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Using performance measures to motivate 'report-averse' and 'report-loving' agents

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Abstract

In designing a quality report, a health plan needs to account for the report's effect on the doctor, hospital or other provider. This paper proposes a simple model of how quality reporting affects a health care provider, using the example of a doctor subject to reporting with a "cut point" that designates the doctor as above or below some standard. Choice of cut point affects the doctor's welfare through the doctor's preferences about income and by affecting market demand for the doctor's services. These factors lead doctors to be "report-averse" or "report-loving," a determination that affects a health plan's cost to enlist a doctor in a contract with reporting and that guides choice of a cut point to maximize the doctors' effort to improve her quality.
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1. Introduction

A public report about the quality of physicians, hospitals, nursing homes and health plans has two purposes: equipping decision makers (e.g., patients, managers, other doctors, regulators) with more information so they can choose the provider that best suits their needs, and motivating providers to improve the quality of the services they offer. The benefits of such reporting must be weighed against its costs, which include not only the costs to collect and distribute the information

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but also costs borne by the provider. These latter costs consist of a financial component, measured perhaps as an impact on expected profits, and also may include a subjective component. For example, a physician may simply be repelled or attracted by the idea of having her professional quality listed in a health plan publication. How this listing is done might also matter to a provider. It might be one thing if a health plan designated a few of its contracting physicians as "gold-star providers," but quite another if the plan flagged its "least-preferred providers." Any net subjective cost associated with reporting would also have to figure into a plan's decision to use a public report, because such costs may affect the terms of the contract that doctors or other providers find acceptable.

This paper proposes a simple model of how a quality report affects a health care provider. We couch our model as an analysis of a doctor and a health plan, and study the expected payoff a doctor receives from participating in reporting, which may be tied to participation in a plan's network. Our analysis is motivated by the observation that the design of a report on quality information needs to account for the perspective of the physician or other provider being reported upon. Importantly, the provider's payoff and the incentives conveyed depend on the nature of the quality report. We study a report that divides physicians into two groups, high and low, and how various "cut points" affect providers. One cut point, for example, might designate the top 5% of physicians, whereas another would designate the top 50%, and so on. Our analysis is intended to assist a health plan considering whether to use quality reporting of this form, and if so how to design such a report.

Our general approach is to regard quality reporting as a mechanism design problem, and to apply familiar tools from principal–agent analysis. The plan (the principal) is interested in using the cut point quality report to convey as much information as possible about physician quality, or in some of our analyses, motivating doctors to improve their quality as much as possible. The doctor (the agent) has her own welfare to consider and the health plan must design a contract that is acceptable to the doctor.[1]

Although a cut point is a specific and limited form of quality report, it has important advantages. A basic tradeoff for much of the paper is between what the plan wants – the cut point that conveys the most information, and what the doctor wants – the cut point that maximizes her expected payoff. In our model below, the most informative cut point is $1/2$, and we can readily analyze the forces from the doctor's side that push a health plan towards a higher cut point designating a few preferred providers or towards a lower cut point designating the least-preferred providers. Furthermore, in practice, a cut point system is often observed in quality reports. In one sense a health plan's network is always of this form, since providers are either in the network (and above some cut point) or not.

In the course of the analysis we find it useful to introduce the terms "report-aversion" and "report-loving" to characterize the payoffs a physician or other provider faces from a quality report, properties that turn out to be potentially critical to the health plan when deciding about quality reports. Report-aversion/-loving can come from a subjective reaction a provider might have to the prospect of being publicly reported upon, or, notably, and as we will show, from cost and competitive conditions in a market.

We do not explicitly model the value health plan members place on information about physician quality (with the exception of one illustration below). We thus avoid a prior question of whether

[1] Although our analysis is cast in terms of a private health plan with which the doctor may choose to contract or not, our analysis also applies to Medicare or other public plans where a physician may essentially have no choice about participation. The issue of elicitation of effort is common in voluntary and compulsory reporting. Also, a well-designed compulsory reporting plan should still take account of the costs it imposes on participating providers.

a plan should report at all. Our analysis also considers only one dimension of physician quality, and one element of information (the cut point) about this dimension. A particularly notable simplification is that we assume throughout the paper that doctors, consumers and the health plan have no prior information about the doctor's quality. An obvious factor contributing to a doctor's attitude towards quality reporting is whether she thinks she is better than the average, and our assumption about information eliminates this as an issue. The assumption may not be as restrictive as it first appears. If it is common knowledge that on average doctors affiliated with teaching hospitals are better qualified than unaffiliated doctors, for example, a quality report conditional upon this information would be analyzed as is done here. The presence of private information held by doctors would complicate the picture in ways that we do not address formally here, but it is conceivable that even information reported privately to the physician that compared her to other physicians would affect the physician's utility. Finally, we adopt a representative doctor framework.

Two literatures bear on our analysis, a health economics and health services literature concerned with provider reaction to quality reports, and a largely theoretical literature on "career concerns" in economics. Both of these are briefly reviewed in Section 2. Section 3 develops our approach to characterizing a provider's payoff from reports, and introduces the concepts of "report-aversion" and "report-loving." We also show how these payoffs are affected by competitive conditions. Section 4 applies the analysis to the question of physician participation in a health plan's provider network in the presence of quality reports taking the form of a cut point. We show how a physician's expected payoff from reports restricts the forms of reports acceptable to the doctor. Section 5 incorporates the effect of cut point reporting on the effort a physician may undertake to improve her quality (and report). We consider how a plan should choose a cut point when motivating effort is the goal, but when it may be constrained by needing to choose a report acceptable to the physician. Section 6 contains a discussion and some potential directions for future research.

2. Professional recognition

Physician quality reports are a form of professional recognition designed to address information gaps in health care. The problem of unobserved elements of quality or productivity of professionals has also been studied in a broader literature where the manager of an organization may not be accurately credited (or blamed) for an organization's performance.

2.1. Physician quality reports

Almost all health plans, as well as hospitals and nursing homes, are subject to quality reports by Medicare, other payers and by state agencies.[2] Physicians, more numerous by far than any of these organizations, and with typically small but highly diverse practices with many lines of business, constitute the most challenging provider from the standpoint of designing a quality report. Over and above issues related to small sample size for any line of business, a quality report

[2] For example, one can obtain information about the frequency of times various process measures of care are satisfied for patients with heart attacks, heart failure, or pneumonia, or having surgery at specific hospitals and how each hospital compares on those measures with all hospitals in the United States as well as all hospitals in the specific hospital's state. See http://www.hospitalcompare.hhs.gov/Hospital/Search/SearchCriteria.asp?version=default&browser=IE%7C7%7CWinXP&language=Enblish&pagelist=Home&dest=NAV-Home-Search-SearchCriteria&Type+ZipCode#astep1a.

on a doctor is "personal," imposing subjective costs and benefits not involved in organization-level reports. Nonetheless, physician quality reports are well established, at least for some specialties, and efforts to expand the reach of reports continue. Moreover, as we describe below, some health plans are beginning to tier physicians on the basis of quality, meaning that patients in the plan pay less to use physicians deemed to be higher quality, a variant of cut point reporting.

