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Nowadays different healthcare policies in OECD countries seem to consider hospital readmissions somehow "quality dependent". Nonetheless, the theoretical literature on the incentives provided by payment systems tend to disregard this aspect, which indeed might be relevant in driving providers' behaviour. In this paper we study the incentives for hospitals to provide quality and cost-reducing effort under different payment regimes, either a global budgeting or a prospective payment system, considering explicitly the role played by financial incentives directly linked to readmissions. As far as the specific results about quality are concerned, we find that prospective payment systems do not necessarily perform better than retrospective systems if the reimbursement to hospitals is not adjusted to take into account specific outcome-based indicators of quality, such as readmissions. More specifically, if patients readmitted are fully paid to hospitals, moving from a retrospective to a prospective payment systems might even induce a reduction on quality and, in turn, an increase in readmission probability. However, if the prospective payment system is adjusted for internalizing this counter-incentive, by a different payment for patients readmitted, it could be able to foster a higher treatment quality through the competition channel.

JEL Classification: I11, I12, I18.

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1. Introduction

The key tenet of many reforms of the healthcare sector has been to introduce incentives for improving efficiency without losing quality of care. For this purpose, in the last decades many OECD countries reformed the providers payment system, introducing fairly anywhere some form of prospective payment system and reducing the scope for global budgeting (Busse et al., 2011), with the aim of increasing the competition in the market and, consequently, quality and efficiency. In this setting, prices are usually regulated and, thus, providers compete on quality to attract more patients. In particular, the incentive to compete for patients should be presumably due to the positive margin (DRG tariff exceeding marginal costs) efficient hospitals can enjoy. However, while the propulsive effect on efficiency would seem to be confirmed by the data, the empirical findings on hospital quality are ambiguous and far from being well-established.

Although there is some evidence suggesting that competition with fixed prices does not erode quality and outcome[1], the empirical literature concerning the introduction of prospective payment system and the effects on quality of care offers a less clear cut picture and for most countries it remains limited (Moreno-Serra and Wagstaff, 2010). The majority of empirical studies trying to assess these effects are relative to the US and, in particular, they look at the impact of the change in Medicare hospital payment system, from a cost plus to a prospective per case payment. Early studies compared Medicare patients before and after the implementation of per case payment system. In Davis and Rhodes (1988) they reported that per case payment reduced hospitalization and length of stay, although mortality and readmission rates did not increase. Similarly, Kahn et al. (1990) documented that length of stay decreased by 24%, although 180-day risk-adjusted mortality and readmission rates remained unchanged. Conversely, in a large influence study Cutler (1995) examined mortality

[1] There is less theoretical and empirical consensus about the effect of competition on quality when prices are market determined. For example, Volpp et al. (2003) and Propper et al. (2004) find that competition decreases quality; conversely, Sari (2002) finds the opposite effect. For a survey see also Gaynor and Town (2011).

and readmission rates of Medicare patients and found that while 1-year mortality rate remained unchanged, readmission rate increased. More recently, Glickman et al. (2007) studied heart attack care processes in 54 hospitals from 2003 to 2006, without finding significant incremental improvement in quality of care or outcomes for acute myocardial infarction attributable to specific changes of hospital financing system. Similarly, Jha et al. (2010) concentrated their attention on 251 hospitals that collected data on 33 quality measures for 3 conditions (heart attack, pneumonia and heart failure), finding very low improvements in mortality rates attributable to a specific change in the payment system.

In the last decade similar analyses have been conducted also in other countries. Quality as reported by patients' experience has been considered by Hagen et al. (2006), who analyzed the effects of a reimbursement reform in Norway, aimed at replacing a capitation-based block grant system with an activity-based system. In particular, they found that patient satisfaction increased after the reform probably for the lower waiting times induced by the introduction of activity-based financing. Farrar et al. (2009) studied the effects of the change from global budgets to case payments in English NHS, with the aim to examine whether the introduction of payment by results was associated with changes in key outcome variables measuring quality of care, volume and costs. Concerning quality of care, mortality measures after hip fractures did not change significantly after the introduction of the new system. Conversely, Berta et al. (2010) carried out a study for the Lombardy Region, finding that financial incentives do affect the pattern of discharges.

Hospital readmissions and their preventability have been the subject of a large debate since the introduction of per case payment. Even if some readmissions cannot be avoided, low readmission rates are among the outcome-based indicators often used as a proxy measure for a good inpatient care quality (e.g. Ashton et al., 1997, Cavalieri et al., 2013). In particular, the idea behind outcome-based indicators is that, if appropriate risk-adjustment is made for patient case-mix and other external factors, differences in readmission rates (or in hospital mortality) are likely to be driven by differences in the unobservable hospital quality. Moreover, a considerable amount of empirical studies used readmission rates also to evaluate other important issues in health research as the impact of new technologies (Xian et al., 2011) and the impact of specific new policy changes (Evans et al., 2008). Therefore, moving from this argument that hospital readmissions might be somehow "quality dependent", in recent years there has been a large interest in introducing incentives for hospitals to avoid post-discharge complications potentially preventable.

In the US a large effort has been put on introducing arrangements of "bundled payments" across multiple providers, so as to avoid the lack of incentives to coordinate healthcare provision, considered as one the major causes of high readmission rates for Medicare beneficiaries (MEDPAC, 2008; McCellan, 2011). Moreover, the Hospital Readmission Reduction Program (HRRP), designed with the objective of reducing readmissions by aligning payment with outcome, introduced a system of penalty in Medicare base reimbursement system for hospitals underperforming in a selected number of 30-day risk-adjusted readmission rates (Foster and Harkness, 2010, Adashi and Kocher, 2011). Likewise, in other institutional settings we can find incentives to prevent high readmission rates in prospective per case payment. For instance, in Germany hospitals have a clear incentive to avoid readmissions because they will not receive additional reimbursement for cases readmitted within 30 days of the initial admission (Geissler et al., 2011). A similar rule has been recently introduced in English NHS (Department of Health, 2011), where hospital payments stop for all emergency admissions occurring within 30 days of a previous discharge.

Despite this explicit consideration in the healthcare policy design, the theoretical literature on the effects of hospital payment systems tend to disregard this aspect (e.g. Ma, 1994, Karlsson, 2007, Brekke et al., 2012, 2013), which indeed might be relevant in driving providers' behaviour. Moreover, for policy design purpose it would be extremely interesting to consider the potential role of financial incentives associated with specific outcome-based indicators, especially since treatment quality is often unobservable for the regulator. In this paper we study the incentives for hospitals to provide quality and cost-reducing effort under different payment regimes, either a global budgeting or a prospective payment system, considering explicitly the role played by financial incentives directly linked to readmissions. While this feature of the payment system would not seem particularly important for inducing cost-reducing effort[2], this turns out to be particularly crucial in driving the provision of quality in the treatment. We consider the analysis of the effects of different reimbursement systems within a context characterized by the existence of non-financial incentives for providers, considered in the literature especially relevant in the healthcare market (e.g. Viggiano et al., 2007, Makris and Siciliani, 2013).

