Economics Bulletin

# Volume 33, Issue 3

## Pay-for-Performance, Reputation, and the Reduction of Costly Overprovision

Nadja Kairies
*University of Duisburg-Essen*

## Abstract

We investigate the effect of reputational motivation on output in a scenario of overprovision of medical treatment. We assume that physicians differ in their degree of altruism, enjoy being perceived as good but, dislike being perceived as greedy. We show that better reputational motivation unambiguously reduces the costs of healthcare provision and the magnitude of overprovision which in turn raises patient benefits.

**Citation:** Nadja Kairies, (2013) "Pay-for-Performance, Reputation, and the Reduction of Costly Overprovision", *Economics Bulletin*, Vol. 33 No. 3 p.A211.
**Contact:** Nadja Kairies - nadja.kairies@ibes.uni-due.de.
**Submitted:** May 27, 2013. **Published:** September 05, 2013.

# 1 Introduction

For policy makers in the healthcare sector improving the quality of care and reducing costs have been of major interest in recent years, see McClellan (2011). In particular, in case of overprovision both aims are not mutually exclusive as a reduction of medical treatment may increase patients' health benefits and decrease costs for the healthcare payer, see Cutler and Ly (2011). In practice, this is likely if the fee-for-service (FFS) is high, see e.g. Medicare in the US. Recent reforms targeting theses issues make use of financial incentives for predetermined performance measures (pay-for-performance), see e.g. Rosenthal et al. (2004) for the US and Doran et al. (2006) for the UK, and non-financial incentives usually in the form of public quality reporting, see e.g. Glazer et al. (2007) or Ma and Mak (2011). Especially the latter incentives have recently become interesting for policy makers as they might motivate physicians to improve patient care out of reputational concerns of wanting to appear as "good" physicians. Physicians might also be motivated by monetary incentives induced by demand changes as a result of public reporting. However, evidence for this effect is little, see e.g. Epstein (2006) for a survey. Kolstad (2013) underline the importance of reputational motivation for physicians going along with public reporting. They analyze the introduction of public report cards for cardiac surgery in Pennsylvania which provides an empirical setting to isolate monetary incentives induced by demand shifts and non-monetary incentives including reputational motivation. Comparing pre- and post-report periods, they find that while monetary incentives induced by demand shifts lead to a decline of 3 percent in the statewide risk adjusted morality rate, non-monetary incentives including reputational aspects lead to a response about four times larger.[1] Hence, better reputational motivation may play an important role in incentivizing physicians and this is the focus of this article.

In the light of those reforms and along the lines of Siciliani (2009) we provide a theoretical framework with both financial and non-financial incentives for physicians. In contrast to Siciliani (2009) we focus on overprovision and reputational motivation. The monetary incentive is modeled by a FFS for each quantity of care. If we abstract from reputational motivation a higher FFS yields an increase in care since it increases physicians' marginal revenues. Concerning the reputational motivation we introduce a patient benefit function which links the quantity of care and the corresponding patient benefit. We assume that physicians are altruistic like in Ellis and McGuire (1986) and care about their reputation like in Bénabou and Tirole (2006). As in Ellis and McGuire (1986) but in contrast to Siciliani (2009) we assume that patients are characterized by a "peaked" patient benefit function which allows for both under- and overprovision of care. In case under- or overprovision is moderate physicians receive an extra utility gain since they are perceived as "good" type. This reputational motivation is different across physicians since they are

[1]Kairies and Krieger (2013) moreover support this finding. They analyze physicians' responses to the introduction of public quality reporting in a controlled laboratory experiment without demand effects and find significant improvements in the quality of care.

heterogeneous in their degree of altruism. Physicians who are more altruistic adjust the quantity of care in order to be perceived as "good" while low altruism physicians maximize profits.

We use the model framework to derive comparative static results with respect to the total amount of care. We show that better reputational motivation unambiguously reduces the magnitude of overprovision which in turn increases patient benefits and decreases costs of healthcare provision. We then introduce a measure for the efficiency of the FFS scheme. Intuitively, an efficiency maximizing FFS trades off the physicians' demand for a high FFS (higher marginal revenues) with the patients' aim for a low FFS (less overprovision). We show that an efficiency maximizing FFS exists and decreases if reputational motivation increases. For policy makers this can be an important result since promoting reputational motivation may actually increase patient benefits and simultaneously decrease costs.

## 2 Model

Let $q$ denote the quantity of medical treatment that a physician provides to a patient.[2] Physicians differ in their degree of altruism $\theta$ as in Ellis and McGuire (1986), where $\theta$ can take a continuum of values $\theta \in [\underline{\theta}, \overline{\theta}]$.[3] The corresponding density function is denoted by $f(\theta)$ while the cumulative density function is $F(\theta)$. For a physician the provision of $q$ involves total costs $C(q)$ with $C_q > 0$ and $C_{qq} > 0$. This cost function $C$ includes all the monetary and non-monetary costs associated with the provision of $q$.

A patient benefits from the provision of medical treatment $q$. Formally, the patient benefit is denoted by $B(q)$ and we assume that there exists a unique global maximum $B(q_B^*)$. If a physician provides $q < q_B^*$ ($q > q_B^*$) the patient suffers from underprovision (overprovision).