Although payments for physician services amount to only a little over 20% of health care costs, physicians make the decisions directing 80% of the care (Eisenberg, 2002), putting doctors in the cross hairs of purchasers and payers seeking to improve the quality and efficiency of health care (Landon et al., 2003). In some high profile cases, physician reports have been shown to improve quality, such as the cardiac surgeon reports in New York State, Pennsylvania, and Massachusetts. The mechanism for the improvement may be a professional concern with providing good quality (Hannan et al., 2003; Marshall et al., 2000). Because these reports are inevitably both partial (not covering all elements of "output") and imperfectly adjusted for differences in severity across practices, once a quality report has power, providers may seek ways to game the reports by shifting activities within their practice or taking different patients (Dranove et al., 2003).

Groups working with health plans are attempting to improve the reliability, precision and utility of quality reports on physicians using administrative data (Lee and Ross, 2005; Scholle et al., 2006). The practical problems are formidable, starting with both identifying the appropriate "denominator" and with attributing causation to a specific provider. The denominator issue arises because it is problematic to identify how many instances a physician has the "opportunity" to do the right thing, against which her performance can be scored. The attribution issue arises because in the fluid American health care system, it is not obvious which doctor to hold responsible for elements of quality for a particular patient even in principle, let alone in practice.

Nonetheless, competing health plans have fielded physician quality reports, though not always successfully. In the mid 1990s United Health Care attempted to provide quality reports on primary care physicians in St. Louis, and Regence Health Care attempted a similar project in Seattle. Both projects failed in the face of provider resistance. Aetna has tiered specialists in certain specialties in certain markets.[3] This effort, which began in three markets and has now expanded to 35, appears to be succeeding, at least in the sense of being tolerable to the affected physicians. One of the themes that emerges from this experience is the need to enlist doctor buy in/participation in quality reporting.

2.2. *Reputation and career concerns*

Our work is also closely related to the large literature in economics on reputation and career concerns (see, for example Holmstron, 1982; Dewatripont et al., 1999; Gibbons and Murphy, 1992; Ottaviani and Sorensen, 2006). The seminal paper in this field is Holmstron (1982), which studies the following scenario: the outcome of an agent's action is a function of the agent's effort and her talent. The agent's talent is unknown to everyone, and effort is observed only by the agent. Outcome is publicly observable, with some noise, and is not contractible. The agent's future earnings, however, may depend on the market's assesment of her talent and, hence, indirectly on the outcome of the agent's current action. The focus of Holmstrom's (1982) paper, as well as many papers that followed, is on the level of effort chosen by the agent in such a case (often referred to as the "implicit contract" case). A main question addressed in this literature (see, for

[3] http://www.aetna.com/producer/e.briefing/2006-02/aexcel.pdf.

example Gibbons and Murphy, 1992) is how the level of effort obtained in this case differs from the level of effort obtained when outcome is contractible (the "explicit contract" case). Another line of research has focused on the question of how the structure of information about outcome affects the agent's effort (Dewatripont et al., 1999).

Our paper contributes to the career concern literature in two aspects. First, unlike most of this literature where it is assumed that the information that the public can observe regarding the agent's ability is exogenously given, we assume that it is the public agency's decision what information to disclose to the public. Second, we focus on the question of how the shape (curvature) of the agent's utility function affects her attitude towards public reporting of her ability, an issue that as far as we know has been largely ignored by the literature.

3. Report-averse and report-loving doctors and cut point reporting

A continuum of doctors differs in their ability, which ranges between 0 (the lowest) and 1 (the highest). The distribution of doctors' ability in the market is given by some density function $f(z)$, $0 \leq z \leq 1$, and is assumed to be common knowledge to all participants in the economy. Let $F(z)$ denote the cumulative distribution of z. Initially, neither the doctor nor the public knows each doctor's ability, and, hence, for each doctor it is only known that her ability is drawn according to $f(z)$. For now we suppose that a doctor's ability is synonomous with the doctor's "quality;" in other words, "ability" is an innate characteristic and the doctor cannot alter her quality. In Section 5, we will consider the effect of reporting on a doctor's effort to improve her quality.

We postulate the existence of a reporting agency (e.g., a health plan) that can observe each doctor's ability and provide information about it to the public. Quality reports are often used as a basis for pay for performance. However, in this paper we study the effects of quality reports alone, when no "pay-for-performance" mechanism is included. Thus, following the career concerns literature, we assume that even though the plan's report about the provider's ability is publicly observable, the provider cannot be offered a contract in which compensation is a function of quality, as reported by the rating agency. The only way in which the agency's report may affect the provider's utility is through its effect on the market's (and/or the provider's own) reaction to the report.

The two most important ingredients of our analysis will be the doctor's utility (payoff) given a report and the reporting mechanism employed by the reporting agency.

3.1. Physician's utility

All doctors are ex ante identical with ability z distributed according to the density function $f(z)$. Focus on one (representative) doctor. Suppose that some additional information about the doctor's ability becomes public. How does this additional information affect the doctor's utility? Certainly, more "favorable" information can be expected to benefit the doctor. Being perceived as higher ability can reward the doctor in a market, either by bringing in more patients or allowing the doctor to set a higher price, or both. Being perceived as a higher quality provider may also convey personal satisfaction to the professional who takes pride in her work.

Specifying a utility function that depends on the market's perception of a doctor's ability obviously will require some assumptions. In the case of our analysis of cut point reporting, we make a simple, intuitive assumption in order to proceed. We first define what we mean by utility of the market's perception of ability: for every $Z \subseteq [0, 1]$ let $f_Z(z)$ denote the posterior distribution of the doctor's ability if it becomes publicly known that $z \in Z$. That is

$$f_Z(z) = \begin{cases} \dfrac{f(z)}{\displaystyle\int_{y \in Z} f(y)\,\mathrm{d}y} & \text{if } z \in Z \\ 0 & \text{if } z \notin Z \end{cases}$$

Let $U(Z)$ denote the doctor's utility when it is publicly known that z is distributed according to $f_Z(z)$.[4] Let $F_Z(z)$ denote the cumulative distribution function of $f_Z(z)$.

Assumption 1 below says that more "favorable" information about a doctor's ability, in the sense that the range of abilities the doctor may have is rated higher, increases the doctor's utility.

Assumption 1. Suppose that $Z_i \subseteq [0, 1]$ for $i = 1, 2$ and $Z_1 \neq Z_2$. Then, $U(Z_2) > U(Z_1)$ if $F_{Z_2}(z) \leq F_{Z_1}(z)$, for every $z \in [0, 1]$.

The implications of Assumption 1 above will be discussed shortly, after we introduce the particular reporting mechanism studied in this paper.

