefit positively. If, in contrast, the principal’s actions are perceived as hostile, the agent values the principal’s benefit negatively (Fehr and Falk, 2002). Reciprocity is widely studied in experimental economics in the form of the gift-exchange game.\(^\text{10}\)

In a stylized model, suppose a patient can potentially benefit from a treatment, represented by \(V\), with a probability. The realization of \(V\) is uncertain and is associated with the physician’s efforts and her choices of treatments. If the physician provides high-quality care, the probability of realizing \(V\) is \(p_1\) and the physician earns \(\pi_1\). If the physician provides low-quality care, the probability of realizing \(V\) is \(p_0\) and the physician earns \(\pi_0\). We also assume that \(p_1 > p_0\). We assume that there is a moral cost of \(H\) for a doctor to perform low-quality care due to medical professionalism as suggested by the Hippocratic Oath. We further assume that patients cannot observe the final clinical results promptly. As a result, a contract based on the realization of \(V\) at the individual level is impossible. The physician can only charge the patient a fixed user-fee (co-payment), and the rest of the medical costs are covered by an insurer or the government.

In this setting, patients are always interested in receiving high-quality care. However, from the perspective of a physician, the profits for providing high-quality treatments is lower than those for providing low-quality treatments. The game can be presented in the following table. In a one-shot game, a patient will always choose to see a doctor because \(p_1 V > p_0 V > 0\). However, if the patient perceives \(\pi_1 < \pi_0 - H\), he will expect low-quality care exclusively.

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\(^{10}\)In a gift-exchange game, the buyer offers a price in order to obtain the desired level of effort on the seller’s part. The seller then chooses a level of quality that is costly to provide but increases the buyer’s payoff. Fehr et al. (1993) found that, in a one-shot game, the buyers offered prices that were substantially above the market-clearing level, expecting sellers to respond by producing high-quality services, and this expectation was largely confirmed by the behavior of sellers. This is one of the earliest experiments showing that reciprocity may exist and can potentially enhance the total welfare. The follow-up literature confirms reciprocity as an independent mechanism in sustaining cooperation in a game of this kind (Berg et al., 1995; Cox, 2004)
Table 3.1: Trust game between patients and doctors without informal payments

<table>
<thead>
<tr>
<th></th>
<th>High-quality</th>
<th>Low-quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>See</td>
<td>((p_1V, \pi_1))</td>
<td>((p_0V, \pi_0 - H))</td>
</tr>
<tr>
<td>Don’t see</td>
<td>((0,0))</td>
<td>((0,0))</td>
</tr>
</tbody>
</table>

Table 3.2: Trust game between patients and doctors with informal payments

<table>
<thead>
<tr>
<th></th>
<th>High-quality</th>
<th>Low-quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make informal payments</td>
<td>((p_1V - m, \pi_1 + m))</td>
<td>((p_0V - m, \pi_0 - H - R + m))</td>
</tr>
<tr>
<td>Don’t make informal payments</td>
<td>((p_1V, \pi_1))</td>
<td>((p_0V, \pi_0 - H))</td>
</tr>
<tr>
<td>Don’t see</td>
<td>((0,0))</td>
<td>((0,0))</td>
</tr>
</tbody>
</table>

The stylized model depicted in Table 3.1 represents patient’s concerns of the physician agency behavior in the health systems of many transition economies. For example, a surgeon may not make her best effort in a public hospital because she can charge much higher prices when moonlighting, operating on those patients who can pay out of pocket (Kornai and Eggleston, 2001). As another example, a physician may prescribe unnecessary drugs because pharmaceutical companies pay kickbacks to the physicians based on the sales of particular brand names (Yu et al., 2010). When physicians tend to provide low-quality care due to a conflict of interest, the physician agency problem arises. Nevertheless, High professional ethical standards are a distinctive feature of the medical profession. As long as the conflict of interest between physicians and patients is not serious, medical professionalism would play a role in making the doctor put high-quality care as her priority (McGuire, 2000). However, over economic transition, physicians lamented that they were underpaid. The income inequality between physicians and other social elites made them believe that they were unfairly treated. In this situation, professionalism was readily sacrificed to short-turn gains (Hsiao and Heller, 2007).

Next, we assume that a patient has the option of offering a fixed-payment amount of \(m\) before the treatment. The payments can play a role in inducing interpersonal reciprocity as defined at the beginning of this section. To illustrate the idea, we assume that the physician has a ad-hoc cost of \(R\) to provide low-quality care on condition of receiving \(m\). The new game is illustrated in Table 3.2. As long as the patient has a belief \(\pi_1 > \pi_0 - H - R\), high-quality care can be secured. We can easily see that the strategy that maximizes the patient’s payoff is to make an informal payment as long as \(p_1V - m > p_0V\).
This stylized model suggests that informal payments are likely to be initiated by patients when the agency problem is a concern (i.e. $\pi_1 < \pi_0 - H$). This concern is caused either by a high level of misaligned incentives or a low degree of professionalism. To mitigate physicians’ agency problem and to incentivize physicians to provide high-quality care, it appears logical to patients to make informal payments, which serve as an informal means for patients to protect themselves. Moreover, given the relatively high cost of informal payments, patients are more likely to make them when the difference between low- and high-quality care has a significant effect on the medical outcome (i.e. $p_1V - m > p_0V$). The cost-benefit tradeoff explains why we are more likely to observe informal payments for procedures in which where patients have the most at stake, such as surgeries.