A physician's remuneration is a FFS $p > 0$, which is financed by the healthcare payer. Hence, profits are

$$\pi = pq - C(q). \tag{1}$$

A physician's utility increases with profits $\pi$ and an altruistic part that accounts for the patient benefit, i.e. $\theta B(q)$. Utility is therefore

$$V(\theta, q) = \pi + \theta B(q). \tag{2}$$

Moreover, physicians care about their reputation among patients and other physicians. Similar to Siciliani (2009) we assume that a physician is perceived as a "good" physician if the provided medical treatment $q$ is within a reputation interval $[\underline{q}, \overline{q}]$ with $q_B^* \in [\underline{q}, \overline{q}]$. Sufficiently strong underprovision $q < \underline{q}$ or overprovision $q > \overline{q}$ yield zero reputation. [4]

[2] Note that $q$ is not a measure for quality or performance as assumed in Eggleston (2005) or Siciliani (2009). Quite in contrary, we focus on overprovision where a higher $q$ implies lower quality for the patient.

[3] Alternatively, it may also be interpreted as intrinsic motivation, see Besley and Gathak (2005).

[4] A typical example of overprovision which yields zero (or even negative) reputation are unnecessary

As physicians enjoy being regarded as good they receive an extra gain in utility from reputation which we model as

$$(\alpha + \lambda\delta p)\, w > 0 \tag{3}$$

with $\alpha, \delta, w > 0$ and $\lambda = 1$ if $q \geq q_B^*$ and $\lambda = -1$ otherwise.[5]

The higher $\alpha$ the more a physician enjoys being perceived as good. A higher $\delta$ reflects a stronger stigma associated with providing care under financial incentives. If a physician provides $q^* < q_B^*$ such that $\lambda = -1$, a higher $p$ devalues reputation. In this case a higher $q$ not only reflects providing better medical treatment but also has a negative stigma associated with financial incentives (greediness) to maximize revenues, see Le Grand (2003). The situation is the opposite in case of overprovision with $q^* > q_B^*$ and $\lambda = 1$. In this case a physician providing less medical treatment can unambiguously be identified as a physician that cares more about patients and less about maximizing revenues. In general, a higher $w$ reflects better reputational motivation.

The specification of reputation is discrete. This assumption may be justified as patients' judgments about physicians' abilities are not extremely accurate and they usually call them a "good" or "bad" physician. Like Siciliani (2009) we assume the dichotomous case, i.e., physicians are either good or not good. Moreover, the specification also assumes that patients judgments is absolute and not in relative terms.[6] If a physician provides $q \in [\underline{q}, \overline{q}]$ the extra gain from reputation yields a utility level of

$$U\left(\theta, q \in [\underline{q}, \overline{q}]\right) = V(\theta, q) + (\alpha + \lambda\delta p)\, w. \tag{4}$$

In contrast, if the physician is not regarded as good utility $U(\theta, q \notin [\underline{q}, \overline{q}])$ is given by (2).

Now, consider a physician's maximization problem. The optimal medical treatment $q^*(\theta)$ in case there is no extra utility gain from reputation ($w = 0$) is implicitly given by

$$p + \theta B_q = C_q \tag{5}$$

with

$$\frac{\partial q^*}{\partial \theta} = \frac{B_q}{C_{qq} - \theta B_{qq}}. \tag{6}$$

More altruistic physicians provide relatively more (less) in case of underprovision (overprovision) since $q^* < q_B^* \Rightarrow B_q > 0$ ($q^* > q_B^* \Rightarrow B_q < 0$). Moreover, it follows

$$\frac{\partial q^*}{\partial p} = \frac{1}{C_{qq} - \theta B_{qq}} > 0 \tag{7}$$

surgeries or MRI tests without (or negative) benefical medial effects but also overprovision of vaccines for irrelevant diseases.

[5]As in Siciliani (2009) we assume $\delta p < \alpha$ for $\lambda = -1$ to secure that the reputation gain is positive.

[6]Hence, in an extreme case with two physicians in a small town patients do not consider a relative ranking but rather judge whether physicians provide quality of care within the reputation interval $[\underline{q}, \overline{q}]$.The judgement whether the quality of care is within the reputation interval is a purely absolute measure.

such that a higher FFS increases the likelihood of overprovision. In the following we focus on overprovision and assume that $p$ is sufficiently high such that $q^* > q^*_B$ for all $\theta$. Note that if $p$ is sufficiently low such that $q^* < q^*_B$ for all $\theta$ we consider the case of Siciliani (2009).

We now explore how altruism shapes the physician's utility. In Figure 1 we focus on three types of physicians who differ in their degree of altruism $\theta_3 > \theta_2 > \theta_1$, with $\theta_3$ being the type with the highest degree of altruism. Due to the extra gain from reputation a physician's utility function $U(\theta, q)$ has three discontinuities. The first one at $q = \underline{q}$ and the one third at $q = \overline{q}$. The utility jumps upwards (downwards) when a quantity weakly above $\underline{q}$ $(\overline{q})$ is provided. The jump is due to the extra utility gain and equal to $(\alpha + \lambda\delta p)\, w$. Moreover, the utility jumps up at $q = q^*_B$ since the sign of $\lambda$ changes.

In the following we show that all types of physicians can be grouped into three categories: i.) *high*, ii.) *intermediate* and iii.) *low* altruism. High altruism physicians provide quantity $q^*(\theta) \in [\underline{q}, \overline{q}]$ - independent of whether reputation yields an extra utility gain or not. This case is illustrated by type $\theta_3$ in Figure 1. If the physician chooses quantity $q^*(\theta_3)$, she obtains a utility (point $C$) which is higher than the utility she would obtain if quantity $\tilde{q} \equiv \overline{q}$ was chosen (point $C'$). Define $\tilde{\theta}$ as the level of altruism such that the provider is indifferent between $q^*(\tilde{\theta})$ and $\tilde{q}$. We assume that $q^*(\overline{\theta}) < \tilde{q}$, otherwise the group with high altruism would be empty. Then, physicians of high altruism type in the range $\tilde{\theta} < \theta < \overline{\theta}$ provide output $q^*(\theta)$ and receive utility $V(\theta, q^*(\theta)) + (\alpha + \delta p)\, w$.