As far as the specific results about the incentives to provide quality are concerned, we find that prospective payment systems (PPS) do not necessarily perform better than retrospective systems (RPS) if the reimbursement to hospitals is not adjusted to take into account specific measures of quality, such as readmissions. More specifically, if patients readmitted are fully paid to hospitals, moving from a global budgeting to a prospective payment system might even induce a reduction on quality and, in turn, an increase in readmission probability. However, if the prospective payment system is adjusted for internalizing this counter-incentive, by a different payment for patients readmitted, it could be able to foster a higher hospital quality through the competition channel.

Considering that actual payment systems rarely (or only recently) provide explicitly for a different payment for patients readmitted, this paper might explain the ambiguity found in previous studies concerning the impact of the introduction of PPS on quality. On the other

[2] Indeed, omitting cost-reducing effort would not have changed much our main results; nonetheless, we decided to maintain it in the analysis for two main reasons. First, it allows us to appreciate also the role of prospective payment system in promoting higher efficiency respect to retrospective system. Second, it makes the paper more comparable to the recent literature on hospital financing systems (e.g. Brekke et al., 2012, 2013).

hand, it underlines that if PPS is well-designed (by a different readmission policy), the introduction of the new system could be able to promote a higher quality. To this extent, our study contributes to the literature on hospital payment systems by introducing this specific feature in the evaluation of the financing system and, in particular, by shedding more light on the design of optimal readmission payment to induce higher hospital quality.

The remainder of this study is organized as follows. The setup of the model is laid out in section 2. Section 3 develops the equilibrium results and their comparison across the different financing systems. Section 4 contains a social welfare analysis and, finally, section 5 provides with some concluding remarks.

2. Model

In this section we introduce the main structure of the model. In line with the previous literature on hospital competition (e.g. Beitia, 2003, Brekke et al., 2008, 2010), the analysis of providers' behaviour is conducted in the framework of the Hotelling spatial competition (Hotelling, 1929), where we study a market for medical treatment with two hospitals located at the either end of the unit line $S = [0, 1]$. We consider providers location as exogenously given, which indeed is somewhat reasonable for the case of healthcare providers. On the line segment S there is a uniform distribution of patients, with density normalised to 1, each demanding only one medical treatment. As fairly realistic for this market, patients do not pay for the treatment they get, rather they mind only for the quality of those. Assuming full market coverage, that is each patient does not have an attractive outside option, all patients simply choose which hospital to demand from. The utility of a patient located at $x \in S$ and receiving treatment from hospital i, located at z_i, is given by

$$U(x, z_i) = v + \eta q_i - \tau |x - z_i| \qquad (1)$$

where v is the gross valuation from medical treatment, $q_i \geq \underline{q}$ is the treatment quality at hospital i, η is the parameter measuring the marginal utility of quality and τ is the transportation cost parameter[3]. The lower bound $\underline{q}$ represents the lowest treatment quality hospitals are allowed to offer, implying that if $q_i < \underline{q}$ then i might lose his licence. Without loss of generality, we set $\underline{q} = 0$. Moreover, as standard in this literature (e.g. Brekke et al. 2012) we normalise the marginal utility of treatment quality to one, $\eta = 1$, implying that now τ can be interpreted as the marginal disutility of travelling relative to treatment quality.

The patient who is indifferent between provider i and provider j, located respectively at $z_i = 0$ and $z_j = 1$, can be implicitly characterised by his location x^*

$$v + q_i - \tau x^* = v + q_j - \tau(1 - x^*) \tag{2}$$

yielding, given the assumption of uniform patients distribution with density 1, the demand for hospital i

$$x_i^D = \frac{1}{2} + \frac{q_i - q_j}{2\tau} \tag{3}$$

On the other hand, the demand for hospital j is simply the complement to 1, that is

$$x_j^D = \left(1 - x_i^D\right) = \frac{1}{2} + \frac{q_j - q_i}{2\tau} \tag{4}$$

Therefore, if hospitals offer the same treatment quality they exactly halve the market. Differently, the hospital with a higher treatment quality gets a market share more than half. Finally, the extent to which the difference in treatment quality affects the hospital market share strictly depends on the marginal disutility of travelling relative to quality τ. In particular, a high τ implies that the disutility of travelling is relatively more important for patients than quality, making demand less responsive to change in quality.

Hospitals are financed by a third-party payer potentially either retrospectively or prospectively. Since we specify both cases later in the paper, here we introduce the general

[3] There is a wide empirical evidence showing that the main predictors of hospital choice by patients are distance to hospitals and quality of treatment. For instance, the empirical studies by Tay (2003), Shen (2003), Howard (2006) and Varkevisser et al. (2012) show quite consistently that both predictors are strongly significant, with a relative weight depending on the case under analysis.

form of the objective function. As mentioned in the introduction, despite the empirical relevance of readmissions, in the existing literature the explicit role of patients readmission is usually neglected. Differently, in this paper we attach much importance on the way in which readmissions affect the incentive provided by different hospitals payment systems. Therefore, we consider explicitly revenue and cost of readmissions in the hospital profit. Moreover, as discussed by different papers in the literature (e.g. Ellis, 1998, Harrison and Lybecker, 2005, Brekke et al., 2011), despite financial incentives actually receive the lion's share of the interest, it is recognized that non-financial incentives might be relevant in the health care market where the relationship between patient and provider is essentially based on trust. Thus, we consider these non-financial motivations as relevant in driving providers' behaviour.

The cost of medical treatments is given by the cost function $C(x^D, q)$, assumed increasing and convex both in output and quality, plus some fixed cost F

$$C(x^D, q) = \frac{c}{2}(x^D)^2 + \frac{k}{2}q^2 + F \tag{5}$$

While the marginal cost for quality kq is equal for both hospitals, the treatment marginal cost cx can be reduced by each hospital exerting a cost-reducing effort e, which to some extent should allow us to capture the incentive provided by different payment systems on cost-efficiency. In particular, a positive cost-reducing effort implies a reduction on cost given by $c = \sigma - e$. Nonetheless, whenever hospitals exert a positive cost-reducing effort, they incur a managerial disutility $\frac{w}{2}e^2$. Furthermore, we consider also a potential managerial disutility induced by a higher quality $\frac{\xi}{2}q^2$, aiming to capture the fact that the quality of medical treatment is not only a money matter but also a diligence matter.