The primary goal of this paper is to establish the statistical association between informal payments and patients’ perceptions of the physician agency problem, which is in line with the patient strategy in Table 3.2. My data does not allow me to test the reciprocity channel directly, but reciprocity seems to be a reasonable deduction if there is a positive correlation between informal payments and patients’ perceptions of the physician agency problem.

### 3.4 Background and Data Sources

#### 3.4.1 Background

This paper investigates the links between informal payments and patients’ efforts to counteract the physician agency problem in the context of China in the past decade. Due to insufficient public funding during the economic transition beginning in the late 1970s, providers were allowed to add a markup to any drugs they sold and to charge a higher fee for technology-intensive diagnoses. On the other hand, the compensation for procedures based on physicians’ efforts and skills was deliberately kept low by the government. This price distortion gave providers strong incentives to favor profitable drugs and diagnostic tests to generate revenue. The fee-for-service (FFS) payment system remained common, adding strong incentives for prescribing multiple drugs at the same time. Also, the motivation for physicians to prioritize healing patients was further threatened by a broad range of illegal incomes such as kickbacks from pharmaceutical companies, which were based on the number and size of prescriptions for drugs of their brand. The public perceived
a low level of medical professionalism as many physicians redirected their discontent toward a system which underappreciated their efforts to a bad attitude toward patients, and recommended unnecessary drugs and procedures merely for short-term profits, without considering patients’ needs. All these institutional features stimulated distrust between patients and doctors, which grew in intensity over time (Blumenthal and Hsiao, 2005, 2015).

The cases of informal payments, or “red packets”, multiplied in China over the period of the economic transition. Zhou and Zhang (2004) documented that in the late 1980s, red packets began to proliferate in the surgical departments of public hospitals. At the same time, Chinese public hospitals started to gain the authority to allocate themselves the resulting revenue from delivering personal medical services. The informal payment phenomenon was most prevalent in the 1990s (Huang, 1996). However, there was a lack of reliable data to estimate the national prevalence rate at that time. A survey which was conducted in Liaoning province in 1999-2000, involving 650 thousand respondents, indicated that the informal-payment rate was 20% to 25% among hospital visitors (at an unspecified time) in that province (Meng et al., 2001). Many scholars in China attribute the increase in red packet payments in this period to the shortage of medical resources in the public sector; patients thus competed for the scarce resource by making extra payments to expedite their treatments or to obtain the level of privileged health care reserved for Communist Party cadres. Though the shortage might partly explain the increased use of red packets in China at a particular time, it did not make a distinction between informal payments in medical settings and bribes to acquire other products in a shortage economy. Over the past decades, the scarcity of medical resources in China was alleviated. Furthermore, many public hospitals started to operate high-end wards, which charge significantly more than ordinary wards. Therefore, affluent patients were able to access these wards promptly without informal channels. In fact, researchers observed a decrease in the rate of red packets in China between the late 1990s and early 2000s (Zhou and Zhang, 2004). However, red packets have not entirely disappeared and remain a serious public concern to date, suggesting that the root of informal payments has not been completely identified.

3.4.2 Primary data sources

This paper investigates a cross-sectional dataset produced in 2008 to explore patients’ motives for making informal payments. The data source is the baseline survey of the Health
Table 3.1: The crude prevalence rate of informal payments among adult inpatients (age ≥ 15) in the sample

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Non-surgical</th>
<th>Surgical</th>
<th>Labor and delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>% inpatients</td>
<td>4.9</td>
<td>3.1</td>
<td>8.7</td>
<td>6.1</td>
</tr>
<tr>
<td>Observations</td>
<td>3,928</td>
<td>2,637</td>
<td>1,297</td>
<td>657</td>
</tr>
</tbody>
</table>

Development of Rural China Program sponsored by the World Bank and UK’s Department for International Development (DFID). The survey was conducted in 8 provinces according to area stratified sampling\(^{11}\), covering 24,000 rural households. The survey contains detailed information about the patients’ experience of their most recent hospital visits in the past year.

Table 3.1 exhibits the informal payment rates among adult inpatients of various categories in the sample.\(^{12}\) The overall informal payment rate among inpatients is relatively low. It should be noted that the survey only asked respondents about the most-recent hospital stay. People who had multiple hospital stays might make informal payments in one of the past stays. Moreover, the crude rate was not adjusted for disease categories and the types of hospitals involved. We would expect there would be a large variation in informal payment rates when patients’ diseases and hospitals’ technical capacity were different. Therefore, the informal payment rate in our sample should not be interpreted as a national prevalence rate of informal payments. It is possible that patients underreported their informal payment behavior, though respondents were anonymous and the doctors involved could not be tracked through the survey. If people underreported their informal payment behavior in a random pattern, we are likely to be underestimating the effects of relevant factors on informal payments in this paper.

We exclude cases that relate to labor and delivery because the meaning of red packets may be more complex at the birth of a baby according to the Chinese social customs. We also exclude cases involving overnight stay, and some typical outpatient cases such as the Upper Respiratory Infection (common cold) and the acute/chronic gastroenteritis. We are left with about 3000 observations, 1/3 of which involve surgeries.

Since both the previous literature and the statistical summaries in Table 3.1 indicate that

\(^{11}\)Within each county, 5 randomly-selected sample townships were surveyed. In each township or neighborhood, two randomly-selected administrative villages or neighborhood committees were surveyed.