3.2. The reporting mechanism and the physician's expected utility

Throughout this paper we consider a particular family of reporting mechanisms described by a cut point designated by k, reflective of common practice in quality reports designed for consumers. The reporting agency, typically a health plan, chooses a cut point $k \in [0, 1]$ and for each doctor it reports whether her ability is "low" (i.e., below k) or "high" (i.e., above k). We assume that the cut point k, chosen by the agency, is common knowledge. Thus, for a given cut point k, if the doctor's ability is reported to be "low" it becomes publicly known that the doctor's ability is distributed according to (the posterior) $f_{[0,k]}(z)$, and if the doctor's ability is reported to be "high" then it becomes publicly known that the doctor's ability is distributed according to (the posterior) $f_{[k,1]}(z)$.

The following observations follow directly from Assumption 1 above

$$\text{Suppose that } 0 < k < 1, \quad \text{then } U([0, k]) < U([k, 1]) \tag{1a}$$

$$\text{Suppose that } 0 < k_1 < k_2 < 1, \quad \text{then } U([0, k_1]) < U([0, k_2]) \tag{1b}$$

and

$$U([k_1, 1]) < U([k_2, 1]) \tag{1c}$$

The first observation (1a) simply says that given some cut point k, the doctor's utility is higher if her ability is reported to be "high" than if her ability is reported to be "low". The second observation (1b) says that if the doctor's ability is reported to be "low" then the higher is the cut point the higher is the doctor's utility, and the third observation (1c) says exactly the same thing but for the case where the doctor's ability is reported to be "high".

[4] Notice that $U(Z)$ depends, among other things, on the prior distribution function $f(z)$. Further notice that the utility function assumed here could, in fact, be derived from the following (more conventional) model: For every density function f let $\mu(f)$ denote the doctor's utility when it is publicly known that her ability is distributed according to the density function f. Then $U(Z) = \mu(f_Z)$ where f_Z is the posterior distribution of the doctor's ability, given that it is publicly known that z belongs to the set Z.

For a given cut point k, let

$$v(k) = F(k)U([0, k]) + (1 - F(k))U([k, 1]). \tag{2}$$

$v(k)$ is the doctor's expected utility from participating in a plan that uses a reporting mechanism with a cut point k.

We next show that, given the particular reporting mechanism assumed in this paper, the doctor's utility function can be redefined as a function of a single variable rather than of a set.

Notice first that for each $z \in [0,.5]$ there exists a unique interval $[0, k]$ such that $z = k/2$ and for each $z \in [.5, 1]$ there exists a unique interval $[k, 1]$ such that $z = (k + 1)/2$. Thus, we can use each $z \in [0,.5]$ to "indicate" the interval $[0, 2z]$ and each $z \in [.5, 1]$ to "indicate" the interval $[2z - 1, 1]$. We can, therefore, define the following (indirect) utility function:

$$u(z) = \begin{cases} U([0, 2z]) & \text{if } z \in [0,.5] \\ U([2z - 1, 1]) & \text{if } z \in [.5, 1] \end{cases} \tag{3}$$

The utility function $u(z)$ is interpreted as the doctor's utility from a report that discloses that her ability belongs to the interval whose midpoint is z.[5]

Proposition 1. *$u(z)$ is strictly increasing with z.*

Proof. Follows directly from (1a), (1b) and (1c). □

Hereafter we will assume that $u(z)$ is differentiable almost everywhere and, hence, by the proposition above, $u'(z) > 0$. Notice, however, that the proposition tells us nothing about the sign of $u''(z)$. As will be shortly shown, the sign of $u''(z)$ plays an important role in the agency's decision about the cut point.

Using our definition of $u(z)$ we can rewrite the doctor's expected utility given a report with cut point k as

$$v(k) = F(k)u\left(\frac{k}{2}\right) + (1 - F(k))u\left(\frac{1 + k}{2}\right)$$

Our main purpose in this paper is to demonstrate how the "shape" of the doctor's utility function $u(z)$ may enter the reporting agency's (the plan's) considerations when choosing the cut point. Another element that may affect the agency's choice of a cut point is the shape of the density function $f(z)$. However, in order to focus on issues concerning the structure of the provider's payoffs and utility as a function of the report, we hereafter "neutralize" the effect of the density function by assuming that each doctor's ability is drawn from a uniform distribution over the interval [0,1]. Therefore we can redefine the doctor's expected utility given a cut point k as follows:

$$v(k) = ku\left(\frac{k}{2}\right) + (1 - k)u\left(\frac{1 + k}{2}\right) \tag{4}$$

With z distributed uniformly over [0,1], at cut point k, $k/2$ is the doctor's expected ability when she is designated "low," and $(1 + k)/2$ is the doctor's expected ability when she is designated "high."

[5] The utility function $u(z)$ should not be interpreted as the doctor's utility when it becomes known that her quality is z. This would only be the case under some special circumstances. Notice also that $u(z)$ may depend, among other things, on the prior distribution of the doctor's ability f. See also footnote 4 above.

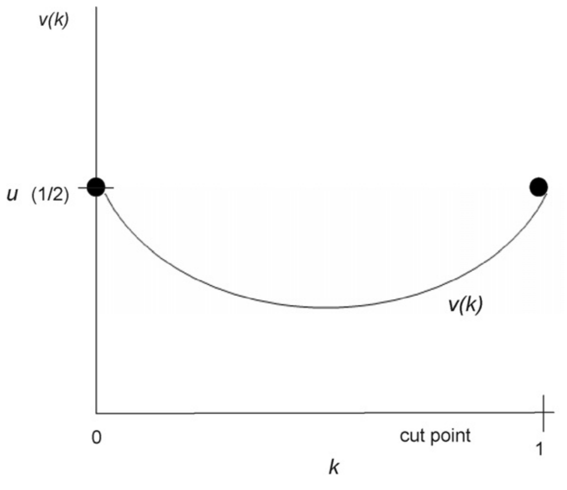

Fig. 1. "Report-averse" doctor valuation of cut points.

3.3. Report-aversion and report-loving physicians

Utility $u(z)$ takes one of two general forms governed by the sign of $u''(z)$, which will play an important role in the analyses to follow. If $u''(z) < 0$, the underlying utility function is concave; if $u'' > 0$, it is convex. The expected utility function is plotted in Fig. 1 in the case of a concave $u(z)$ function. When $k = 0$ or 1, the cut point conveys no information to the market, and each physician's expected ability is simply 1/2. Thus $v(0) = v(1) = u(1/2)$. Furthermore, it can be shown that when $u'' < 0$, $v(k) < u(1/2)$ over the range of k between 0 and 1. Thus, $v(k)$ will be convex as shown in Fig. 1. We will refer to the case of $u'' < 0$ as the case of a "report-averse" doctor, meaning that any cut point other than 0 or 1 makes the doctor worse off on expectation.[6] Fig. 1 illustrates an example of a report-averse doctor.