Each patient treated by hospitals has a positive probability of being readmitted, governed by a certain *severity index h*. However, moving from the argument that hospital readmissions might be somehow "quality dependent", we consider also that the readmission probability can be consistently reduced by a high quality treatment. In particular, the probability of being readmitted is assumed to be given by

$$Pr(h, q) = \max\{h(1 - \theta q), 0\} \quad (6)$$

where θ is the parameter governing the impact of quality on the readmission probability[4]. Therefore, knowing that $\underline{q} = 0$ is the lowest hospital quality standard to be licensed, the severity index h represents the upper bound readmission probability for each patient[5]. Whenever a patient is readmitted hospitals incur a readmission cost R, thought to be somewhat smaller than the marginal cost at the initial admission. In particular, this assumption on R should capture the idea that patients readmitted usually do not need to repeat all medical procedures performed at the first admission. On the other hand, contingent on the payment system, hospitals receive a payment, which in a prospective system is strictly related to the parameter $\lambda \in [0, 1]$. In particular, when $\lambda = 1$ hospitals receive a full per-treatment price as for the first admission, whereas when $\lambda = 0$ hospitals receive nothing and, thus, they suffer all the readmission cost. Therefore, the parameter λ can be interpreted as the degree of *risk sharing* in the system (between providers and third-party payer) relative to readmission.

It is evident that, whenever the risk of readmission is discharged entirely to provider ($\lambda = 0$), there is an incentive for hospitals to avoid somehow to readmit patients. Nonetheless, in the first part of the paper we assume that hospitals are not able to make rationing. Even if this might be somewhat unreasonable, this allows us to highlight the main role played by the readmission policy in driving providers' behaviour and, in turn, the equilibrium quality under PPS. Then, in the final part of the paper we discuss explicitly the occurrence of hospitals rationing.

[4] Evidently, there is a propulsive role for quality in reducing readmission probability as long as $\theta > 0$, which we consider reasonable in the majority of medical branches. On the other hand, our specification (6) explicitly rules out non-negative probabilities.
[5] To some extent, there may potentially be other plausible specifications different from (6) describing the readmission probability. We decided to adopt (6) because on the one hand it allows algebraically to derive the model implications, on the other hand it has a clear interpretation of both the severity index and the readmission "quality dependence". Nonetheless, we tried to derive the equilibrium of the model with other specifications and, indeed, as long as the specification allows us to handle it, we found exactly the same implications.

Finally, we include explicitly the non-financial motivation of provider management $\alpha B(q, x^D)$, with the parameter $\alpha \geq 0$ governing its relative weight in the provider objective function. The main idea behind this non-financial part is that offering a high quality medical treatment gives hospital staff a high social and professional status which, in turn, gives them a higher non-monetary utility. Therefore, the assumptions we consider reasonable to make are that $B_q > 0$, $B_{x^D} > 0$ and $B_{q,x^D} > 0$. In particular, for the sake of simplicity we assume that the provider non-financial motivation is given by[6]

$$\alpha B(q, x^D) = \alpha q x^D \tag{7}$$

Therefore, the objective function of hospital i is assumed to be given by

$$\Omega_i = T + p x_i^D - C(x_i^D, q_i) + (\lambda p - R) Pr(h, q_i) x_i^D + \alpha B(q_i, x_i^D) - \frac{w}{2} e_i^2 - \frac{\xi}{2} q_i^2 \tag{8}$$

where T is a potential lump-sum transfer and p is a prospectively regulated price per-treatment, differentiated according to the payment system under consideration.

In what follows we will consider the simultaneous game where each hospital chooses independently his treatment quality q and his cost-reducing effort e, in order to maximise his objective function. In particular, we will firstly derive the hospital reaction-curves to study the kind of strategic interaction is induced by different payment systems and, then, we will look for the symmetric Nash equilibrium. Finally, we will move towards a welfare analysis to derive the main implication of the model in terms of different payment systems and, in particular, in terms of hospital readmission policy.

3. Nash equilibrium

In the general formulation, the hospital i's maximization problem is given by

[6] The standard way in the literature to introduce the non-financial motivation is to imagine that providers management receive a positive utility from the consumer surplus. However, in that specification even providing a very low quality medical treatment (remember that $\underline{q} = 0$) gives a positive non-financial utility, which is something we consider unreasonable. Differently, in (7) hospitals management receive a positive non-financial utility only providing at least a quality higher than the license standard, emphasizing the interpretation of the non-financial utility as a higher social and professional status given by a high quality health services. Nonetheless, it can be easily found that the two different interpretations produce indeed the same model implications.

$$\underset{q_i,e_i}{\text{Maximise}}\,\Omega_i = T + px_i^D - \frac{\sigma - e_i}{2}\left(x_i^D\right)^2 - \frac{k}{2}q_i^2 - F + (\lambda p - R)h(1 - \theta q_i)x_i^D$$
$$+ \alpha q_i x_i^D - \frac{w}{2}e_i^2 - \frac{\xi}{2}q_i^2$$

with T and p depending on the hospital payment system under consideration[7]. The solution to this maximization problem is given by the two FOC

$$\frac{\partial \Omega_i}{\partial q_i} = 0 \tag{9}$$

$$\frac{\partial \Omega_i}{\partial e_i} = 0 \tag{10}$$

In the following, we will consider two standard hospital payment systems: retrospective payment system and prospective payment system[8]. Later on, we will show that the specification of the *risk sharing* readmission policy (λ) has crucial implications with respect to the comparison of the two payment systems.

3.1 Retrospective payment system

In a basic retrospective payment system hospitals do not receive a predetermined price for any patient they treat, rather they are fully reimbursed according to how much cost they already faced. Therefore, the hospital revenue is given only by a retrospective lump-sum transfer, that is

$$p^{RP} = 0 \tag{11}$$

$$T^{RP} = \frac{c_i}{2}\left(x_i^D\right)^2 + \frac{k}{2}q_i^2 + F + Rh(1 - \theta q_i)x_i^D \tag{12}$$

Inserting (11) and (12) in the hospital objective function (8) yields

$$\Omega_i^{RP} = \alpha\, q_i\, x_i^D - \frac{w}{2}e_i^2 - \frac{\xi}{2}q_i^2 \tag{13}$$

Applying the FOC to the objective function (13) we have

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[7] Notice that we are explicitly ruling out the existence of corner solution in the readmission probabilities (that is, $h(1 - \theta q_i) < 0$); thus, our subsequent analysis is valid only for those medical branches where readmissions are relevant. After all, it would not make sense to discuss on the effect of readmission policy and its optimal design in those medical branches where readmissions are somewhat insignificant.

[8] Indeed, there are at least two different general payment systems ascribed to prospective, that is the prospective budget allocation (e.g. Austria, Portugal, Spain) and the prospective case payment (e.g. in England, France, Germany, Italy, the US). However, as usual in this literature we consider the prospective payment system in the meaning of the prospective case payment.

$$q_i^{RP} = \frac{\alpha\tau}{2(\tau\xi - \alpha)} - q_j \frac{\alpha}{2(\tau\xi - \alpha)} \tag{14}$$

$$e_i^{RP} = 0 \tag{15}$$

From the reaction curve (14) we can see that in a retrospective payment system hospitals act as *strategic substitute* in quality[9]. To grasp the intuition for this result we should consider that in a retrospective payment system there are not "financial" incentives to increase quality for attracting more patients; rather, providers' behaviour is more driven by the "non-financial motivation", as (13) clearly shows. In particular, when hospital *j* increases quality, fewer patients demand medical treatment from hospital *i*, which in turn reduces the marginal (altruistic) benefit from improving quality. Moreover, when the quality of *j* is high, then hospital *i* might find too costly in terms of managerial disutility to keep up with *j*. Thus, once behind the competitor hospital *i* might even find optimal to reduce quality.