\(^{12}\)Compared with the published statistical summary of China’s Fourth National Health Service Survey (NHSS), our sample has slightly higher overall informal payments rates than the rural sample of NHSS (3.5%).
informal payments are far more frequent among patients undergoing surgeries, this paper divides the results into patients undergoing surgeries or not.

3.4.3 Measurements

The survey asked respondents: “Did you ever give a cash packet or gift to physicians during the period of your latest hospitalization?” We identify the informal payment behavior from this question by constructing a 0-1 variable. 1 indicates that the patient reported either cash or gift or both.

To measure patients’ perceptions of the physician agency problem, we adopt two measurements: patient-reported trust in their doctors and patient-reported ratings of doctor’s communication performance.

The measurement of patient-reported trust in their doctors is obtained from following survey question: “To what extent do you trust the doctor?” The options are: 1. Strong distrust, 2. Some distrust, 3. Neither distrust nor trust; 4. Some trust; 5. Strong trust; and 6. No answer. We group Option 1-3 into a new category of “distrust” as the number of observations in the first three categories are small. This results in a three-level trust measurement: distrust, some trust, and strong trust.

A serious problem with using patient-reported trust as a measurement of patients’ perceptions of the physician agency problem is that we cannot determine whether trust is formed before the treatment or after the treatment based on the survey question. Because the survey asked people to respond retrospectively, the behavior of informal payment giving itself might have affected the trust levels. Both upward and downward biases could occur when we evaluate the correlation between informal payments and patient-reported trust. We will address this issue when we present the results in the next section.

In additional to trust, we can use patients’ subjective ratings of physician-patient communication as a measurement of patients’ perception of physician agency. It is well documented that how physicians communicate with patients affects the about patients’ conclusion about whether doctors have maintained the highest level of professionalism and put their patients’ interests first (Thom et al., 2001; Roter and Hall, 1992). As we have shown in the stylized behavioral model, in cases involving conflicts of interest between physicians and patients, if patients perceive that
their doctors cannot maintain a high standard of medical professionalism, the patients expect low quality of care due to the agency problem.

There are two relevant questions about how doctors communicated with patients in the survey. The first question asks patients: “To what extent do you feel the doctor has explained your disease condition to you?” The second question asks patients: “To what extent do you feel the doctor has listened to your feedback about the treatment plan?” The options include: 1. Very poor; 2. Poor; 3. Fair; 4. Good; 5. Very good; and 6 No answer. As with the trust measurement, we combine Option 1-3 to construct a 3-level measurement for both aspects of communication in order to prevent unstable results because of a small number of observations in the first three categories. If patients’ ratings fall into the first three categories, we simply relabel it as poor.

It should be noted that a communication measurement might be less likely to suffer from an overestimation if there is a positive correlation between informal payments and perceptions of the physician agency problem, because it is difficult to find a plausible reason that informal payments would worsen the doctor-patient communication. However, it could still be possible that informal payments would make doctors reciprocate with better communication with their patients.

Beside these measurements discussed above, the survey covered standard demographic information and socioeconomic background of a respondent. The survey also divided patients’ diseases (pre-existing chronic conditions and the disease leading to hospital admission) into 126 categories according to “International Statistical Classification of Diseases and Related Health Problems-9 (ICD-9)” hierarchy and linkage. Based on that information, we can further control disease categories of admission in our analysis.

3.4.4 Supplementary data source

To supplement our primary study, we designed a short survey on informal payments, and implemented it along with the 2015 household survey of the Ningxia Provider Payment System Reform Project (hereafter, Ningxia Project) carried out by Harvard-Oxford research team, covering 5 rural counties in Ningxia. In each county, the Ningxia Project research team sampled every town and select villages in each town randomly based on their economic status.\(^\text{13}\) In each

\(^{13}\text{They stratified villages according to their economic situation, then selected 40\% of villages in each stratum.}\)
selected village, 20-33 households were involved. A total of approximately 6700 households were interviewed.

The paper only analyzes respondents of household heads who reported themselves or whose family members had made informal payments in the past three years. A total of 101 households reported informal payments in the previous three years. Out of these, 75 were inpatient cases and this from the study sample. We mainly focus on the inpatient cases to check the consistency of the findings between the primary data and the supplementary data. It should be noted that the sample size is small because most households may not have any inpatient for a given period.  

For households who reported informal payments, they were asked at which level of health facilities did the informal payments occur and what services they were for. There were two critical questions relevant to our primary research question. First, they were asked how their trust levels changed before and after the payments, in a 1-5 scale, with 5 standing for strong trust. The goal of tracking the change of trust levels before and after informal payments was to understand how making informal payments affect patient trust ex-post. Second, they were asked about their primary goals for making the payments, with the options of the question based on existing theories (listed behind a dash) in the literature, including:

- doctors asked for them directly or indirectly —provider rent-seeking behavior
- to avoid undertreatment by doctors —agency problem
- to avoid overtreatment by doctors—agency problem
- to prevent medical negligence by doctors —agency problem
- other patients gave them —social-psychology
- for particular needs (e.g. to order specific medical tests or procedures, change wards or hire outside doctors) —consumer choices
- to express gratitude —gratitude money.

The detailed survey questions are listed in Table 3.A.1 in the Appendix section.