Fig. 2 depicts the opposite case. When the underlying utility function $u(z)$ is convex the doctor gets $u(1/2)$ at $k = 0$ and 1 as before, but now intermediate values of the cutoff k increase the doctor's payoff. In this case the doctor's payoff is maximized when k takes an intermediate value. This is a "report-loving" doctor.

Definition. A provider with a concave $u(z)$ is report-averse; a provider with a convex $u(z)$ is report-loving.

A number of factors contribute to determining the curvature of a doctor's $u(z)$ function and her resulting classification as a report-averse or report-loving provider. Both cases are plausible and can be expected in some circumstances. The shape of the underlying marginal utility of income schedule is one factor affecting the doctor's position on reporting. Suppose the market rewards a physician directly in proportion to expected ability z. A doctor might value higher income at a declining marginal utility, giving the $u(z)$ a concave shape. Increasing marginal utility of income would yield the opposite case. Note that the $u(z)$ function embodies the market's reward for

[6] We assume that demand for physician service is unaffected by designating all physicians above the cut point as opposed to all physicians below it.

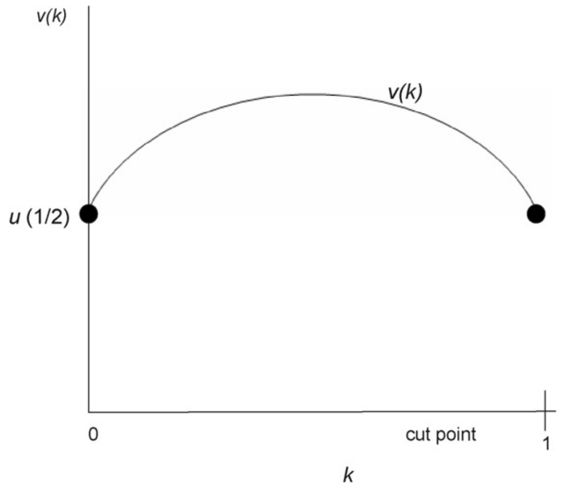

Fig. 2. "Report-loving" doctor valuation of cut points.

higher z as well the subjective utility the doctor enjoys from income or non-pecuniary rewards deriving from ability. If patients place decreasing (increasing) marginal value on expected ability z, $u(z)$ will tend to be concave (convex).[7] Cost conditions also will affect the curvature of $u(z)$. Suppose quantity demanded of a physician goes up directly in proportion with z. If marginal cost is increasing, profits will go up less than proportionally, implying concave $u(z)$. Decreasing marginal cost creates the opposite case.

If $u''(z) > 0$, then $v(k)$ will be maximized at the interior of [0,1] and if $u''(z) < 0$ then $v(k)$ will be minimized at the interior of [0,1]. It is interesting to see what determines the exact location of these extreme values. Taking the derivative of $v(k)$ we get

$$\begin{aligned} v'(k) &= u\left(\frac{k}{2}\right) - u\left(\frac{1+k}{2}\right) + \frac{k}{2}u'\left(\frac{k}{2}\right) + \frac{(1-k)}{2}u'\left(\frac{1+k}{2}\right) \\ &= \frac{k}{2}u'(\frac{k}{2}) + \frac{(1-k)}{2}u'\left(\frac{1+k}{2}\right) - \int_{k/2}^{(1+k)/2} u'(x)\,\mathrm{d}x \end{aligned}$$

Integrating $\int_{k/2}^{\frac{1+k}{2}} u'(x)\,\mathrm{d}x$ by parts we get

$$\begin{aligned} &= \frac{k}{2}u'\left(\frac{k}{2}\right) + \frac{(1-k)}{2}u'\left(\frac{1+k}{2}\right) \\ &\quad - \left[\frac{1+k}{2}u'\left(\frac{1+k}{2}\right) - \frac{k}{2}u'\left(\frac{k}{2}\right) - \int_{k/2}^{(1+k)/2} xu''(x)\,\mathrm{d}x\right] \end{aligned}$$

7 An interesting special case is if patients, or the market, value higher expected ability but dislike risk. Suppose patients' utility is equal to expected ability less the standard deviation of ability. Then, in the case of a uniform distribution of z over [0,1], utility is $z - (z/2)$ for values of z up to $1/2$ and $z - ((1-z)/2)$ for values over $1/2$. Thus, patient marginal utility of z is $1/2$ up to the value of $z = 1/2$. Between $1/2$ and 1, the marginal utility of z is $3/2$. Increasing marginal utilities create a convex $u(z)$ function.

$$= ku'\left(\frac{k}{2}\right) - ku'\left(\frac{1+k}{2}\right) + \int_{k/2}^{(1+k)/2} xu''(x)\,\mathrm{d}x = \int_{k/2}^{(1+k)/2} (x-k)u''(x)\,\mathrm{d}x$$

$$= \int_{k/2}^{k} (x-k)u''(x)\,\mathrm{d}x - \int_{k}^{(1+k)/2} (k-x)u''(x)\,\mathrm{d}x$$

Thus, $v'(k)$ will be equal to zero at the point k^* where

$$\int_{k^*/2}^{k^*} (k^*-x)u'(x)\,\mathrm{d}x = \int_{k^*}^{(1+k^*)/2} (x-k^*)u''(x)\,\mathrm{d}x$$

We can now state the following proposition, the proof of which is derived directly from the equation above.

Proposition 2.

(a) *If the provider is report-loving and if $u''(z)$ is increasing ($u'''(z) \geq 0$) then $v(k)$ is maximized at $k^* \geq 1/2$. If $u''(z)$ is decreasing ($u'''(z) \leq 0$), $v(k)$ is maximized at $k^* \leq 1/2$.*
(b) *If the provider is report-averse and if $u''(z)$ is decreasing ($u'''(z) \leq 0$) then $v(k)$ is minimized at $k^* \geq 1/2$. If $u''(z)$ is increasing ($u'''(z) \geq 0$), then $v(k)$ is minimized at $k^* \leq 1/2$.*

Proposition 2 helps us understand how a cut point affects a doctor. One implication of the proposition above is that if the provider is report-loving (report-averse) and u'' is constant, then the provider's utility is maximized (minimized) when the cut point is set at the at the mean of the distribution, i.e., at $k = 1/2$. The cut point $k = 1/2$ is special because it is the most informative cut point in the case of the uniform distribution, in the sense that it leads to the largest expected change in the market's evaluation of the doctor. Proposition 2 describes how the desire for the most informative cut point by the report-loving doctor is modified by changes in curvature of the $u(z)$ function. When $u''(z)$ is increasing, for example, the doctor gets a very high utility from being recognized as "the best." If the market essentially confers a prize on the few very best providers, a report-loving doctor wants to take the chance to get the prize and prefers a high cut point (with the lower probability of being above). Conversely, the report-averse doctor with $u''(z)$ increasing is particularly averse to having a very low ability recognized, and dreads most a low cut point with the risk of being labeled "among the worst."