If the physician's degree of altruism is below the threshold $\tilde{\theta}$, it follows $q^*(\theta) > \tilde{q}$. Now the physician faces a trade-off. If she provides $\tilde{q}$, she gains a good reputation which increases her utility by $(\alpha + \delta p)\, w$. However, providing $\tilde{q}$ is costly (in terms of foregone revenue) as it is below $q^*(\theta)$. The physician provides $\tilde{q}$ if

$$(\alpha + \delta p)\, w > V(\theta, q^*(\theta)) - V(\theta, \tilde{q}), \tag{8}$$

i.e., if the additional utility from being perceived as a good physician is higher than the loss in utility from choosing quantity $\tilde{q}$ instead of $q^*(\theta)$. Since

$$\frac{\partial [V(\theta, q^*(\theta)) - V(\theta, \tilde{q})]}{\partial \theta} = -[B(\tilde{q}) - B(q^*(\theta))] < 0 \tag{9}$$

we can conclude that physicians with a higher degree of altruism have a lower loss of utility from choosing $\tilde{q}$. We assume that for the physician with the lowest degree of altruism it is not optimal to provide quantity $\tilde{q}$. Then, there exists a level of altruism $\hat{\theta}$ defined by $V(\hat{\theta}, q^*(\theta)) - V(\hat{\theta}, \tilde{q}) = (\alpha + \delta p)\, w$ such that physicians with a degree of altruism below (above) $\hat{\theta}$ choose quantity $q^*(\theta)$ $(\tilde{q})$. We refer to physicians in the first group as low altruism physicians, and to the second group as physicians with intermediate levels of altruism.

As illustrated in Figure 1, physician $\theta_1$ obtains a higher utility by choosing quantity $q^*(\theta_1)$ (point $A$) rather than quantity $\tilde{q}$ (point $A'$). Physician $\theta_1$ therefore belongs to the category of low-altruism physicians. In contrast, physician $\theta_2$ obtains a higher utility

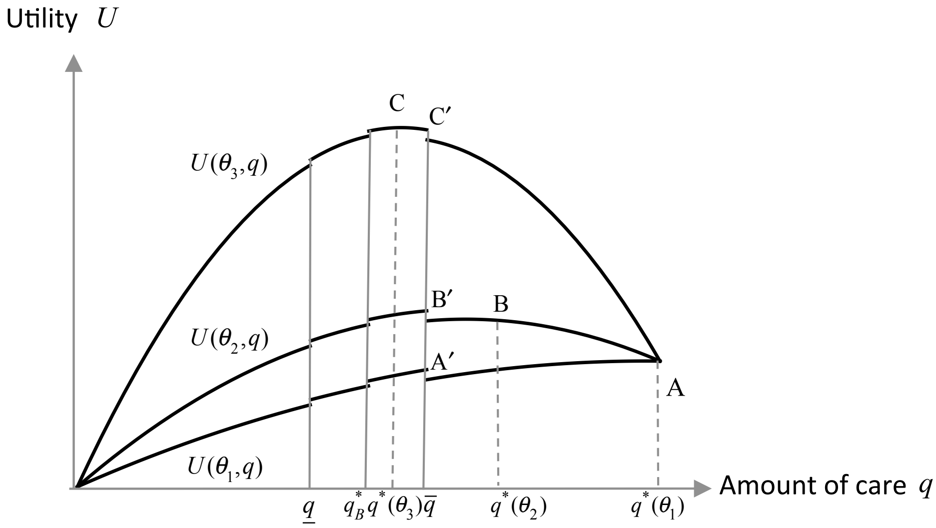


Figure 1: Physician's utility function for different degrees of altruism

by choosing quantity $\tilde{q}$ (point $B'$) rather than quantity $q^*(\theta_2)$ (point $B$). Physician $\theta_2$ belongs to the category of physicians with intermediate altruism. Notice that even if a physician has a higher (but still intermediate) degree of altruism compared to provider $\theta_2$, she provides the same quantity $\tilde{q}$. Figure 2 illustrates the three different altruism groups and their optimal treatment levels for over- and underprovision. All groups overprovide (underprovide) while the magnitude of overprovision (underprovision) is most severe for the low altruism group.[7]

As in Siciliani (2009) we consider the total amount of care across physicians

$$Q(p,w) = \int_{\underline{\theta}}^{\hat{\theta}(p,w)} q^*(\theta,p)\, f(\theta)\,\mathrm{d}\theta + \int_{\hat{\theta}(p,w)}^{\tilde{\theta}(p,w)} \tilde{q} f(\theta)\,\mathrm{d}\theta + \int_{\tilde{\theta}(p,w)}^{\overline{\theta}} q^*(\theta,p)\, f(\theta)\,\mathrm{d}\theta \tag{10}$$

and derive comparative statics with respect to reputational motivation and the FFS.[8] First, assuming an uniform distribution for the degrees of altruism we obtain[9]

$$\frac{\mathrm{d}Q}{\mathrm{d}w} = -\frac{(\alpha+\delta p)\,(q^*(\hat{\theta})-\tilde{q})}{B(\tilde{q}) - B(q^*(\hat{\theta}))} < 0. \tag{11}$$

[7]We note at this point that a higher degree of altruism does not induce patients to shift from phyisicians with a lower degree of altruism to phyiscians with a higher degree.