---

14It is estimated based on the sample that about 20-25% of families may have inpatients in the past three years, with an average number of 1.1. Then, the informal payment rate for inpatients is about 4-5% in the sample, which is consistent with the national data.
3.5 Results

3.5.1 Relationship between informal payments and perceived physician agency problem as measured by patient-reported trust levels

Figure 3.1 shows that the informal payment rates among patients by patient-reported ratings of trust in their doctors at three levels, ranging from distrust to strong trust. It indicates that as the trust levels rise, the informal payment rates drop. In the surgical setting, although the contrast between “Distrust” and “Strong trust” is dramatic, the informal-payment rates are similar between “Some trust” and “Strong trust”. In the non-surgical setting, informal payments are rarely found in the “Strong trust” category.

Although patient-reported trust might be a direct measurement for patients’ perception of the physician agency problem, we are not ready to arrive at any conclusion from this pattern due to the potential biases due to the measurement errors of patient-reported trust and the omitting variables that are correlated with patient-reported trust. First, patient-reported trust may not capture the perception of physician agency. For example, trust may reflect confidence in a physician’s technical competency (Hall et al., 2001; Mechanic and Meyer, 2000), which can be partially addressed by controlling for primary, secondary and tertiary care hospitals. Nevertheless, if a physician’s technical competency plays a dominant role in the trust measurement, we may
instead observe patients who reported trust or strong trust come with high informal payment rates, especially when a patient made payments to recruit a capable doctor. The correlation between low patient-reported trust levels and high informal payment rates is to be expected if trust measures the perception of the physician agency problem, and informal payments are made to address patients’ concerns about the agency behavior.

Second, this pattern might be a reflection of underlying disease severity or risk. Patients who have a relapse or a resistance to treatment may present low trust levels, and some of them may want immediate access to health care and/or the ability to bypass the rationing rules or clinical protocol that a physician follows. Therefore, we want to control for the disease severity and ideally compare patients with similar severity.

Finally, as we mentioned in the section of data and measurement, an alternative explanation for the correlation shown in Figure 3.1 would be that if doctors demand extra payments from patients, patients who have to make the payments will report low trust. This problem can be avoided by using measurements of patients’ perceptions before the payments, in order to show that low trust precedes the informal payment behavior. However, the survey did not ask respondents at what time-point they had the trust level that they reported. In fact, when the patient trust was surveyed retrospectively, it was hard to make a distinction in trust levels before and after making informal payments. Therefore, there is an issue of reverse causality, which would lead to a positive correlation between distrust and the informal payment behavior as shown in Figure 3.1.

A related issue is that, according to the rationale for using informal payments to the physician agency problem, one may expect that some patients who made informal payments increased their self-reported trust, perhaps due to the establishment of reciprocity. If that is the case, a hypothetical figure for prepayment trust might present even higher informal-payment rates for patients with low trust and even lower informal-payment rates among those with high trust. Therefore, if we can observe an increase of trust levels before and after the payment, even from the retrospective survey, then reverse causality is not a primary concern. However, another problem follows. The ex-post improvement of trust levels after making informal payments will cause severe underestimation of the correlation. In other words, one would also expect that some informal payments occur among patients who reported high trust levels. In figure 3.1, we can observe that even though some people indicated they trusted their doctors, their informal payment rates were
Table 3.1: Regression estimates of informal payment behavior on patient-reported trust

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Surgical inpatients (1)</th>
<th>Non-surgical inpatients (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distrust</td>
<td>0.112**</td>
<td>0.0413**</td>
</tr>
<tr>
<td></td>
<td>(0.0439)</td>
<td>(0.0171)</td>
</tr>
<tr>
<td>Some trust</td>
<td>0.0186</td>
<td>0.0286***</td>
</tr>
<tr>
<td></td>
<td>(0.0295)</td>
<td>(0.00808)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.434*</td>
<td>0.0722</td>
</tr>
<tr>
<td></td>
<td>(0.244)</td>
<td>(0.0594)</td>
</tr>
<tr>
<td>Observations</td>
<td>965</td>
<td>1,957</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.227</td>
<td>0.144</td>
</tr>
</tbody>
</table>

Age, sex, ethnicity, education, occupation/job, log of household income, medical insurance, log of length of stay, hospital types, adapted Charlson index for pre-existing chronic conditions, disease categories of admission and county dummies are included as control variables. Robust standard errors clustered at the county level are reported in parentheses.

*** p < 0.01, ** p < 0.05, * p < 0.1.

not zero. In fact, about 8% patients who reported “Strong trust” made the payment in the surgical setting.

To deal with the first and second issues, we present the regression results in Table 3.1, controlling for hospital levels and disease categories of hospital admission, as well as for other individual characteristics, including age and adapted Charlson index for pre-existing chronic conditions (Charlson et al., 2008). In the regression, we treat trust levels as categorical and use “strong trust” as a reference, so the table shows to what extent lower trust levels will increase the rate of informal payments compared to the rate when there is strong trust. Column 1 shows that, in the surgical setting, the difference in the informal payment rates between “Distrust” and “Strong trust” is as large as 11.2 percentage points, which is statistically significant at the 5% level. In the non-surgical setting, the difference in the informal payment rates as shown in Column 2 is smaller in magnitude between “Distrust” and “Strong trust”, up to 4.1 percentage points, and this amount is significant, too.