3.4. Market structure and physician payoff from quality reports

The payoff a physician receives from a quality report can depend on competitive factors in the market in which she works as well as on the shape of the $u(z)$ function. Consider a situation in which there are many doctors, all of whom are subject to a quality report and whose market position relative to the others is affected by the pattern of reports.

Suppose that there are $n+1$ profit maximizing doctors in a plan. Each doctor's ability is ex-ante uniformly distributed over the interval [0,1]. The plan chooses a cut point k, and after privately observing each doctor's ability it announces whether the doctor's ability is h (i.e., above the cut point) or l (below the cut point). Let $k \in [0, 1]$, $r \in \{l, h\}$, $j \in [0, 1, 2, \ldots, n]$ and let $\pi(k, r, j)$ denote a doctor's profit if the cut point, chosen by the plan, is k, the doctor's ability is reported to be r and there are j other doctors whose ability is reported to be h.

We shall now demonstrate how the market conditions, as captured by the shape of the doctors' profit function, may determine the doctor's preferences over the cut point k. We consider two cases.

Suppose first that

$$\pi(k, r, j) = \begin{cases} 1 & \text{if } k \in [0, 1]\, r = h \text{ and } j = 0 \\ 0 & \text{otherwise} \end{cases}$$

That is, the doctor gets a (strictly positive) profit of 1 if she is the only one whose quality is above the cut point, otherwise her profit is 0. This profit function captures a very competitive market situation (Bertrand) in which if two (or more) doctors are perceived as having the same ability, price competition will drive their profit to zero. In such a case, each doctor's expected profit is $v(k) = (1 - k)k^n$. Since $v'(k) = k^{n-1}(n - k(n + 1))$ we can conclude that $v'(k) \geq 0$ if $k \leq n/(n + 1)$ and $v'(k) \leq 0$ if $k \geq n/(n + 1)$ and, hence, the doctor's profit is maximized at $k^* = n/(n + 1)$. A high threshold maximizes the probability there will be one (and only one) doctor designated "high." The optimal cut point, from the doctor's point of view, increases with the number of doctors, and approaches 1 when n gets very large.

Suppose, instead, that

$$\pi(k, r, j) = \begin{cases} \dfrac{1}{j + 1} & \text{if } k \in [0, 1]\, r = h \text{ and } j \in [0, 1, 2, \ldots, n] \\ 0 & \text{otherwise} \end{cases}$$

This profit function represents a cartel-like situation where the monopoly profit (of size 1) is equally divided among all doctors whose ability is above the cut point. Here, the doctor's expected profit is

$$v(k) = (1 - k)\sum_{j=0}^{n} \frac{1}{j + 1} \frac{n!}{j!(n - j)!}(1 - k)^j k^{n-j} = \frac{1 - k^{n+1}}{n + 1}$$

Thus, the doctor's profit maximizing cut point is at $k^* = 0$.[8]

The two cases above capture two extreme situations, one in which (price) competition is very aggressive and the other in which there is no (price) competition at all. In the first case the doctor's most desired cut point was somewhere in the interior approaching 1 as the number of doctors approached infinity. In the second case, the doctor's most desired cut point was at $k = 0$. One could think, of course, of cases where there is some but not extreme price competition. It is beyond the scope of this paper to analyze these more general cases, but it seems reasonable to expect that the doctor's most desired cut point in these cases would be at some intermediate value.

3.5. *Other competitive factors and physician payoff*

Less formally, we can consider how other factors might influence the love or aversion a physician might have for a quality report. A new physician whose practice is not "full" is likely to have a different view than an established physician who is not accepting new patients.[9] The former

[8] Notice, however, that if, in this case, the monopoly profit was not fixed at 1, but rather was an increasing function of k, capturing the idea that the higher the doctor's expected quality the higher is patients' willingness to pay, then the optimal cut point would not be 0.

[9] Administratively set prices mean doctors are constrained from raising prices when demand for their time increases.

is more likely to be in the "nothing-to-lose" or risk-loving category, whereas the latter is in the opposite position.[10] Further, any belief by newly trained physicians that they are likely to rank higher because of their more recent training reinforces this attitude (Choudhry et al., 2005).

In general, it is probably easier to measure the quality with which specialists perform certain procedures than to measure the quality of primary care physicians. Among surgeons, for example, one can compare infection rates or operative mortality. Further, many physicians performing invasive procedures tend to specialize in particular procedures, for example, a cardiac surgeon may primarily carry out coronary artery bypass operations, an interventional cardiologist may primarily carry out angioplasties, and one orthopedic surgeon may specialize in total hip replacements whereas another may specialize in total knee replacements. Such physicians are likely to have a reasonably large and homogeneous sample of patients from which to draw inferences about their quality as compared with primary care physicians, who see patients with a wide range of diseases and within disease a wide range of severity (e.g., varying combinations of comorbidities). In the case of primary care physicians treating diabetic patients, even drawing inferences about cost, something presumably one can measure with less error than quality, is problematic because of the small number of diabetics in any primary care physician practice—and diabetes is a relatively common disease (Hofer et al., 1999). Furthermore, in the case of procedures it is less problematic to attribute outcomes to a given physician than in the case of managing a patient with a medical problem who may have seen several physicians.[11] It is interesting to note that the two cases described in Section 2.1 in which quality rating failed both attempted to rate primary care physicians, whereas the case that appears to be succeeding rates physicians in 12 different (non-primary care) specialties.

One way to think about the differences between specialists and primary care physicians is to regard quality in primary care to be subject to more measurement error. Travel costs or other kinds of patient preferences may make the consequences of a good or bad report less consequential for certain types of physicians where (measured) variation in quality is less. In a career concerns type model one could have the report a function of underlying ability, effort, and a random error with the variance of the error term larger for primary care physicians (e.g., Gibbons and Murphy, 1992).

4. Quality reports and doctor participation

As noted above, quality reports may serve two purposes. The first is to provide decision makers (e.g., patients, managers, the doctors themselves as well as other (referring) doctors) better information about the doctor's ability, so that they can make better decisions. The second is to induce doctors to put more effort into improving their ability and, hence, their performance. In doing so, however, the reporting agency must take into account the doctor's reaction to the disclosure of more information about her performance. When effort is variable, an important consideration in the construction of the report is how the report affects doctor's effort. This issue will be discussed in Section 5. Even when effort is not variable, however, and the only purpose of the report is to provide patients with more information about the doctor's ability, an important consideration in the construction of the report is the doctor's "participation constraint". As was shown above, the doctor's utility is affected by a report and, hence, if she has some alternatives, she may choose not to participate in a plan that uses a particular quality report, unless she is

[10] A similar contrast between new and old-timers is made in Prendergast and Stole (1996).