[8]We note that the total amount of care across physicians as given by (10) assumes that the altruism factor of each physicians is fixed and constant over time. Hence, we do not model entry or exit of phyiscians with different altruism factors. However, the following comparative static results clearly show that even for a constant altruism factor different groups of pyhsicians will change their individual supply.

[9]See Appendix i) for details.

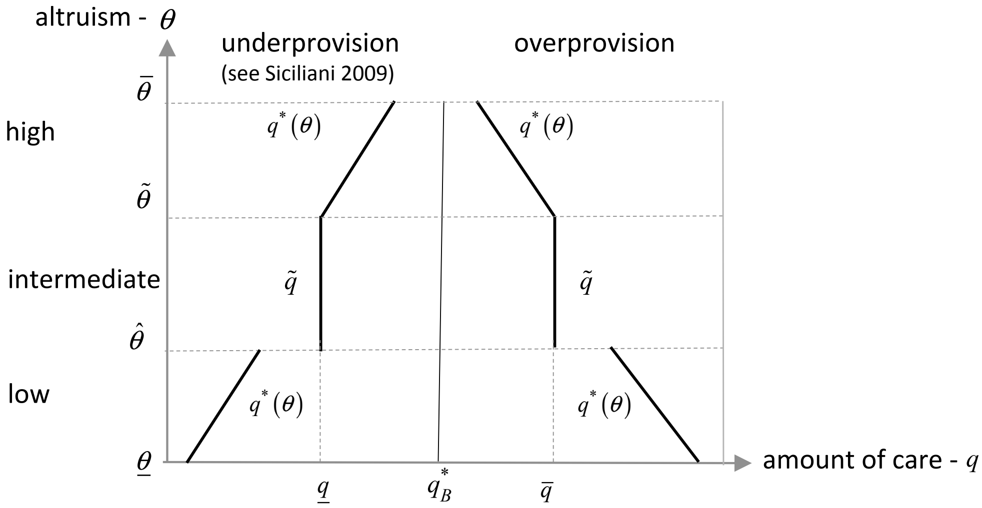


Figure 2: Amount of care for different types.

Intuitively, better reputational motivation increases the incentive for low-altruism physicians to provide $\tilde{q}$ which in turn decreases $\hat{\theta}$. As illustrated in Figure 3 this reduces the magnitude of overprovision (area $C$).[10] This implies the important result that the costs of healtcare provision ($p\,Q$) decrease with better reputational motivation.[11]

Second, a higher FFS has an ambiguous effect on $Q$

$$\frac{\mathrm{d}Q}{\mathrm{d}p} = \int_{\underline{\theta}}^{\hat{\theta}} \frac{\partial q^*(\theta, p)}{\partial p} \mathrm{d}\theta + \int_{\tilde{\theta}}^{\overline{\theta}} \frac{\partial q^*(\theta, p)}{\partial p} \mathrm{d}\theta + \frac{q^*(\hat{\theta}) - \tilde{q}}{B(\tilde{q}) - B(q^*(\hat{\theta}))} \left[ q^*(\hat{\theta}) - \tilde{q} - \delta w \right]. \qquad (12)$$

In case the extra gain of reputation is sufficiently large, i.e., if $\delta w > q^*(\hat{\theta}) - \tilde{q}$, an increase in $p$ can lead to a lower $Q$. Intuitively, a higher $p$ has two effects. First, an increase in $p$ induces physicians with low and high altruism to increase output. Second, it changes $\hat{\theta}$ and $\tilde{\theta}$.[12] Both intermediate and high altruism physicians receive the extra reputation gain, while the latter group increases $q^*$. Hence, the cutoff $\tilde{\theta}$ increases and less physicians are considered as high altruism type. The change in physicians between the low- and intermediate-altruism group is ambiguous. On the one hand, a higher $p$ makes it less attractive for intermediate-altruism physicians to provide quantity $\tilde{q}$ due to the foregone revenue. On the other hand, an increase in $p$ also increases the reputation gain. If the

[10]Moreover, we show in Appendix ii) that in case of underprovision (see Siciliani (2009)), better motivational reputation increases the quantity of medical treatment and reduces the magnitude of underprovision.

[11]It is clear that better reputational motivation may involve extra administrative costs which may dampen the reduction.

[12]Note that a change in $\tilde{\theta}$ or $\hat{\theta}$ does not imply that a physician's exogenously given degree of altruism changes. However, an increase in $p$ changes the endogenous classifications, e.g., a lower $\hat{\theta}$ implies that some former low altruism physicians are considered to be of intermediate altruism type.