As for the third issue, the national data could not provide much information to address the reverse causality issue due to its survey design. To shed light on the potential bias of allowing informal payments to occur before patient-reported trust was surveyed, in the Ningxia data,
Table 3.2: Change of trust levels for patients before and after formal payments in the Ningxia Survey

<table>
<thead>
<tr>
<th>Trust levels</th>
<th>Pre-payment trust</th>
<th>Post-payment trust</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16%</td>
<td>1.3%</td>
</tr>
<tr>
<td>2</td>
<td>20%</td>
<td>N.A.</td>
</tr>
<tr>
<td>3</td>
<td>42.7%</td>
<td>14.7%</td>
</tr>
<tr>
<td>4</td>
<td>8%</td>
<td>45.3%</td>
</tr>
<tr>
<td>5</td>
<td>13.3%</td>
<td>38.7%</td>
</tr>
<tr>
<td>No. of observations</td>
<td>75</td>
<td>75</td>
</tr>
</tbody>
</table>

we asked those who made informal payments to consider their trust levels before and after these payments. Results in Table 3.2 clearly show that informal payments largely improved the self-reported trust of those who made them. Before the payments were made, 79% of patients expressed a trust level equal to or below the median point of 3. After the payments were made, only 16% of patients indicated that their trust levels were equal to or below 3. Only one person’s trust levels dropped from 5 to 3, which could be viewed as an exceptional case. Moreover, although we had few observations in this subsample (less than 10%) who indicated that the primary reason for making the payments was due to doctors’ extortion, we did not observe that anyone reporting that his trust levels dropped.

Given these results, the possibility that making informal payments will cause low ex-post trust should not be a primary concern. The more serious problem is underestimation of the correlation between low ex-ante trust and informal payment behavior. We can understand why informal payments existed when people reported “Trust” and “Some trust” when examining the retrospective measurement of trust obtained from the large-scale survey. However, since informal payments may improve trust ex-post, our regression analysis in the previous sections could have underestimated how much low trust would have resulted in informal payments. Unfortunately, we could not quantify the underestimation, as our supplementary survey was implemented locally in Ningxia province and did not have the full scope of the large-scale sample.
3.5.2 Relationship between informal payments and the perceived physician agency problem as measured by ratings of doctors’ communication performance

Effective communication plays a central role in building a trust relationship between physicians and patients (Thom et al., 2001; Fiscella et al., 2004; Zolnierek and DiMatteo, 2009). In an environment where physicians’ compensation largely depends on their ordering diagnostic tests and drug prescriptions that may not be necessary but where clinic decisions requiring greater efforts and higher skills are not rewarded, doctors who show little interest in communicating with patients would cause patients to worry about the agency problem (Thom et al., 2002). As a result, we would expect that a low patient-reported rating of doctors’ communication would be associated with a high probability of informal payments. Doctors’ communication is further divided into “Explaining to patients” and “Listening to patients.” From Figure 3.2, we observe a similar negative correlation between patients’ ratings of doctors’ communication and patients’ informal-payment-making behavior, on the one side, and between trust levels and these payments, on the other side.

The concerns about the relationship between trust levels and informal payment rates may apply to the relationship between communication ratings and informal payment rates. Physicians’ competency and disease severity are potential omitting variables that correlated with both communication ratings and informal payment rates. However, one advantage of the communicating
ratings is that it is based on some actual experiences rather than mere subjective feelings. It is possible that the ex-post communication will improve after informal payments. However, this could only make the negative correlation between communication ratings and informal payments less strong. More importantly, there is no particular reason that informal payments would make patients feel that the doctor’s communication performance became worse afterward. Therefore, the correlation between low communication ratings and high informal payment rating suggests that poor communication is likely to increase informal payments, but not the other way around.

Table 3.3 shows the regression with patient-reported ratings of doctors’ communication as an independent variable, controlling for hospital levels and disease categories of admission as well as other individual factors. Compared with “Very good” communication regarding explaining and listening to patients, a rating of “Poor” was associated with an increase in the informal payment rate by 5.4 and 6.9 percentage points in the surgical setting respectively, and 3.2 and 3.3 percentage points in the non-surgical setting. Not all coefficients for “Poor” communications are statistically significant. However, only magnitudes of coefficients for “Poor” regarding listening to patients are significant at the 5% level in the both surgical and non-surgical setting, but those regarding explaining to patients are insignificant in the surgical setting. It seems that patients are sensitive to whether doctors are listening to their opinions to a greater extent. In fact, it is well recognized in the doctor-patient communication literature that listening to patients can create empathy (Spiro, 2009).

### 3.5.3 Supplementary findings

One drawback of the previous results using the national data was that the measurements used did not measure patients’ motives directly. The Ningxia survey asked patients to report on their primary reasons to make informal payment directly. The results are presented in Table 3.4. Among the 75 inpatient cases, over 68% of informal payments were directly related to patients’ concerns about physicians’ behavior (avoiding undertreatment, overtreatment, or medical negligence), of which 2/3 were to prevent undertreatment. This finding suggests that one significant motivation for making informal payments is to offset the agency problem. Other patient motives do coexist, but none of them plays a dominant role. Doctors’ extortion and patients’ gratitude are two major alternative reasons for patients to make the payments.
### Table 3.3: Regression analysis of informal payment behavior on doctors’ communication ratings