[11] Even in the case of a procedure, of course, a less than optimal outcome may have come from the actions of the surgeon, the anesthesiologist, nursing care, or some other aspect of treatment. That said, in general the magnitude of the attribution problem is less in the case of procedures.

sufficiently compensated. In this section we discuss how the doctor's attitude towards reporting may affect the reporting agency's choice of a cut point.[12]

4.1. General considerations

Consider a health plan that wishes to choose a cut point that will be the most informative.[13] Given our assumption about the uniform distribution of ability one can see that, in the absence of any constraints, the plan should set $k = 1/2$. However, suppose that doctors can choose whether or not to participate in this plan and if they decide not to participate, they have an alternative employment under which their utility will be $\underline{v}$. This $\underline{v}$ might be conceived of as deriving from an alternative plan that a physician could contract with that did not use quality reporting.

The plan's problem can therefore be thought of as a principal–agent (PA) problem, where the plan's objective (the principal) is to choose a cut point that maximizes the value of the information provided to the public minus the doctor's compensation, subject to the doctor's (the Agent) participation constraint, namely, that her utility given the report, $v(k)$ plus the compensation she gets, is greater than her outside option.

Before considering a formal analysis of such a problem, we informally discuss the tension that arises between the plan's and the doctor's objectives and how it may affect the plan's choice of a cut point. Based on the discussion in the previous section, one can see that the plan's considerations will be quite different, depending on whether the doctor is report-averse or report-loving. A doctor's utility from a quality report is not observed directly by a health plan proposing to contract with the doctor. In the course of the doctor–plan interaction, either in the form of a bargaining model or a principal–agent type model, the doctor's preferences factor into the outcome. In a principal–agent model, for example, the plan may not know the doctor's alternative utility from not contracting with the plan, but is assumed to be able to set a contract that just satisfies such a participation constraint.

If the doctor is report-averse, her utility is maximized at $k = 0$ and 1, and it decreases as k moves toward the interior of the interval [0,1]. Without further knowledge of the doctor's utility function we cannot say whether the plan's choice of (the second-best) k will be to the right or to the left of the most informative cut point. One can see however, that the degree of "report-aversion" (measured, for example, by the concavity of the doctor's utility function), will determine how far away from $k = 1/2$ the plan's choice of a cut point will be if the plan needs to incorporate the doctor's participation constraint.

If the doctor is report-loving, then her utility is maximized at some point in the interior of the interval [0,1]. This point could be either to right or the left of the plan's desired cut point $k = 1/2$. The plan's (second-best) cut point in this case will be somewhere between $k = 1/2$ and the doctor's most desired cut point. The intensity of the doctor's affection for reports will determine how far away from $k = 1/2$ will be the plan's choice of a cut point.

We can now present these observations more formally. Let $w(k)$ denote the consumer's welfare as a function of the cut point k. Following the discussion above we assume that the consumer welfare is maximized at the most informative cut point, $1/2$. Let T denote the transfer from the plan

[12] The incidence of any monetary costs in constructing and distributing the report can be addressed using standard methods, and is likely to be independent of any utility costs.

[13] The health plan's underlying purpose may be profit maximization. A formal connection between profit and information could be made by recognizing that to attract enrollees, a plan seeks to maximize their expected utility in the plan. In plausible circumstances, the most informative cut point would maximize an enrollee's expected utility.

to the doctor. Assume that the plan's objective is to maximize its profit which is increasing with the consumer's welfare and is decreasing with the payment to the doctor. The plan's principal–agent (PA) problem can, therefore, be presented as follows:

$$\begin{aligned} &\max_{k,t} \quad w(k) - T \\ &\text{s.t.} \qquad v(k) + T \geq \underline{v} \end{aligned}$$

where $v(k)$ is the doctor's expected utility given the cut point and $\underline{v}$ is her outside option.

It is easy to see that the solution to the PA problem above is obtained at the cut point $k^0 = \text{argmax } w(k) + v(k)$. We can now state the following proposition:

Proposition 3. *Let k^0 denote an interior solution to the PA problem above.*

(i) *Assume that the doctor is report-loving and let k^* denote her most desired cut point, then* $\min\{k^*, 1/2\} \leq k^0 \leq \max\{k^*, 1/2\}$.
(ii) *Assume that the doctor is report-averse and let k^* denote her least desired cut point, then either* $k^0 \leq \min\{k^*, 1/2\}$ *or* $k^0 \geq \max\{k^*, 1/2\}$.

Proof. Assuming an interior solution (i.e., $w'(k^0) + v'(k^0) = 0$) we know that at k^0 it must be that either $w'(k^0) \leq 0$ and $v'(k^0) \geq 0$ or $w'(k^0) \geq 0$ and $v'(k^0) \leq 0$. □

4.2. An example

A physician is located at a point on a circle of uniformly distributed potential patients with total mass of 1. A patient who has to travel distance x to see the physician must pay a travel cost x. The patient has no other costs, so the net value of treatment to a patient at distance x is $z - x$, where z is the doctor's true ability. Assume patients seek care if the net expected value of the care is positive. Thus, if the doctor's expected quality is z, the total number of patients treated by her will be:

$$n(z) = 2z \tag{5}$$

The physician's cost of production is $c(n)$ where n is the number of patients treated, with $c' > 0$. Assuming the doctor receives a fixed payment of t for each patient treated, then

$$\pi(z) = t2z - c(2z) \tag{6}$$

is the physician's profit given expected quality z. If we assume the doctor cares only for profit, then $u(z) = \pi(z)$.

The sign of u'' in this case depends only on c''. Based on our earlier discussion, we know that:

- If $c'' > 0$ the doctor is "report-averse."
- If $c'' < 0$ the doctor is "report-loving."

Suppose that a plan chooses a cut point k and, if the doctor elects to participate in the plan, the plan learns the doctor's ability and announces whether it is below or above the cut point. We continue to assume that z is uniformly distributed over the interval [0,1]. Thus, for a given cut point k, $z_{\mathrm{l}}(k) = k/2$ and $z_{\mathrm{h}}(k) = k + 1/2$ are equal to the expected ability of the doctor designated to be "low" or "high" respectively in relation to cut point k.

Let $n_{\mathrm{l}}(k)$ be the number of patients treated by the doctor if she is reported to be below the cut point and $n_{\mathrm{h}}(k)$ be the number of patients treated by the doctor if her ability is reported to be above the cut point. Then

$$n_{\mathrm{l}}(k) = 2z_{\mathrm{l}}(k) \tag{7}$$

$$n_{\mathrm{h}}(k) = 2z_{\mathrm{h}}(k) \tag{8}$$

For a given k and t, define the expected surplus of patients in the plan[14]

$$w(k, t) = kn_{\mathrm{l}}(k)\left(z_{\mathrm{l}}(k) - \frac{n_{\mathrm{l}}(k)}{4} - t\right) + (1-k)n_{\mathrm{h}}(k)\left(z_{\mathrm{h}}(k) - \frac{n_{\mathrm{h}}(k)}{4} - t\right) \tag{9}$$

One can easily see that for every t, $w(k, t)$ is maximized at $k = 1/2$. Thus, in the absence of any constraints associated with physician participation, the plan would choose the cut point at $1/2$.[15]