Similarly, from (15) we can see that in a retrospective payment system there is no scope for exerting a positive cost-reducing effort. Again, the intuition is that in such kind of payment system providers' behaviour is more driven by the non-financial motivation, which has to do with the quality of medical treatment but not much with the cost-efficiency.

Finally, solving for the symmetric Nash equilibrium we find

$$q^{RP} = \frac{\alpha\tau}{2\tau\xi - \alpha} \tag{16}$$

$$e^{RP} = 0 \tag{17}$$

Analysing the comparative statics properties of (16), they are quite reasonable and intuitive. In particular, a higher weight of the non-financial motivation in the provider objective function (α) leads to a higher equilibrium quality. On the other hand, a higher marginal managerial disutility of quality (ξ) and a higher marginal disutility of travelling relative to

[9] Notice that the SOC for this maximization problem reads

$$\frac{\partial \Omega_i^{RP}}{\partial q_i} = \left(\frac{\alpha}{\tau} - \xi\right) < 0 \qquad \Rightarrow \qquad \alpha < \xi\tau$$

Not surprisingly when the non-financial utility is significantly high, in a payment system where all costs are reimbursed, there is an unlimited incentive for increasing quality. Nonetheless, we prefer to rule out this case on the one hand because it is somewhat unreasonable, on the other hand because it eliminates any scope for the analysis of the incentives provided by the different payment systems. Indeed, in that case financial incentives provided by payment systems become less relevant.

treatment quality (τ), implying a lower demand responsiveness to change in quality, lead to a lower equilibrium quality[10].

3.2 Prospective payment system

Differently, in a prospective payment system hospitals receive a prospectively regulated price for any patient they treat, plus potentially some fixed lump-sum transfer aiming often to cover the fixed cost[11]. Therefore, in this case the hospital revenue is given by

$$p^{PP} = \overline{p} \tag{18}$$

$$T^{PP} = \overline{T} \tag{19}$$

Inserting (18) and (19) in the hospital objective function (8) yields

$$\Omega_i^{PP} = \overline{T} + \overline{p}x_i^D - C(x_i^D, q_i) + (\lambda\overline{p} - R)Pr(h, q_i)x_i^D + \alpha\, q_i\, x_i^D - \frac{w}{2}\, e_i^2 - \frac{\xi}{2}\, q_i^2 \tag{20}$$

Differently from (13), we notice that in a prospective system, not only the "non-financial", but also the "financial" part of provider objective function depends on the level of medical treatment quality and cost-reducing effort. Using the FOC with the objective function (20) we have

$$q_i^{PP} = \frac{\left(\overline{p} - \frac{c}{2}\right) + \alpha\tau - (\lambda\overline{p} - R)h(\tau\theta - 1)}{\frac{c}{2\tau} + 2\tau(k + \xi) + 2(\lambda\overline{p} - R)h\theta - 2\alpha} + q_j \frac{\frac{c}{2\tau} + (\lambda\overline{p} - R)h\theta - \alpha}{\frac{c}{2\tau} + 2\tau(k + \xi) + 2(\lambda\overline{p} - R)h\theta - 2\alpha} \tag{21}$$

$$e_i^{PP} = \frac{\left(\frac{1}{2} + \frac{q_i - q_j}{2\tau}\right)^2}{2w} \tag{22}$$

Looking at the reaction curve (21), we can see that in a prospective payment system, as long as the weight of the non-financial motivation is not so high, hospitals act as *strategic complement* in quality[12]. The main intuition is that in a prospective payment system hospitals

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[10] From (16) we obtain

$$\frac{\partial q^{RP}}{\partial \alpha} = \frac{2\tau^2\xi}{(2\tau\xi - \alpha)^2} > 0, \qquad \frac{\partial q^{RP}}{\partial \xi} = -\frac{2\alpha\tau^2}{(2\tau\xi - \alpha)^2} < 0 \qquad \text{and} \qquad \frac{\partial q^{RP}}{\partial \tau} = -\frac{\alpha^2}{(2\tau\xi - \alpha)^2} < 0.$$

[11] For instance, in England only the 60% of hospitals revenue is financed according to the DRG-based case payment, while the remaining is financed by global budget and other additional payments. Furthermore, a fairly similar picture is present in France, Germany and other European countries (see Cots et al., 2011).

[12] In particular, the condition on the weight of the non-financial motivation, implying that hospitals act as *strategic complement*, is simply

revenue strictly depends on the actual number of patients they treat. Therefore, this gives providers a consistent financial incentive to keep up with the level of treatment quality to avoid losing demand, which indeed represents the essential stimulus provided by competition in a market with regulated price.

Similarly, from (22) we see that the presence of a fixed payment for patient treated also provides the incentive for hospitals to exert a positive cost-reducing effort, in order to reduce the marginal cost and, in turn, to increase the profit margin.

Then, applying symmetry to (21) and (22) the candidate Nash equilibrium are

$$q^{PP} = \frac{\left(\overline{p} - \frac{c}{2}\right) + \alpha\tau - (\lambda\overline{p} - R)h(\tau\theta - 1)}{2\tau(k + \xi) - \alpha + (\lambda\overline{p} - R)h\theta} \tag{23}$$

$$e^{PP} = \frac{1}{8w} \tag{24}$$

Differently from the previous case, the comparative statics of the equilibrium quality (23) are quite interesting. In particular, we can notice from (25) that, as long as the degree of *risk sharing* (λ) is sufficiently high, a higher fixed payment ($\overline{p}$) might even reduce the equilibrium quality.

$$\frac{\partial q^{PP}}{\partial \overline{p}} = \frac{[1-\lambda h(\tau\theta-1)][2\tau(k + \xi)-\alpha+(\lambda\overline{p}-R)h\theta]-\lambda h\theta\left[\left(\overline{p} - \frac{c}{2}\right)+\alpha\tau-(\lambda\overline{p}-R)h(\tau\theta-1)\right]}{[2\tau(k + \xi) - \alpha + (\lambda\overline{p} - R)h\theta]^2} \begin{cases} < 0 \; if \; \lambda \; high \\ > 0 \; if \; \lambda \; low \end{cases} \tag{25}$$

Likewise, from (26) we see that, as long as the impact of quality on the readmission probability (θ) is sufficiently high, a higher degree of *risk sharing* (λ) reduces the equilibrium quality[13]. This constitutes the first main result of the paper.

$$\frac{\partial q^{PP}}{\partial \lambda} = -\overline{p}h\frac{(\tau\theta - 1)[2\tau(k + \xi)-\alpha+(\lambda\overline{p}-R)h\theta]+\theta\left[\left(\overline{p} - \frac{c}{2}\right)+\alpha\tau-(\lambda\overline{p} - R)h(\tau\theta - 1)\right]}{[2\tau(k + \xi) - \alpha + (\lambda\overline{p} - R)h\theta]^2} \begin{cases} < 0 \; if \; \theta \; high \\ > 0 \; if \; \theta \; low \end{cases} \tag{26}$$

$$\alpha < \frac{c}{2\tau} + (\lambda\overline{p} - R)h\theta \quad \Rightarrow \quad \frac{\partial q_i^{RC}}{\partial q_j} > 0,$$

which we think as being fairly reasonable in our context.