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Surgical patients (1)</th>
<th>Non-surgical patients (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Explain to patients</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>0.0539</td>
<td>0.0324**</td>
</tr>
<tr>
<td></td>
<td>(0.0428)</td>
<td>(0.0145)</td>
</tr>
<tr>
<td>Good</td>
<td>-0.0385</td>
<td>0.00217</td>
</tr>
<tr>
<td></td>
<td>(0.0363)</td>
<td>(0.0126)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.403*</td>
<td>0.0694</td>
</tr>
<tr>
<td></td>
<td>(0.227)</td>
<td>(0.0596)</td>
</tr>
<tr>
<td>Observations</td>
<td>962</td>
<td>1,951</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.230</td>
<td>0.147</td>
</tr>
<tr>
<td><strong>Panel B: Ask for patients’ opinions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>0.0686**</td>
<td>0.0329**</td>
</tr>
<tr>
<td></td>
<td>(0.0326)</td>
<td>(0.0155)</td>
</tr>
<tr>
<td>Good</td>
<td>0.0112</td>
<td>0.0110</td>
</tr>
<tr>
<td></td>
<td>(0.0225)</td>
<td>(0.0122)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.419*</td>
<td>0.0741</td>
</tr>
<tr>
<td></td>
<td>(0.217)</td>
<td>(0.0587)</td>
</tr>
<tr>
<td>Observations</td>
<td>961</td>
<td>1,941</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.226</td>
<td>0.146</td>
</tr>
</tbody>
</table>

Age, sex, ethnicity, education, occupation/job, log of household income, medical insurance, log of length of stay, hospital types, adapted Charlson index for pre-existing chronic conditions, disease categories of admission and county dummies are included as control variables. Robust standard errors clustered at the county level are reported in parentheses.

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

### Table 3.4: Primary reasons for patients who made informal payments in the Ningxia Survey

<table>
<thead>
<tr>
<th>Reason</th>
<th>All inpatients</th>
<th>Patients with surgeries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extorted by doctor</td>
<td>9.3%</td>
<td>13.0%</td>
</tr>
<tr>
<td>Avoid undertreatment by doctors</td>
<td>42.7%</td>
<td>42.6%</td>
</tr>
<tr>
<td>Avoid overtreatment by doctors</td>
<td>5.3%</td>
<td>3.7%</td>
</tr>
<tr>
<td>Avoid medical errors by doctors</td>
<td>20%</td>
<td>18.5%</td>
</tr>
<tr>
<td>Followed others</td>
<td>5.3%</td>
<td>7.4%</td>
</tr>
<tr>
<td>Require extra services</td>
<td>1.3%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Express Gratitude</td>
<td>10.7%</td>
<td>9.3%</td>
</tr>
<tr>
<td>Other unspecified reasons</td>
<td>5.3%</td>
<td>3.7%</td>
</tr>
</tbody>
</table>

Observations 75 54
If a primary goal of making informal payments is to mitigate the physician agency problem, one would expect when patients have formal channels to make complaints about undesired clinical results, they may not rely on informal payments as much. With such a system in place, we would expect that the prevalence of informal payments would be reduced. In fact, in the large-scale data, patients also reported to what extent they felt free to make complaints about their care. We would expect that if patients felt free to make complaints, the informal payment rate should drop off. The following regression results confirm this point, where we classify how easy it was for patients to make complaints into three levels as Poor, Good, and Very Good. We find that, when making complaints become easier, the informal payment rate decreases (see Table 3.5). These correlations shed light on whether the formal complaint channel could reduce informal payments, supplementing the main findings.

The cross-regional survey has extra information which allows the examination of a few alternative consumer-choice explanations. First, as line jumping is often cited as the main reason to explain the informal payments phenomenon, we tested whether the waiting time for admission and operation was affected by informal payments in our primary sample. We found there was
no clear empirical evidence in this sample to suggest that informal payments could reduce waiting time. Second, if informal payments reflect patients’ choices of specific tests or procedures, we would expect that those who made informal payments would also spend more on overall medical services. We found there was no clear empirical evidence in this sample to suggest that informal payments might lead to an increase in medical expenditure over the period of hospitalization. It is noteworthy that, if reciprocity is the channel for informal payments to mitigate the physician agency problem, informal payments might even reduce overall expenditure if physicians reciprocate with fewer unnecessary drugs and procedures, especially when the patients need to pay for the entire medical bill out of pocket. We found there was a negative correlation between informal payments and medical expenditures for patients whose spending could not be reimbursed at all, however, the coefficients were not significant.

3.6 Limitations and Future Studies

As a preliminary step to explore the behavioral explanation underpinning the informal payment phenomenon, there are many limitations to our study. First, we use patient-reported trust and patient-rated doctor’s communication as measurements for patients’ perceptions of the physician agency problem, and both measures suffer from measurement errors. After checking the change of trust levels before and after informal payments using the Ningxia data, we expect that the primary results would suffer from underestimation. However, we could not quantify how large the bias would be.