Assume, however, that when choosing the cutoff, the plan has to also take into account the effect of the cutoff on the physician's payoff, here consisting only of profit. Assume that the physician has an alternative profit $\underline{v}$ and she is willing to work for the health plan only if her expected profit is above $\underline{v}$. Assume that if the physician agrees to contract with the plan, she must take all patients who seek her services. The doctor's only decision therefore is whether or not to join the plan's network. We can write the physician's expected payoff assuming she participates in the network as

$$v(k, t) = k(n_{\mathrm{l}}(k)t - c(n_{\mathrm{l}}(k)) + (1-k)(n_{\mathrm{h}}(k)t - c(n_{\mathrm{h}}(k)))) \tag{10}$$

The plan's constrained problem can, therefore be written as

$$\max_{k,t} w(k, t) \tag{11}$$

$$\text{s.t. } v(k, t) = \underline{v} \tag{12}$$

One can see that the optimal cut point, in this case, is independent of t and is given by[16]:

$$1 - 2k - 4(kc'(k) + (1-k)c'(1+k) + c(k) - c(1+k)) = 0 \tag{13}$$

Using a technique similar to the one used in Section 3 it can be shown that Eq. (14) above can be written as:

$$1 - 2k - 4\int_{k}^{1+k} (x - 2k)c''(x)\,\mathrm{d}x = 0 \tag{14}$$

Thus, if $c'' = 0$, the solution to Eq. (13) is obtained at $k = 1/2$. That is, if the doctor is "report-neutral" the solution to the plan's problem is obtained at the most informative cut point. This, however, will not necessarily be the case if $c'' \neq 0$, in which case the solution to the plan's problem may be obtained at a cut point higher or lower than $1/2$. If the provider is "report-loving" (i.e., $c'' < 0$) and c'' is constant, then the provider's most desired cut point is at $k = 1/2$, which is also the plan's most desired cut point, and, hence, the solution to the plan's problem is achieved

[14] Without treatment patients do not travel and have net benefits of zero. This formulation also assumes that patients pay t perhaps through premiums for joining the plan.

[15] t cannot be too large, otherwise the average surplus per encounter is negative. t cannot be larger than $1/2$.

[16] We thank Richard Frank for pointing out this result can be interpreted as an application of a "separating hyperplane." For more information about this perspective, contact him at frank@hcp.med.harvard.edu.

at $k = 1/2$. If the provider is report-loving but c'' is decreasing (increasing), then the provider's most desired cut point is a point to the right (left) of $1/2$, and the solution to the plan's problem is reached at some point higher (lower) than $1/2$. To illustrate the intuition behind these results, a decreasing c'' implies that the doctor's total profits will be very high when the volume of patients is high and she would be willing to accept a lower probability of passing the cut point in exchange for more volume. If, on the other hand, the provider is report-averse (i.e., $c'' > 0$) and c'' is decreasing (increasing) the provider's worst cut point is to the left (right) of $1/2$ and the solution to the plan's problem is at a point higher (lower) than $1/2$.

5. Using a quality report to induce a high effort

5.1. Maximizing effort by choice of cut point

As mentioned at the outset, one function of quality reporting is to induce the provider to improve quality. To analyze this phenomenon, we need to introduce a malleable element of quality, and so in this section we assume that quality is determined by a combination of a doctor's innate ability and the effort she chooses to improve quality. From the standpoint of the health plan contracting with the doctor, the limited objective considered in this section is to induce the doctor to put as much effort as possible into improving quality. We assume in this section that the doctor is committed to contracting with the insurer.

Assume that a doctor's ability z is a function of her initial ability z_0 and the effort she devotes to improving her ability, e. More specifically, assume that $z = z_0 + e$, where $e \geq 0$ is the effort level chosen by the doctor and z_0 is a random variable, uniformly distributed over the interval [0,1]. Effort, in this model, is regarded as an investment. In order to simplify the analysis, we assume that effort is observable by the market.[17]

Effort is costly to the doctor. Let $c(e)$ denote the doctor's cost of effort with, $c' > 0$ and $c'' > 0$. When choosing an effort level, the doctor does not know the realization of her initial ability, z_0, but she knows its distribution.

As before, we assume that a health plan (or a rating agency) can perfectly observe the doctor's ability, z, and report about it to the public. Here too, we assume that the plan uses the cut point reporting mechanism, as described before.

The order of moves is as follows:

- *Stage 1*: The plan announces a cut point k.
- *Stage 2*: The doctor chooses an effort level e. Effort is observable.
- *Stage 3*: The rating agency observes the doctor's ability z and announces whether it is "low" (i.e., $z < k$) or "high" (i.e., $z \geq k$).
- *Stage 4*: The market observes the agency's report and updates its beliefs regarding the (distribution of) the doctor's ability. The doctor receives utility according to the market's beliefs about her expected ability.

We shall discuss first stages 3 and 4 (given a cut point k and an effort level e). We shall then move recursively to stage 2 to see how the doctor chooses her effort level, given a cut point, and finally consider the plan's problem of choice of a cut point, in stage 1.

[17] The main insights of this paper will still hold if we assume, instead, that effort is not observable by the public, but in equilibrium the market infers the doctor's chosen effort.

Given a cut point k and a doctor's effort level e, the probability that the agency's report will turn out to be "low" is $\Pr(z < k) = \Pr(z_0 < k - e) = k - e$, and the probability that the report will turn out to be "high" is $1 + e - k$.[18] Assume that the doctor's utility depends only on her expected ability as perceived by the market. Thus, if the report is "low" then the doctor's expected ability is $E(z|z < k) = (k + e)/2$ and her utility will be $u((k + e)/2)$. If the report is "high" then the doctor's expected ability is $E(z|z \geq k) = (k + e + 1)/2$ and her utility will be $u((k + 1 + e)/2)$. We further assume that $u' > 0$.[19]

We can now analyze how the doctor chooses her level of effort, in stage 2, given a cut point k. Let

$$v(k, e) = (k - e)u\left(\frac{k + e}{2}\right) + (1 + e - k)u\left(\frac{1 + e + k}{2}\right) - c(e) \tag{15}$$

denote the doctor's expected utility given a cut point k and effort level e.