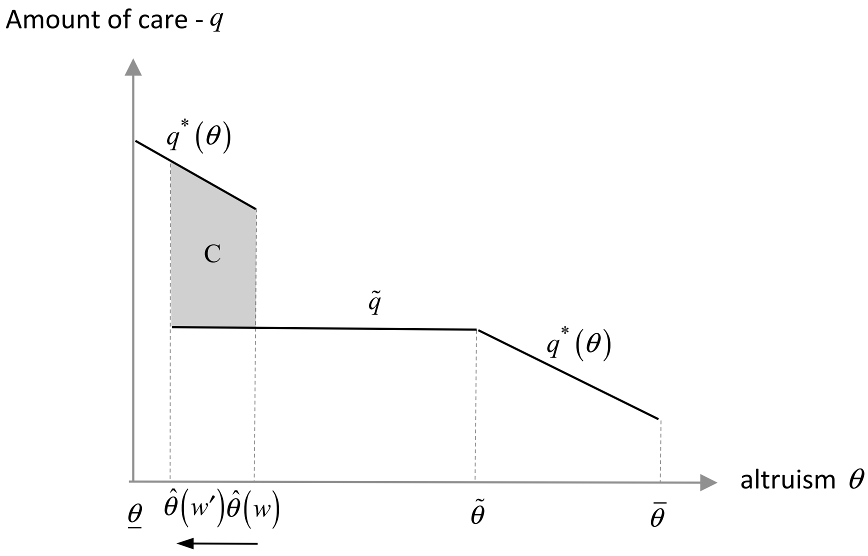


Figure 3: Effect of an increase in motivational reputation on the amount of care.

latter effect dominates, an increase in $p$ reduces $Q$. Graphically, the reduction in quantity (area $C$ in Figure 4) offsets the increase in quantity (area $A + B$). Nevertheless, it is an important result that a lower $p$ may actually increase the costs of healthcare provision.

## 3 Policy regimes

The standard policy regime is to set a FFS. As a complementary instrument, policy makers may also induce better reputational motivation to decrease costs.[13] In the following we explore the relationship between both instruments. To do so, we derive $p^*$ that maximizes the "efficiency" of the incentive scheme and show that $p^*$ decreases with better reputational motivation. The efficiency of incentive scheme is assumed to be given by

$$W = \sigma\, U^* + (1 - \sigma)\, B^* \tag{13}$$

with $\sigma \in (0, 1)$ and where a higher (lower) $\sigma$ puts a stronger weight on physicians' utility $U^* \equiv \int_{\underline{\theta}}^{\overline{\theta}} U(\theta)\, \mathrm{d}\theta$ (patients' benefit $B^* \equiv \int_{\underline{\theta}}^{\overline{\theta}} B(\theta)\, \mathrm{d}\theta$).[14]

[13]Typical policy instruments to induce better reputational motivation are websites that report the quality of care to the public, see e.g. within the Quality and Outcomes Framework in the UK http://www.qof.ic.nhs.uk/search/ (retrieved 07/29/2013), as well as public awards, see e.g.the Texas Physician Practice Quality Improvement Award http://award.tmf.org/ (retrieved 07/29/2013).

[14]As Siciliani (2009) we do not consider a budget constraint since we focus on the trade-off between physicians' utilities and patients' benefits. Nevertheless, a budget constraint would imply that $p^*$ is bounded from above.

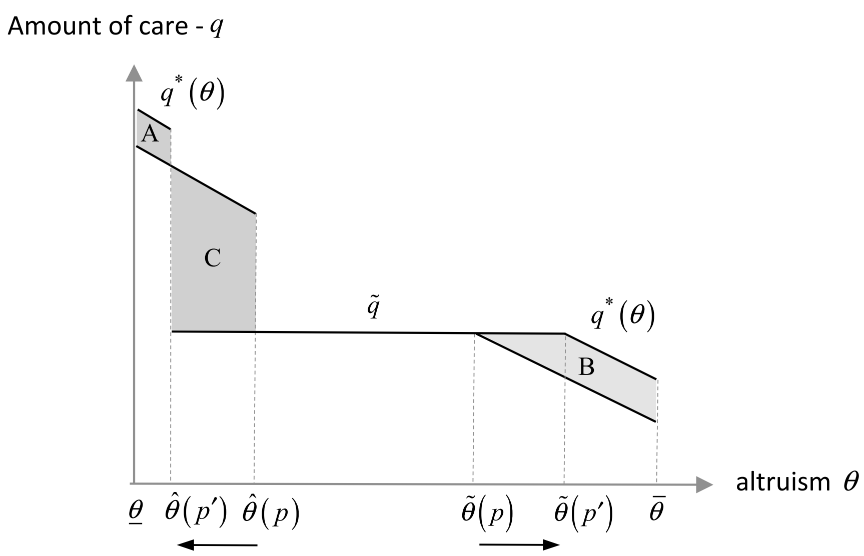


Figure 4: Effect of an increase in the FFS on the amount of care.

Physicians aim for a higher FFS (see Appendix iii) for details) since

$$\frac{\mathrm{d}U^*}{\mathrm{d}p} = Q + \int_{\hat{\theta}}^{\overline{\theta}} \delta w \mathrm{d}\theta > 0. \tag{14}$$

First, a higher $p$ increases the marginal revenue of care ($Q$). Second, the reputation effect $\partial(\alpha + \delta p)w/\partial p = \delta w$ is positive since being regarded as a "good" physician yields a greater extra utility gain. Conversely, patients prefer a lower FFS since it reduces the magnitude of overprovision. Formally,

$$\frac{\mathrm{d}B^*}{\mathrm{d}p} = \int_{\underline{\theta}}^{\hat{\theta}} \frac{\partial B}{\partial q^*}\frac{\partial q^*}{\partial p}\mathrm{d}\theta + \int_{\tilde{\theta}}^{\overline{\theta}} \frac{\partial B}{\partial q^*}\frac{\partial q^*}{\partial p}\mathrm{d}\theta - \left[q^*(\hat{\theta}) - \tilde{q} - \delta w\right] < 0 \tag{15}$$

where the two integrals are negative since a higher FFS increases the quantity of low- and high-altruism providers.[15]

Using (14) and (15) the efficiency maximizing $p^*$ (see Appendix iv) for details) satisfies

$$\frac{\mathrm{d}W}{\mathrm{d}p} = \sigma\,\frac{\partial U^*}{\partial p} + (1-\sigma)\,\frac{\partial B^*}{\partial p} = 0. \tag{16}$$

Using (16) allows us to derive comparative statics for $p^*$ with respect to $w$. We show

[15]We assume that the group of low- and high-altruism physicians is sufficiently large such that the first two terms dominate the third term which can become negative if $\delta w$ is sufficiently large. Otherwise an increase in $p$ has a negligible effect on the total amount of care. In the extreme case of $p \to \infty$ there are no low- and high-altruism providers which we rule out since the comparative statics are then meaningless.