[13] More specifically, a sufficient condition for being (26) negative relates θ with the degree of competition in the market, requiring that the impact of quality in the readmission probability has to be higher when the competition in the market is higher $\theta \geq \frac{1}{\tau}$. This is not surprising because the two parameters θ and τ determine respectively the marginal expected cost (in terms of lower readmissions) and the marginal expected benefit (in terms of higher demand) of increasing quality. Therefore, the extent to which θ should be high for being (26) negative has to be necessarily related to the degree of competition in the healthcare market $\frac{1}{\tau}$.

Proposition 1. *As long as the impact of quality on the readmission probability* (θ) *is sufficiently high, in a PPS the equilibrium quality is strictly decreasing with the risk sharing relative to readmission* λ.

The main intuition for this result is that when patients readmitted are costly for hospitals, that is λ is low, and the probability of readmission depends on the quality of treatment, there is a clear incentive in PPS for increasing quality to reduce readmissions. Conversely, when hospitals receive a higher payment for patients readmitted, the higher revenue increases the attractiveness of readmissions and, to the limit, there might be a scope for reducing quality to increase readmissions and, in turn, the revenue. On the other hand, when the readmission probability depends only barely on quality, there are no reasons concerning the amount of patients readmitted affecting the choice of quality. Rather, in this case a higher λ increases the expected benefit of each patients and, *ceteris paribus*, the hospital's incentives for quality provision.

To some extent, since the majority of the actual PPS do not provide explicitly for a readmission policy, implying that hospitals receive a full payment for patients readmitted, the Proposition 1 might be extremely useful in offering an easy instrument to induce a higher quality of medical treatment.

Finally, the other comparative statics of (23) are more expected. In particular, a higher weight of the non-financial motivation (α) and a higher competition (τ) lead to a higher equilibrium quality. On the other hand, a higher marginal managerial disutility of quality (ξ) and higher marginal costs (κ) and (c) lead to a lower equilibrium quality[14]. Moreover, from

[14] From (23) we get the following

$$\frac{\partial q^{PP}}{\partial \alpha} = \frac{2\tau^2(k+\xi) + \left(\overline{p} - \frac{c}{2}\right) + (\lambda\overline{p} - R)h}{[2\tau(k+\xi) - \alpha + (\lambda\overline{p} - R)h\theta]^2} > 0, \qquad \frac{\partial q^{PP}}{\partial \tau} = -\frac{[\alpha - (\lambda\overline{p} - R)h\theta\,]^2 + 2(k+\xi)\left[\left(\overline{p} - \frac{c}{2}\right) + (\lambda\overline{p} - R)h\right]}{[2\tau(k+\xi) - \alpha + (\lambda\overline{p} - R)h\theta]^2} < 0,$$

$$\frac{\partial q^{PP}}{\partial \xi, k} = -2\tau\,\frac{\left(\overline{p} - \frac{c}{2}\right) + \alpha\tau - (\lambda\overline{p} - R)h(\tau\theta - 1)}{[2\tau(k+\xi) - \alpha + (\lambda\overline{p} - R)h\theta]^2} < 0 \quad \text{and} \quad \frac{\partial q^{PP}}{\partial c} = -\frac{1}{2\,[2\tau(k+\xi) - \alpha + (\lambda\overline{p} - R)h\theta]} < 0.$$

(24) we see that a higher marginal managerial disutility of effort (w) reduces the equilibrium cost-reducing effort[15].

3.3 Payment systems comparison

In this section we compare the equilibrium values of the two payment systems. From (27) we can see that the comparison of the equilibrium cost-reducing effort between RPS and PPS highlights unambiguously the advantage of PPS in terms of cost-efficiency.

$$e^{RP} = 0 < \frac{1}{8w} = e^{PP} \tag{27}$$

The main intuition is that in a payment system with price established prospectively, hospitals enjoy entirely the increased profit margin associated with a reduction in the marginal cost, since the greater hospital efficiency does not imply a reduction in the revenue. Differently, in a system where reimbursement is established retrospectively, there is not any incentive for hospitals in reducing costs, since all the reduction is enjoyed by the third-party payer.

Differently, from (28) we can see that the comparison of the equilibrium quality between RPS and PPS is quite ambiguous and, indeed, strictly depends on the parameter values. Moreover, since the impact of the fixed price on the equilibrium quality in PPS is also ambiguous (25), even an increase of $\overline{p}$ does not imply unconditionally a higher equilibrium quality in PPS respect to RPS. Therefore, the propulsive role of competition induced by a prospective payment system might not be enough to induce a higher treatment quality.

$$q^{RP} = \frac{\alpha\tau}{2\tau\xi - \alpha} \gtrless \frac{\left(\overline{p} - \frac{c}{2}\right) + \alpha\tau - (\lambda\overline{p} - R)h(\tau\theta - 1)}{2\tau(\kappa + \xi) - \alpha + (\lambda\overline{p} - R)h\theta} = q^{PP} \tag{28}$$

However, since a higher degree of *risk sharing* (λ) decreases the equilibrium quality in PPS when θ is sufficiently high, whereas has not impact on RPS, we can certainly maintain that

[15] Similarly, from (24) we have that $\frac{\partial e^{PP}}{\partial w} = -\frac{1}{8\,w^2} < 0$.

should exist a potential role for PPS in inducing a higher equilibrium quality, this would certainly be curbed by a higher λ.

To shed more light on this comparison, in Figure 1 we show the reaction curves and, in turn, the equilibrium quality under RPS and PPS resulting by a simulation with the same parameter values[16]. In particular, since the PPS often do not provide explicitly for a readmission policy implying a different payment, we start our numerical exercise considering a full payment for patients readmitted ($\lambda = 1$).