Second, there could be biases in our regressions due to excluding variables whose values are largely unobservable, but correlated with patient-reported trust/communicating ratings. We have discussed two categories of variables that were omitted: competency of physicians and severity of diseases. Omitting physician competency may lead to underestimation. According to the patient-gratitude or pay-for-senior-doctor explanation, physicians with high competency are more likely to involve in informal payments. If trust is correlated with competency, the association that we find in this paper runs counter to the patient-gratitude or pay-for-senior-doctor explanation. Omitting severity of diseases may lead to overestimation. Patients with severe diseases are likely to develop a suspicion of their doctors’ recommendation, and the informal payment rate among
sicker patients is higher. Possibly, informal payments may be made just to meet the extra demand of sicker patients. Finding proper control variables to address these omitting variables could be challenging. An alternative way is it to find instrumental variables that determine patient-reported trust/communication ratings exogenously. One may expect that such an instrumental variable can be derived from patients’ learning process using the market-level information, such as the change of hospital rankings and adverse medical events exposed by the media, which may affect patients’ trust in their doctors (Dafny and Dranove, 2008). In this paper, such instrumental variables have not been available.

Finally, the paper uses reciprocity to explain how patients ensure their doctors’ commitment after the doctors have received informal payments, which remains a hypothesis to be tested in the future. A recent paper by Currie et al. (2013) had shown that in a field experiment in urban Chinese hospital outpatient clinics, when patients gave small gifts, doctors reciprocated with better service and fewer unnecessary prescriptions of antibiotics. The field experiment demonstrates the existence of reciprocity in the doctor-patient relationship. However, in an experiment, the patients’ informal payments are set by the experimenters. It does not answer whether, in reality, patients would be motivated by the goal of establishing reciprocity and how important this motive would be, compared with other reasons, in determining the informal payment behavior. Moreover, as the previous literature has shown, informal payments are widely observed when the diseases are relatively severe and complicated, involving inpatient care and surgical operations (Mechanic and Meyer, 2000). The experimental results in outpatient settings may not necessarily be applicable because doctors’ incentives and patients’ stakes vary enormously between the outpatient and inpatient settings. This paper sheds light on the potential of reciprocity relationships in the clinical settings involving complicated procedures. It would also be interesting if a future investigation could determine how physicians reciprocated after receiving informal payments, for example, whether or not physicians were more likely to provide appropriate care and even reduce medical expenditures by reducing unnecessary care.15

15To investigate such research questions, one would need to evaluate patients who have similar disease conditions but who differ in their informal payment behavior.
This paper proposes that an important motivation for patients to initiate informal payments, a widespread phenomenon in health systems in transitional countries, is to mitigate the physician agency problem. In line with the proposition, the national data show that low trust levels and physicians’ communication ratings, which reflect patients’ perceptions of the physician agency problem, are associated with high informal payment rates. The supplementary data from Ningxia confirm this finding and indicate that inpatients tend to make informal payments to avoid undertreatment and medical negligence. As noted by Gaal et al. (2006a), “researchers often overlook how patients, to offset [the] power of the physician, may seek to create [an] obligation by giving.” However, there has been little progress in the study of informal payments from this perspective.

One possible channel for informal payments to create a physician’s commitment to put forth her best effort or provide strictly appropriate care is reciprocity. This paper calls for further studies to fill the gap by identifying the reciprocity in the patient-doctor relationship, particular in situations when the disease is severe, and the treatment involves complicated procedures.

Our results suggest that, when the conflict of interests between patients and physicians are widespread in a health system and the public considers physicians’ professionalism is deemed to be seriously compromised, informal payments can be viewed as a response of patients who have suspicions about their doctors. This perspective suggests a variety of new policies that have not previously been considered relevant to informal payments. In order to curtail informal payments, policymakers have to take steps to reverse the loss of trust between patients and doctors. Merely raising physician salaries may only have limited effect, because high salaries are not necessary to ensure physicians’ commitments to patients’ best interests. Realigning physicians’ incentives with patients’ interests with payment system reforms is one of the factors, which facilitates a trust relationship between patients and doctors. Since informal payments could be regarded as patients’ self-protection, it is also important to set up channels for patients to make complaints and have access to resolution-dispute mechanisms to reduce informal payments. Broadly speaking, the reform of governmental regulation systems in the health sector, and the reform of governance in medical organizations to establish accountability are all relevant to eliminate the information
payments as long as they mitigate the physician agency problems and provide assurance to patients.
Appendix
## 3.A Survey Questions on Informal Payments

**Table 3.A.1: Survey questions on informal payments**

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Did you or your family member give any red packets (or cash) or gifts when seeing a doctor in the past three years?</td>
<td>(1) red packet (2) gift (3) both (4) neither</td>
</tr>
<tr>
<td>2</td>
<td>In which year did the visit occur?</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Which kind of provider was involved?</td>
<td>(1) village clinic (2) township health center (3) county hospital (4) municipal or provincial hospital (5) private clinic (6) private hospital (7) other</td>
</tr>
<tr>
<td>4</td>
<td>What kind of medical services were provided?</td>
<td>(1) routine outpatient care (2) specialist outpatient care (3) inpatient care without surgery (4) inpatient care with surgery (5) other</td>
</tr>
<tr>
<td>5</td>
<td>How much did you trust the doctor BEFORE you gave the red packets or/and gifts?</td>
<td>(1 stands for strong distrust, and 5 stands for strong trust)</td>
</tr>
<tr>
<td>6</td>
<td>How much did you trust the doctor AFTER you gave the red packets or/and gifts?</td>
<td>(1 stands for strong distrust, and 5 stands for strong trust)</td>
</tr>
<tr>
<td>7</td>
<td>What was the primary reason for you to give the red packets or/and gifts?</td>
<td>(1) doctors asked for them directly or indirectly (2) to avoid undertreatment by doctors (3) to avoid overtreatment by doctors (4) to prevent medical negligence by doctors (5) other patients gave them (6) for particular needs (e.g., to order specific medical tests or procedures, change wards or hire alternative doctors) (7) to express gratitude (8) other</td>
</tr>
</tbody>
</table>
Conclusion