In stage 2 the doctor chooses an effort level to maximize $v(k, e)$. The first order condition of the doctor's problem yields:

$$\frac{\partial v(k, e)}{\partial e} = -u\left(\frac{k + e}{2}\right) + \frac{(k - e)}{2}u'\left(\frac{k + e}{2}\right) + u\left(\frac{1 + e + k}{2}\right) + \frac{(1 + e - k)}{2}u'\left(\frac{1 + e + k}{2}\right) - c'(e) = 0 \tag{16}$$

We can now see how the plan's choice of a cut point k, in stage 1, affects the doctor's choice of effort, in stage 2. Using the first-order condition (16) above we know that:

$$\frac{\mathrm{d}e}{\mathrm{d}k} = -\frac{\partial^2 v/\partial e \partial k}{\partial^2 v/\partial e^2} \tag{17}$$

In the case of the report-averse doctor ($u'' < 0$), the second-order condition is easily seen to be satisfied. In the case of the report-loving doctor ($u'' > 0$), the second-order condition will be satisfied if c'' is positive and large enough. We assume in what follows the second-order condition is satisfied. By the second-order condition of the doctor's maximization problem we know that the denominator of (17) is negative and thus $\mathrm{d}e/\mathrm{d}k$ is positive (negative) if $\partial^2 v/\partial e \partial k$ is positive (negative). Since

$$\frac{\partial^2 v}{\partial e \partial k} = \frac{1}{4}\left[(k - e)u''\left(\frac{k + e}{2}\right) + (1 + e - k)u''\left(\frac{1 + e + k}{2}\right)\right] \tag{18}$$

We can conclude that:

Proposition 4. $\mathrm{d}e/\mathrm{d}k > 0$ *if* $u'' > 0$ *and* $\mathrm{d}e/\mathrm{d}k < 0$ *if* $u'' < 0$.

Proof. Follows directly from (17) and (18) above. □

Proposition 4 above tells us that if the agency's objective is to induce high effort then in the case where $u'' > 0$ it should aim at setting the cut point as high as possible, whereas if $u'' < 0$, it should aim at setting the cut point as low as possible. Effort is motivated by the expected

[18] Throughout the analysis we assume an interior solution, namely $e < k < 1 + e$.

[19] The assumption that the doctor's utility depends only on her expected ability is made in order to simplify the discussion.

subjective return. In the case of a report-loving doctor, the plan wants to take advantage of the thrill the doctor gets from being labeled the greatest because of her increasing marginal utility of z. In the case of the report-averse doctor, the plan can exploit the dread the doctor feels at being singled out as the worst because of the opposite curvature of $u(z)$.

5.2. *Inducing high effort within a participation constraint*

Suppose that the plan's objective is to induce the doctor to put a high effort; however, the contract must satisfy a doctor participation constraint.[20] If the plan offers a contract too unfavorable from the doctor's point of view, the doctor will not agree to contract with the plan. How should then the plan set its cut point k? Based on the analysis in the previous sections we know that the answer to this question may depend crucially on the shape of the doctor's utility function and in particular on the sign of u''. We shall now discuss each of the two cases, one where $u'' > 0$ and the other where $u'' < 0$.

Suppose that $u'' > 0$. By the discussion above we know that in such a case the plan would like to set a high cut point since $\mathrm{d}e/\mathrm{d}k > 0$. (This is the doctor's incentive compatible constraint to the plan's principal–agent problem.) However, by the discussion in Section 3 above, we know that when $u'' > 0$ the doctor is "report-loving" and, hence, from a certain point onwards her expected utility decreases with k (the doctor's participation constraint to the plan's principal–agent problem). Thus, the optimal cut point in this case from the plan's point of view should balance these two elements. The optimal cut point would be not as high as it would have been in the absence of the participation constraint, but higher than the one that maximizes the doctor's expected utility.

Suppose, instead, that $u'' < 0$ hence, $\mathrm{d}e/\mathrm{d}k < 0$ and the doctor is "report-averse". In such case the solution to the plan's principal–agent problem calls for a low as possible k. Decreasing k increases the doctor's effort and at the same time increases her expected utility net of the effort's costs. The cost of effort determines how low k can go.

6. Discussion

Quality reports on individual physicians will be one of the last set of provider reports to come on line, partly because the large number and diversity of physician practices makes these reports costly and error prone, and partly because physician reports are "personal," affecting members of a professional group who are accustomed to be held in uniformly high regard. Initially physicians are likely to react viscerally against the whole idea of being reported upon, but given the broad and powerful impetus in health policy towards transparency and making more information available to consumer–patients, movement to more reporting will be hard to slow. Colleges and hospitals first resisted national quality reports, but now they mainly accept, watch, and even play to them. Once quality reporting becomes part of the routine contracting issues between doctors and health plans, the fundamental factors affecting physician welfare will come to determine a doctor's position on the presence and form of a quality report. In anticipation of this, our paper begins an investigation of how underlying risk aversion and market structure influence the impact of a report on a physician, and on the physician's reaction to that report.

We approach the issue as a mechanism design problem. From a modeling standpoint, our paper is "different" in the way we characterize physician utility as a function of the distribution

[20] In this section we abstract from the plan's/agency's "other" objective, informing patients about a provider's quality, and focus on the plan's desire to motivate provider effort.

of her quality as perceived by the market. This approach allows us to model the effect of quality reporting on a set of doctors in a market and to characterize the distribution of possible outcomes for a doctor. This analysis highlights that a quality report may decrease the uncertainty patients have about doctors' quality, but it introduces a new kind of risk to doctors, depending on how each doctor and her competitors are scored. We are also able to represent how a set of reports affects the surplus available to doctors and how this is shared.

Our analysis yields several insights into health plan's contracting with doctors in the presence of quality reports. The outcome of a new quality report is to some degree uncertain, and so while introduction of quality reports reduces uncertainty for patients about doctors' quality, it creates risk for doctors subject to the report. Indeed, the more informative a report is to the market, the more is at stake for doctors. A health plan's anticipating that doctors are averse to reporting risk should choose a cut point tending away from the informative midpoint. In the case of report-aversion, we argue that when the plan also cares about incentives for doctors to improve their quality, the direction to go in is a lower cut point, including more than half of the doctors in the "high" category. A report-averse doctor particularly dreads failing when only really low quality constitutes a failure, and this dread motivates effort.

Depending on preferences and market circumstances, doctors, or at least some doctors, may be report-loving, welcoming the chance for the advantage of a positive differentiation from a set of competitors. Health plans have more scope to inform patients in such circumstances, but will still be advised when effort is an issue to tilt a report away from the most informative cut point to a higher one to most efficiently use the lure of the "gold-star" to elicit quality improving effort from doctors.

At the same time, we recognize that our approach is just a start and the ideas here need more development. The form of report we analyze, the one-cut-point report, though observed, is very simple and more informative forms of report should be considered. Heterogeneity among physicians in their true quality would introduce an important new factor in the analysis, and we did not consider heterogeneity of risk preferences among physicians. Physician private information about quality clearly should play a role in an analysis of "report-loving." Finally, measurement of quality and measurement error is a major area of health services research and needs to be integrated with the approach laid out here. Once these considerations are introduced, the plan's choice of a cut point becomes a richer question. A plan might choose a high cut point to attract doctors who think they are likely to satisfy it. A cut point might signal patients that a plan has high standards for its doctors. A doctor's measured performance might also reflect the case mix of her patients, particularly if the quality measure has only imperfect adjustments for patient severity. In this case a plan could set a high cut point to deter doctors with more severe case mixes of patients from joining the plan's network. Interestingly, all of these strategic considerations regarding the plan's choice of cut point tend to push the cut point towards the upper end.

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