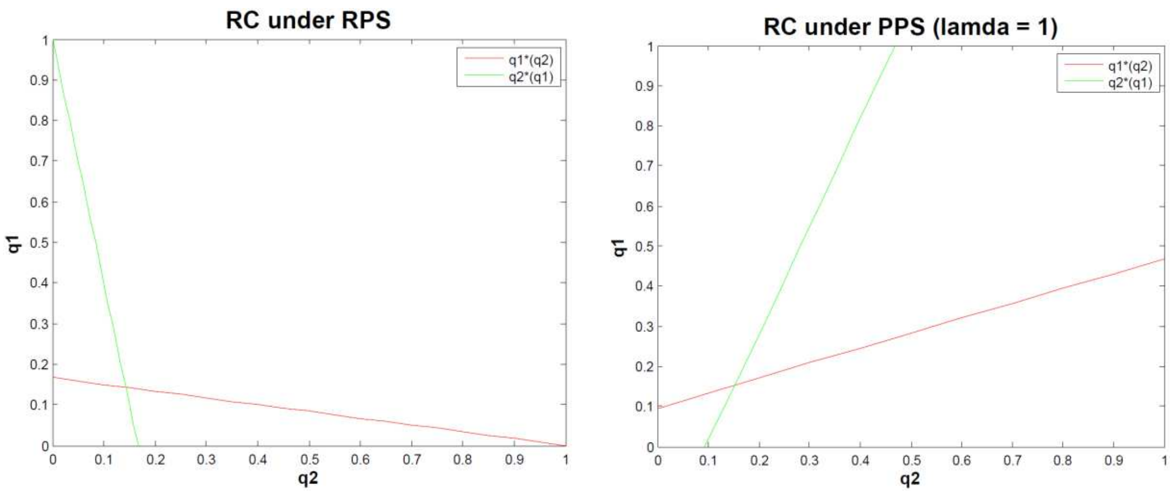

Fig. 1. Reaction curves and equilibrium quality under RPS and PPS

As we can notice, whereas in RPS the presence of competitors in the healthcare market induces a reduction in the equilibrium quality, PPS is indeed able to convert the kind of *strategic interaction* between providers and, therefore, there seems to be a potential role for competition in stimulating a higher equilibrium quality. However, as Figure 1 shows this propulsive role might not be enough to guarantee unconditionally a higher equilibrium quality

[16] The numerical exercise has been conducted with the following parameters:

$$v = 3, \tau = 1, p = 2.8, \sigma = 5, k = 1, F = 2, w = 1, \xi = 1, \alpha = 0.3, h = 0.2, \theta = 1, R = 2.$$

Notice that the condition for being (26) negative has been matched only with the equality (that is, $\theta = \frac{1}{\tau}$), so that the effect of the different readmission policies in this simulation is just at the minimum amount. In fact, from (26) we know that the higher is θ, the higher is the negative effect of λ on equilibrium quality. More information on the algorithm are promptly available under request by authors.

in the market and, in particular, the presence of a full readmission payment might frustrate its propulsive effect[17]. This result is summarized in the proposition below.

Proposition 2. *As long as the impact of quality in the readmission probabilities is sufficiently high and hospitals receive a full payment for patients readmitted, a PPS might even induce a reduction in quality and, in turn, an increase in readmission probability.*

To some extent, the content of Proposition 2 could explain the large empirical evidence concerning the impact of the introduction of PPS on quality. As we noted in the introduction of the paper, while the evidence on cost-efficiency would seem to highlight the advantage of PPS, the empirical findings on hospital quality are still quite ambiguous. Indeed, considering that the actual PPS often do not provide explicitly for a readmission policy implying a different payment for patients readmitted ($\lambda = 1$), Figure 1 might represent exactly the ambiguity we find in the data.

On the other hand, Proposition 2 gives rise to the fair question if such limitation of the effect of competition might be internalized in the payment system by a different readmission policy. Therefore, in Figure 2 we report the PPS equilibrium quality, along with the associated readmission rate, under different readmission policies. We can see that already a limited reduction in the readmission payment is enough to allow the propulsive role of competition to do more successfully the job. More generally, Figure 2 shows that the bigger is the reduction in the readmission payment, the higher is the equilibrium quality and, in turn, the lower is the readmission rate[18]. This constitutes the content of the next proposition.

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[17] In particular, in the numerical simulation reported in Figure 1 the equilibrium qualities in the two payment systems are quite close:

$$q^{RP} = 0.176 \cong 0.172 = q^{PP}.$$

[18] More precisely, the equilibrium qualities showed in Figure 2 are

$$q^{PP}(\lambda = 0.5) = 0.185 \quad \text{and} \quad q^{PP}(\lambda = 0) = 0.201,$$

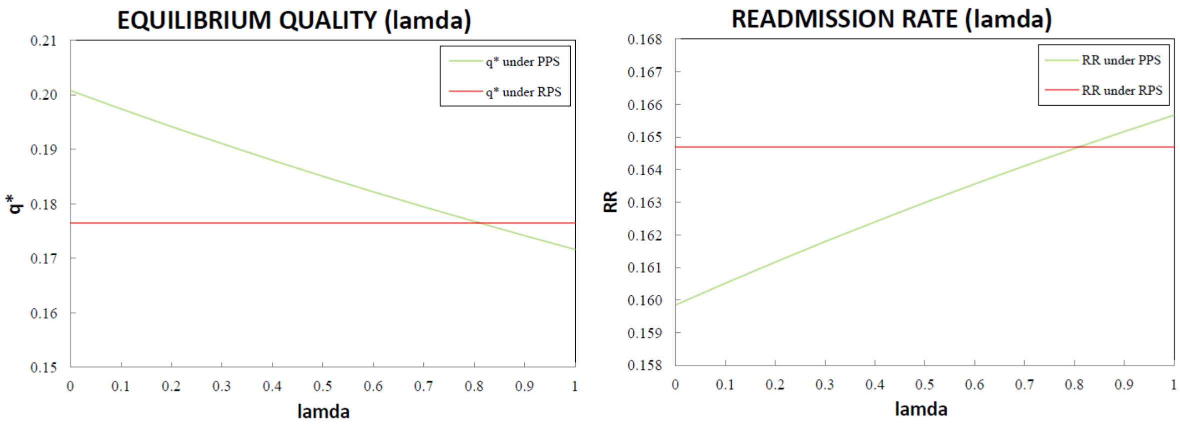

Fig. 2. PPS quality and readmission rate under different readmission policies

Proposition 3. *The propulsive role of competition induced by a PPS should be more successful in driving a higher equilibrium quality and, in turn, lower readmission rate in those systems providing for a lower degree of risk sharing relative to readmission.*

The aim of this comparison has been to identify the different incentives given by the two payment systems to providers' behaviour. In particular, we established that, as long as hospitals receive a high payment for patients readmitted, the propulsive role of competition induced by PPS might not be enough to ensure a higher equilibrium quality respect to RPS. On the other hand, PPS should be successful in driving a higher equilibrium quality whenever the readmission policy provides for a low degree of *risk sharing*.

However, at this stage nothing ensures neither that the equilibrium quality induced by PPS would be indeed the first-best quality, nor that the first-best quality can be really achieved under PPS by some optimal policy instrument regulation. Therefore, in the next section we move to the welfare analysis in order to answer to these crucial questions. In particular, in what follows we will try to emphasize mainly the role of the optimal

implying a quality increase respectively of 10% and 20% respect to the equilibrium quality with full readmission payment and, all the more so (see footnote 17), respect to the equilibrium quality under retrospective payment system.

readmission policy as an instrument in the context of a prospective payment system to induce the first-best quality.