When the physician agency problem hinders the buildup of the trust relationship between doctors and patients, both sides may take measures to mitigate the agency problems because a trust relationship is mutually beneficial: patients want to ensure that their interests are given top priority, and physicians seek to increase the size of their practices. This thesis has examined physicians’ efforts to monitor their peers to improve their group reputation as well as the practice of patients initiating gift-giving to their doctors as a means of improving the healthcare they receive. These measures are examples of institutional and societal behaviors to manage the physician agency problem and to bolster patients’ trust, but I believe they are fundamental elements, which are ingrained in relationships between patients and physicians and in peer-to-peer relationships among physicians (Dixit, 2009).

Summary of findings

Chapters 1 and 2 demonstrate that forming and maintaining reliable physician groups with high reputations require intragroup institutions that feature information sharing and enforcement. The former mechanism enables physicians in a group to monitor each other’s behavior, and the latter mechanism enforces punishment on those who tarnish the group reputation. Generally speaking, it is advantageous to expand the scope of information sharing and to efficiently sanction a specific physician who jeopardizes the group reputation. Chapter 1 proposes that enforce peer monitoring can be matched with suspension based on peers’ reports, rather than a reliance on grim-trigger strategies among peers. In reality, suspension and its more extreme form, revocation of membership, are widely used in the governance of physician groups and medical organizations. Our model analyzes how suspension can enforce peer monitoring at the outset of misbehavior, and highlights some design features that prevent the mechanism from being abandoned or even
abused by physician peers.

In real-world health care organizations, physician groups may actively select their colleagues by recruiting highly-regarded physicians and dismissing those who fall into disrepute by providing under- or overtreatments. Chapter 2 presents an experiment to test empirically whether a peer-selection mechanism can significantly reduce overtreatment rates, compared situations in which there is lack of peer monitoring enforcement. The results show that improving information-sharing among peers has only limited effect on encouraging appropriate care. When the selection mechanism is available, physician groups in the experiment can recruit doctors whose behavior is in line with the collective interests of the physicians’ group and screen out doctors who ignore their patients’ interests and thus harm the group reputation. When the peer selection features are present, overtreatments rates decline significantly.

Chapter 3 explores, how, when institutions on the provider side do not discipline physicians who exploit patients at times of radical social and economic changes, patients will take the initiative to protect themselves by making informal payments. Data from China shows that the correlation between informal payments and patients’ perceptions of the physician agency problem is strong, suggesting that the informal payments are used to address patients’ concerns about their physicians’ fiduciary responsibility. The informal-payment phenomenon can be viewed as a “degenerative institution” in which patients sacrifice material wealth to ensure physicians’ commitment to their patients’ best interests. The social cost is significant if a health system develops such an informal institution because patients’ trust toward the medical profession, on the whole, will be damaged (Hsiao, 2008), with ramifications including barriers to healthcare access, undesirable clinical outcomes, and health inequity.

Policy Implications

My findings suggest that a monitoring system with effective enforcement (either by suspension or selection) involving doctor peers is far more effective than the monitoring and enforcement (either by exiting or by making informal payments) by patients alone. Information sharing among physicians facilitates effective peer monitoring. This, in turn, provides reliable data upon which physicians can impose effective sanctions on misbehaving peers. According to what we have
learned from the theoretical model and experimental results, policy changes in the real world
aiming to mitigate the physician agency problem and bolster patients’ trust through repairing
relational institutions may include the following steps:

- 1) provide physicians with the means to obtain relevant information about their peers’
   performance;
- 2) allow physicians to implement sanctions based on this information, but with carefully
designed mechanisms that discourage their misconducts;
- 3) make it possible for patients to access reliable records for physician groups and to have
   the freedom to make informed choices among different physician groups.

**Future Research**

There are many shortcomings in my thesis research to be addressed in the future. With the model
presented in Chapter 1, we only discuss suspension as a means of peer monitoring enforcement.
There is a variety of mechanisms that we have not considered from a theoretical perspective. The
transaction costs of peer monitoring are under-addressed. The laboratory experiment described in
Chapter 2 may suffer from the external validity problem if the experiment does not capture some
important elements that prevail in the real world. Those elements that our experimental design
fails to capture could be the focus of future experiments design. Additionally, field experiments
and surveys might yield complementary results to our laboratory experiment by getting real
physicians and actual patients involved. The results in Chapter 3 are largely descriptive, although
the association between informal payments and patients’ perceptions of the agency problem is
indeed intriguing. Future studies of the possible identification of reciprocity channels could also
help corroborate the associations between informal payments and patients’ perception of the
agency problem.

Nevertheless, my thesis sets up an agenda to study the physician agency problem using
experimental approaches based on theoretical considerations. This approach allows researchers
to make ceteris paribus changes in institutional features of physician groups and healthcare
organizations to observe outcomes like under-or-overtreatments, which are not easy to identify in
a real medical setting. For these reasons, the practical implications of research in this area could be dramatic. Furthermore, a better understanding of the trust relationship in medical settings can provide valuable insights into the behavior of patients, physicians as individuals and as physician groups.
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