(see Appendix iv) for details) that $\partial p^*/\partial w = -\left(\partial W_p/\partial w\right)\left(\partial W_p/\partial p\right)^{-1} < 0$. In words, an increase in reputational motivation decreases the efficiency maximizing FFS.[16]

## 4 Conclusion

We have provided a model where physicians differ in their degree of altruism and that explicitly allows for overprovision of medical treatment. Our main result is that in case of overprovision better reputational motivation decreases overall output and the efficiency maximizing FFS. Abstracting from any demand effects, promoting reputational motivation may therefore both decrease the costs in the healthcare system and simultaneously increase patient benefits.

[16]In Appendix v) we show that in case of underprovision both physicians and patients aim for a higher FFS. This implies that policy makers are likely to find themselves in an overprovision scenario.

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# Appendix

**i)** *Total amount of care* is given by $Q$ as stated in (10). To see that the change with respect to $p$ is given by (12) consider

$$\begin{aligned} \frac{\mathrm{d}Q}{\mathrm{d}p} &= \int_{\underline{\theta}}^{\hat{\theta}} \frac{\partial q^*}{\partial p}\mathrm{d}\theta + q^*(\hat{\theta})\frac{\partial\hat{\theta}}{\partial p} + \int_{\hat{\theta}}^{\tilde{\theta}} \frac{\partial\tilde{q}}{\partial p}\mathrm{d}\theta + \tilde{q}\frac{\partial\tilde{\theta}}{\partial p} - \tilde{q}\frac{\partial\hat{\theta}}{\partial p} + \int_{\tilde{\theta}}^{\overline{\theta}} \frac{\partial q^*}{\partial p}\mathrm{d}\theta - q^*(\tilde{\theta})\frac{\partial\tilde{\theta}}{\partial p} \\ &= \int_{\underline{\theta}}^{\hat{\theta}} \frac{\partial q^*}{\partial p}\mathrm{d}\theta + + \int_{\tilde{\theta}}^{\overline{\theta}} \frac{\partial q^*}{\partial p}\mathrm{d}\theta + \frac{\partial\hat{\theta}}{\partial p}\left[q^*(\hat{\theta}) - \tilde{q}\right] \end{aligned} \tag{17}$$

and note that the indifference condition given by (8) implies

$$\frac{\partial\hat{\theta}}{\partial p} = \frac{q^*(\hat{\theta}) - \tilde{q} - \delta w}{B(\tilde{q}) - B(q^*(\hat{\theta}))} < 0 \tag{18}$$

if $\delta w$ is sufficiently large, see Siciliani (2009) for this assumption. Using (18) in (17) yields (12).

**ii)** *Comparison to Siciliani (2009)*: We claim that in case of underprovision better reputational motivation increases the overall quantity of medical treatment and reduces the magnitude of underprovision. To consider underprovision, we assume for the moment that the FFS $p$ is sufficiently low such that $q < q_B^*$ for all degrees of altruism $\theta$. Now consider a higher $w$. The change in $Q$ is given by

$$\frac{\mathrm{d}Q}{\mathrm{d}w} = \frac{\partial\hat{\theta}}{\partial w}\left[\tilde{q} - q^*(\hat{\theta})\right] = \frac{(\alpha - \delta p)}{B(\tilde{q}) - B(q^*(\hat{\theta}))}\left(\tilde{q} - q^*(\hat{\theta})\right) > 0. \tag{19}$$

It is unambiguously positive since in case of underprovision we have i.) $B(\tilde{q}) > B(q^*(\hat{\theta}))$, ii.) $\tilde{q} > q^*(\hat{\theta})$ and iii.) $\alpha > \delta p$, see Siciliani (2009) for a detailed discussion of those properties. Intuitively, a better general reputational motivation unambiguously increases the incentive to provide more medical treatment. In contrast to the case of overprovision no physician has an incentive to decrease the amount of medical treatment.

**iii)** *Efficiency maximizing FFS* $p^*$: First, aggregated physicians utility is given by

$$U^* \equiv \int_{\underline{\theta}}^{\overline{\theta}} U(\theta)\, \mathrm{d}\theta. \tag{20}$$