4. Social Welfare

Following the previous literature, we define social welfare as the sum of consumer utility net of monetary costs as well as disutility costs. In addition, in the most general formulation we include the non-financial utility of providers, which clearly disappears considering $\alpha = 0$[19]. Therefore, the social welfare function is given by[20]

$$W = \int_0^{x_i^D} (v + q_i - \tau s) ds + \int_{x_i^D}^1 \left(v + q_j - \tau(1 - s)\right) ds + \alpha \left(q_i x_i^D + q_j(1 - x_i^D)\right)$$
$$- \frac{c_i}{2}\left(x_i^D\right)^2 - \frac{c_j}{2}\left(1 - x_i^D\right)^2 - \frac{k}{2}\left(q_i^2 + q_j^2\right) - 2F - \frac{w}{2}\left(e_i^2 + e_j^2\right) - \frac{\xi}{2}\left(q_i^2 + q_j^2\right)$$
$$- Rh(1 - \theta q_i)x_i^D - Rh\left(1 - \theta q_j\right)\left(1 - x_i^D\right) \quad (29)$$

4.1 Optimal readmission policy

We start out by deriving the first-best cost-reducing efforts and qualities. Maximising (29) with respect to cost-reducing efforts and qualities yields

$$e_i = e_j = e^* = \text{argmax}_{e_i, e_j} W = \frac{1}{8w} \quad (30)$$

and

$$q_i = q_j = q^* = \text{argmax}_{q_i, q_j} W = \frac{1 + \alpha + Rh\theta}{2(k + \xi)} \quad (31)$$

[19] Indeed, there is a heated discussion in the literature concerning the inclusion of the altruistic (or non-financial) component in the social welfare function as this would lead to double-counting (see e.g. Chalkley and Malcomson, 1998). Nonetheless, in our general formulation we decided to include this component, knowing that it clearly disappears considering $\alpha = 0$.

[20] Notice that in (29) we are implicitly assuming that patients readmitted, after being re-treated, enjoy the same utility of those patients not readmitted. Indeed, considering a double cost for patients readmitted would lead to the following more complicated "social welfare function"

$$W = \int_0^{x_i^D} \left(v + q_i - \tau s\left(1 + h(1 - \theta q_i)\right)\right) ds + \int_{x_i^D}^1 \left(v + q_j - \tau\left(1 + h\left(1 - \theta q_j\right)\right)(1 - s)\right) ds + \ldots$$

Nonetheless, since this welfare function would produce exactly the same implications in terms of policy than (29), for the sake of simplicity we decided to neglect the double cost issue, knowing that the inclusion of it does not enrich significantly the picture. Indeed, this allowed us to keep the results of welfare analysis as simple as possible, without changing the main policy implications.

Looking at (30), we see that the first-best cost-reducing effort depends negatively only on the marginal disutility of effort (w). Concerning the first-best quality (31), on the one hand higher monetary (κ) and disutility costs (ξ) reduce it; on the other hand, higher provider non-financial utility (α) and expected readmission costs (Rh) lead to a higher first-best quality.

Furthermore, the comparison between (24) and (30) reveals that $e^{PP} = e^*$, a standard result in the multi-task agency literature (e.g. Chalkley and Malcomson, 1998).

Proposition 4. *Regardless of the readmission policy, a PPS with regulated price is able to induce the first-best cost-efficiency.*

Differently, the comparison between (23) and (31) reveals that the equilibrium quality under PPS is not generally equal to the first-best quality, that is $q^{PP} \neq q^*$. Nonetheless, from (23) we know that the regulator has two policy instruments to induce the first-best quality level, the fixed price (p) and the degree of *risk sharing* relative to readmission (λ). Indeed, the more usual regulation considered in the literature is to choose the price to induce the equilibrium quality equal to the first-best quality. Nonetheless, as expected the addition of the readmission policy as an instrument on regulator's hands, adds some degree of freedom to the optimal policy design.

Looking at the first instrument, the optimal price regulation p^* is implicitly characterized by

$$p^* : q^{PP}(p^*) = q^*$$

yielding

$$p^*(\lambda) = \frac{\frac{c}{2} + \tau(1 + Rh\theta) - \alpha\frac{(1+\alpha+Rh\theta)}{2(k+\xi)} - Rh\left[\frac{\theta(1+\alpha+Rh\theta)}{2(k+\xi)} + (\tau\theta - 1)\right]}{1 - \lambda h\left[\frac{\theta(1+\alpha+Rh\theta)}{2(k+\xi)} + (\tau\theta - 1)\right]} \qquad (32)$$

Thus, the first-best quality can be implemented in PPS by the optimal price regulation. However, notice that such optimal price depends on the degree of *risk sharing* relative to readmission. Therefore, the regulator does not have a unique optimal price to induce the first-best quality, but in principle he has a bundle of optimal policies made by all possible couples (p, λ) given by (32). Interestingly, from (33) we can see that, as long as the impact of quality on the readmission probability (θ) is sufficiently high, the optimal price inducing the first-best quality has to be higher when the degree of *risk sharing* is higher. This central result is resumed in Proposition 5.

$$\frac{\partial p^*(\lambda)}{\partial \lambda} = p^*(\lambda) \frac{h\left[\frac{\theta(1+\alpha+Rh\theta)}{2(k+\xi)} + (\tau\theta - 1)\right]}{1 - \lambda h\left[\frac{\theta(1+\alpha+Rh\theta)}{2(k+\xi)} + (\tau\theta - 1)\right]} > 0 \tag{33}$$

Proposition 5. *As long as the impact of quality on the readmission probability* (θ) *is sufficiently high, the optimal price inducing the first-best quality has to be higher in those systems with a higher degree of risk sharing relative to readmission.*

The intuition behind this result can be appreciated by the combination of (25) and (26). From the former we know that an increase in price (p) does not induce unconditionally a higher equilibrium quality (q^{PP}) and, in particular, as long as the degree of *risk sharing* (λ) is consistently greater than zero, a higher fixed payment might even lead to a reduction in the equilibrium quality. From the latter we know that, regardless of the price, a higher degree of *risk sharing* (λ) reduces the equilibrium quality (q^{PP}). Therefore, a higher degree of *risk sharing* not only reduces *per se* the equilibrium quality, but also reduces the marginal effect of the per-treatment price. On the contrary, a lower degree of *risk sharing* not only allows to the price instrument to do more effectively its job, but also helps to induce a higher quality through its own effect on it.

Hence, the regulator not only can induce the first-best quality, but can also select a couple of policy instruments trying to reduce the monetary cost of the policy. Since funding healthcare services requires always some form of distortionary taxation (e.g. Brekke et al.

2008, Siciliani et al., 2013), it would be certainly valuable for the regulator being able to reduce the costs of regulation. Therefore, to the extent that all optimal policies in the bundle (p, λ) given by (32) are able to induce first-best quality in the healthcare market, the optimal policy regulation is that couple of policy instruments (p, λ) in the bundle minimising the cost of public funds. Thus, conditional on the hospitals inability to rationing, the optimal policy regulation is simply given by

$$\lambda^* = 0 \tag{34}$$

and

$$p^*(\lambda = 0) = \frac{c}{2} + \tau(1 + Rh\theta) - \alpha \frac{(1 + \alpha + Rh\theta)}{2(\kappa + \xi)} - Rh\left[\frac{\theta(1 + \alpha + Rh\theta)}{2(\kappa + \xi)} + (\tau\theta - 1)\right] \tag{35}$$

Proposition 6. *The optimal policy regulation is that couple of policy instruments (p, λ) such that the degree of risk sharing is equal to zero (34) and the optimal price is accordingly set as (35).*

The main intuition for being (34) and (35) the optimal policy is that with a null *risk sharing*, that is $\lambda = 0$, readmissions become extremely costly for hospitals and, thus, there is the strongest possible incentive for increasing quality to reduce readmissions. Correspondently, the optimal price given by (35) represents indeed the lowest possible price still able to induce the first-best quality in the market.

In principle, the result contained in Proposition 6 might offer to healthcare policy makers a valid instrument not only to induce the first-best quality in the market, but also to implement the policy in the cheapest way. To some extent, the feature of the optimal policy to minimise the cost of public funds should be extremely important, as it is well-recognised that there is a positive cost from collecting money through some form of distortionary taxation in the society. Moreover, even in the case policy makers would not be able to implement such policy, the principle underpinning the result in Proposition 5 is still valid: that is, the lower is the degree of *risk sharing*, the lower is the price needed to induce the first-best quality.

4.2 Policy implementation

Although the optimal policy regulation is in principle implementable, there are different reasons why it might not be optimal in practice. First, notice that all normative results have been derived conditional on the hospitals inability to rationing. However, as we already observed this assumption might be somewhat unreasonable, since hospitals do have instruments to try to put in practice some form of rationing. Therefore, the readmission policy ($\lambda^* = 0$) might be extremely risky, inducing hospitals to avoid somehow to readmit those patients requiring a new treatment. Moreover, for political and economic reasons, it might be difficult for the government to stand by such readmission policy. Last but not least, in those countries using PPS the per-treatment price is usually set according to the treatment average cost and, indeed, it might be extremely difficult to implement all calculations required by the optimal price (35).

In those plausible cases where one or more of these conditions are significant, that readmission policy might not be feasible or optimal. Therefore, one should try to find some policy design feasible and easy to implement, but still able to produce the required effect to induce the first-best quality. Indeed, the results of this paper would seem to suggest a plausible route.

The principle underpinning our main results is that the readmission policy does influence providers' behaviour on quality by offering a revenue ($\lambda > \frac{R}{p}$) or imposing a cost ($\lambda < \frac{R}{p}$). In particular, we found that a lower degree of *risk sharing* not only reduces the equilibrium quality, but also reduces the optimal price needed to induce the first-best quality. Therefore, a fairly reasonable readmission policy might be

$$\lambda^* = \frac{R}{p} \tag{36}$$

On the one hand, this readmission policy does eliminate the economic attractiveness of readmissions induced by a full payment ($\lambda = 1$); on the other hand, it does eliminate the scope for hospitals to make rationing induced by the optimal readmission policy ($\lambda^* = 0$). Finally, it should be both politically and economically sustainable for government and healthcare providers.

Looking at the price, notice that the optimal price (32) implied by (36) would be

$$p^*\left(0 < \lambda = \frac{R}{p} < 1\right) = \frac{c}{2} + \tau(1 + Rh\theta) - \alpha\frac{(1 + \alpha + Rh\theta)}{2(\kappa + \xi)} \tag{37}$$

Nonetheless, the implementation of (37) still would require different calculations which, indeed, might be difficult to make. Therefore, for the sake of simplicity, a fairly reasonable alternative might be

$$p^*\left(0 < \lambda = \frac{R}{p} < 1\right) \cong \frac{c}{2} + Rh\theta \tag{38}$$

On the one hand, respect to the standard average cost-based rule, the implementation of (38) should be extremely simple, requiring just the calculation of the average readmission costs ($Rh\theta$), which indeed have an empirical counterpart. On the other hand, respect to the theoretical optimal price (37), we are neglecting a bit adding ($+\tau$) and a bit subtracting ($-\alpha$), which might somehow compensate and, thus, reduce the extent of the approximation, with the crucial advantage of making the implementation extremely easier.

To resume, a reasonable and very easy to implement policy regulation could be

$$\lambda^* = \frac{R}{p} = \frac{R}{\frac{c}{2} + Rh\theta} \tag{39}$$

and

$$p^*\left(0 < \lambda = \frac{R}{p} < 1\right) \cong \frac{c}{2} + Rh\theta \tag{40}$$

More generally, we have seen from Figure 2 that even a reduction of λ different from (34) or (39) should be able to produce a significant effect in terms of higher quality respect to the equilibrium quality with full readmission payment. Thus, those countries providing a full payment for patients readmitted ($\lambda = 1$) should be still able to get a significant effect in terms of higher quality and, in turn, lower readmission rates even without providing necessarily for the optimal readmission policy ($\lambda^* = 0$) or for the policy implementation discussed ($\lambda^* = \frac{R}{p}$). Therefore, at least for those medical sectors where the readmission probability strictly depends on quality, the theoretical results underlined in this paper and the associated policy recommendations represent certainly a valid contribution for both scholars and policy makers.

5. Conclusions

Inspired by some recent healthcare policies in OECD countries, in this paper we have studied the incentives for hospitals to provide quality and cost-reducing effort under different payment regimes, either a retrospective global budgeting or a prospective payment system. In particular, we have conducted our analysis within the spatial Hotelling framework where two hospitals compete in quality to attract a larger demand in the market for medical treatment. Differently from the existing literature, we focused on the role played by the readmission policy in driving providers' behaviour and, in turn, in leading to the equilibrium quality.

In our analysis we found that the propulsive role of competition provided by a prospective system might not be enough to guarantee unconditionally a higher equilibrium quality respect to a retrospective system. In particular, as long as the probability of readmission depends on the quality of treatment and hospitals receive a full payment for patients readmitted, a prospective payment system might even induce a reduction in quality and, in turn, an increase in readmission probability. Therefore, in the final part of the paper we have explored the impact of different readmission policies with the aim of adjusting this counter-incentive. This led us to the central result of our study, if the prospective payment system is adjusted by a different payment for patients readmitted, it could be able to foster a higher hospital quality through the competition channel. Thus, the main implication of the paper is that those countries providing a full payment for patients readmitted in the context of a DRG-based PPS should be able to promote a higher quality and, in turn, lower readmission rates by partially discharging the risk of readmission to providers.

Looking at the recent experience of those countries introducing severe limitation on the readmission payment (e.g. the US, Germany, the UK), once the pattern of readmission rates will be available, further empirical investigations will be able to test the role played by different readmission policies. Interestingly, the choice made by some countries of stopping entirely the payment for patients readmitted might not be the optimal solution according to our discussion, potentially inducing hospitals to avoid somehow to readmit those patients requiring a new treatment. Indeed, the readmission policy suggested in the final part of the paper should still be able to promote a higher healthcare quality, eliminating the scope for hospitals to make rationing.

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