Physicians unambiguously aim for a higher price since

$$\begin{aligned}
\frac{\mathrm{d}U^*}{\mathrm{d}p} &= \int_{\underline{\theta}}^{\hat{\theta}} q^* \mathrm{d}\theta + V(q^*(\hat{\theta}))\frac{\partial\hat{\theta}}{\partial p} + \int_{\hat{\theta}}^{\tilde{\theta}} \tilde{q}\mathrm{d}\theta - V(\tilde{q})\frac{\partial\hat{\theta}}{\partial p} + V(\tilde{q})\frac{\partial\tilde{\theta}}{\partial p} \\
&\quad + \int_{\tilde{\theta}}^{\overline{\theta}} \frac{\partial q^*}{\partial p}\mathrm{d}\theta - V(q^*(\tilde{\theta}))\frac{\partial\tilde{\theta}}{\partial p} + \int_{\hat{\theta}}^{\overline{\theta}} \delta w \mathrm{d}\theta - (\alpha+\delta p)\, w \frac{\partial\hat{\theta}}{\partial p} \\
&= Q + \int_{\hat{\theta}}^{\overline{\theta}} \delta w \mathrm{d}\theta + \frac{\partial\hat{\theta}}{\partial p}\left[V(q^*(\hat{\theta})) - V(\tilde{q}) - (\alpha+\delta p)\, w\right] \\
&= Q + \int_{\hat{\theta}}^{\overline{\theta}} \delta w \mathrm{d}\theta > 0.
\end{aligned} \tag{21}$$

Note that the last term in the brackets is zero due to the indifference condition given by (8). Second, aggregated patient benefit is given by

$$B^* \equiv \int_{\underline{\theta}}^{\overline{\theta}} B(\theta)\, \mathrm{d}\theta \tag{22}$$

and patients aim for a lower FFS since

$$\begin{aligned}
\frac{\mathrm{d}B^*}{\mathrm{d}p} &= \int_{\underline{\theta}}^{\hat{\theta}} \frac{\partial B}{\partial q^*}\frac{\partial q^*}{\partial p}\mathrm{d}\theta + B(q^*(\hat{\theta}))\frac{\partial\hat{\theta}}{\partial p} - B(\tilde{q})\frac{\partial\hat{\theta}}{\partial p} + B(\tilde{q})\frac{\partial\tilde{\theta}}{\partial p} + \int_{\tilde{\theta}}^{\overline{\theta}} \frac{\partial B}{\partial q^*}\frac{\partial q^*}{\partial p}\mathrm{d}\theta - B(q^*(\tilde{\theta}))\frac{\partial\tilde{\theta}}{\partial p} \\
&= \int_{\underline{\theta}}^{\hat{\theta}} \frac{\partial B}{\partial q^*}\frac{\partial q^*}{\partial p}\mathrm{d}\theta + + \int_{\tilde{\theta}}^{\overline{\theta}} \frac{\partial B}{\partial q^*}\frac{\partial q^*}{\partial p}\mathrm{d}\theta + \frac{\partial\hat{\theta}}{\partial p}\left[B(q^*(\hat{\theta})) - B(\tilde{q})\right] < 0 \\
&= \int_{\underline{\theta}}^{\hat{\theta}} \frac{\partial B}{\partial q^*}\frac{\partial q^*}{\partial p}\mathrm{d}\theta + \int_{\tilde{\theta}}^{\overline{\theta}} \frac{\partial B}{\partial q^*}\frac{\partial q^*}{\partial p}\mathrm{d}\theta - q^*(\hat{\theta}) + \tilde{q} + \delta w < 0
\end{aligned} \tag{23}$$

if the group of high- and low-altruism physicians is large enough. As explained in footnote 13 this is our general assumption to secure that the comparative static results are meaningful. Third, consider the second-order-conditions. In order to secure that $p^*$ which solves (16) actually is a maximum, we have to show that $W_{pp} = \sigma B_{pp} + (1-\sigma)U_{pp} < 0$ for $p = p^*$. Hence, consider

$$\begin{aligned}
\frac{\mathrm{d}U_p^*}{\mathrm{d}p} &= \int_{\underline{\theta}}^{\hat{\theta}} \frac{\partial q^*}{\partial p}\mathrm{d}\theta + \int_{\tilde{\theta}}^{\overline{\theta}} \frac{\partial q^*}{\partial p}\mathrm{d}\theta + \frac{q^*(\hat{\theta}) - \tilde{q}}{B(\tilde{q}) - B(q^*(\hat{\theta}))}\left[q^*(\hat{\theta}) - \tilde{q} - \delta w\right] - \delta w \left[\frac{q^*(\hat{\theta}) - \tilde{q} - \delta w}{B(\tilde{q}) - B(q^*(\hat{\theta}))}\right] \\
&= \int_{\underline{\theta}}^{\hat{\theta}} \frac{\partial q^*}{\partial p}\mathrm{d}\theta + \int_{\tilde{\theta}}^{\overline{\theta}} \frac{\partial q^*}{\partial p}\mathrm{d}\theta + \frac{(q^*(\hat{\theta}) - \tilde{q} - \delta w)^2}{B(\tilde{q}) - B(q^*(\hat{\theta}))} > 0
\end{aligned} \tag{24}$$

which is unambiguously positive. Hence, if $\sigma$ is low such that $U_{pp}$ yields $W_{pp} > 0$, the solution of $W_P = 0$ actually is a minimum. In this case physicians' will for a higher price dominates the decrease in the patients' benefit. Now consider the second-order-condition of patient benefit which is given by

$$\frac{\mathrm{d}B_p^*}{\mathrm{d}p} = \int_{\underline{\theta}}^{\hat{\theta}} \frac{\partial B_p}{\partial p}\mathrm{d}\theta + B_p(\hat{\theta})\frac{\partial\hat{\theta}}{\partial p} + \int_{\tilde{\theta}}^{\overline{\theta}} \frac{\partial B_p}{\partial p}\mathrm{d}\theta - B_p(\tilde{\theta})\frac{\partial\tilde{\theta}}{\partial p} - \frac{\partial q^*(\hat{\theta})}{\partial\hat{\theta}}\frac{\partial\hat{\theta}}{\partial p} < 0 \tag{25}$$

where $B_p < 0$, $B_{pp} < 0$, $\partial\tilde{\theta}/\partial p > 0$, $\partial q^*(\hat{\theta})/\partial\hat{\theta} < 0$, and $\partial\hat{\theta}/\partial p < 0$ is given by (18). Again we assume that the group of high- and low-altruism physicians is large enough such that $B_{pp}^*$ is unambiguously negative. This is important to secure that for a sufficiently high $\sigma$ a $p^*$ that solves (16) actually constitutes a maximum since then we have $W_{pp} < 0$. Note that if either the group of high- and low-altruism physicians is small or $\sigma$ is low a higher FFS does not necessarily constitute a trade-off between patients and physicians. If $\sigma$ is low (physicians' utilities are most important) the efficiency maximizing $p^*$ would be infinitesimally high while if $\sigma$ is high (patients' benefits are most important) $p^*$ would be infinitesimally small.

**iv)** *Reputational motivation and* $p^*$: In the text we claim that better reputational motivation decreases the efficiency maximizing FFS $p^*$. To show this result consider

$$\frac{\partial B_p}{\partial w} = B_p\frac{\partial\hat{\theta}}{\partial w} - \frac{q^*(\hat{\theta})}{\partial\hat{\theta}}\frac{\partial\hat{\theta}}{\partial w} + \delta < 0 \tag{26}$$

which is negative if the change in $\partial q^*/\partial\hat{\theta} < 0$ is sufficiently strong. Furthermore, consider

$$\frac{\partial U_p^*}{\partial w} = \frac{\mathrm{d}Q}{\mathrm{d}w} + \int_{\hat{\theta}}^{\overline{\theta}} \delta\mathrm{d}\theta - \delta w\frac{\partial\hat{\theta}}{\partial w} < 0 \tag{27}$$

where $\mathrm{d}Q/\mathrm{d}w$ is given by (11) and again it is assumed that the group of high- and low-altruism physicians is large enough. This secures that $\partial U_p^*/\partial w <$ is unambiguously negative. Taken together we have $\partial W_p/\partial w < 0$ and $W_{pp} < 0$ such that $\partial p^*/\partial w = -(\partial W_p/\partial w)/W_{pp} < 0$. An analogous approach yields the comparative static results for $\alpha$ and $\delta$.

**v)** *Comparison to Siciliani (2009)*: Similar to the case of overprovision, in case of underprovision physicians also aim for a higher price since

$$\begin{aligned}
\frac{\mathrm{d}U^*}{\mathrm{d}p} &= \int_{\underline{\theta}}^{\hat{\theta}} q^*\mathrm{d}\theta + V(q^*(\hat{\theta}))\frac{\partial\hat{\theta}}{\partial p} + \int_{\hat{\theta}}^{\tilde{\theta}} \tilde{q}\mathrm{d}\theta - V(\tilde{q})\frac{\partial\hat{\theta}}{\partial p} + V(\tilde{q})\frac{\partial\tilde{\theta}}{\partial p} \\
&\quad + \int_{\tilde{\theta}}^{\overline{\theta}} \frac{\partial q^*}{\partial p}\mathrm{d}\theta - V(q^*(\tilde{\theta}))\frac{\partial\tilde{\theta}}{\partial p} - \int_{\hat{\theta}}^{\overline{\theta}} \delta w\mathrm{d}\theta - (\alpha - \delta p)\, w\frac{\partial\hat{\theta}}{\partial p} \\
&= Q - \int_{\hat{\theta}}^{\overline{\theta}} \delta w\mathrm{d}\theta + \frac{\partial\hat{\theta}}{\partial p}\left[V(q^*(\hat{\theta})) - V(\tilde{q}) - (\alpha - \delta p)\, w\right] \\
&= Q - \int_{\hat{\theta}}^{\overline{\theta}} \delta w\mathrm{d}\theta > 0
\end{aligned} \tag{28}$$

if the greediness "penalty" $\delta w$ is not too strong. Next, consider the patients' benefits given by

$$\begin{aligned}\frac{\mathrm{d}B^*}{\mathrm{d}p} &= \int_{\underline{\theta}}^{\hat{\theta}} \frac{\partial B}{\partial q^*}\frac{\partial q^*}{\partial p}\mathrm{d}\theta + \int_{\tilde{\theta}}^{\overline{\theta}} \frac{\partial B}{\partial q^*}\frac{\partial q^*}{\partial p}\mathrm{d}\theta + \frac{\partial \hat{\theta}}{\partial p}\left[B(q^*(\hat{\theta})) - B(\tilde{q})\right] \\ &= \int_{\underline{\theta}}^{\hat{\theta}} \frac{\partial B}{\partial q^*}\frac{\partial q^*}{\partial p}\mathrm{d}\theta + \int_{\tilde{\theta}}^{\overline{\theta}} \frac{\partial B}{\partial q^*}\frac{\partial q^*}{\partial p}\mathrm{d}\theta + \delta w + \tilde{q} - q^*(\hat{\theta}) > 0 \qquad (29)\end{aligned}$$

which is unambiguously positive since in the case of underprovision a higher FFS mitigates the underinvestment problem, i.e., $B_p > 0$ and not $B_p < 0$ as in the case of overprovision. Hence, both physicians and patients aim for a higher FFS in case of underprovision which can unambiguously be seen by (28) and (29), respectively. This in turn implies that in the case of underprovision an efficiency maximizing FFS $p^*$ which solves $W_p = 0$ as given by (16) cannot exist.