Bargaining and the Provision of Health Services

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Abstract

This paper models the interaction between three agents: a welfare maximising government (or regulator), a purchaser of health services (for example a health authority) and a provider (the hospital). We analyse and compare three regulatory settings: a) the regulator sets the price but the activity is bargained between the purchaser (a health authority) and the provider (activity bargaining); b) the price is bargained between the purchaser and the provider, while activity is chosen unilaterally by the provider (price bargaining); c) price and activity are bargained between the purchaser and the provider (efficient bargaining). We show that welfare is highest and prices are lowest under "activity bargaining". Providers have highest utility under "price bargaining". Activity is highest under efficient bargaining.

1 Introduction

Prospective payment systems are regularly used for remunerating hospitals. The existing literature comparing the relative merits of cost reimbursement

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and prospective payment normally assumes that payers are able to set the prices (and often activity) unilaterally, while providers simply react to these conditions by adjusting the amount of quality and cost-containment effort (see for example, Ma, 1994; Chalkley and Malcomson, 1998a and 1998b, Mougeot and Haegelen, 2005). This implies that purchasers or regulators have all the bargaining power. However, some empirical studies (like Propper, 1996) suggest that this may be a simplifying assumption, as providers may also hold at least some of the bargaining power. Also, it is often informally argued that it is the providers who set the conditions of the contract, rather than the purchasers (Cookson, Goddard and Gravelle, 2005).

This paper models the interaction between three agents: a welfare maximising government (or regulator), a purchaser of health services (for example a health authority) and a provider (a hospital).

We analyse and compare three plausible regulatory settings: a) the regulator sets the price but the activity is bargained between the purchaser (a health authority) and the provider (activity bargaining); b) price is bargained between the purchaser and the provider, but activity is chosen unilaterally by the provider (price bargaining); c) price and activity are bargained between the purchaser and the provider (efficient bargaining).

The first regime resembles the new policy of "payment by results" in the UK, where prices are set centrally by the government. The second and third regime are more similar to the "cost and volume" contracts or "sophisticated" contracts implemented in the UK in the last decade, where prices (or transfers) are negotiated between health authorities and providers.

1.1 Related literature

This study contributes to the existing literature on bargaining in healthcare, which is briefly reviewed below.[1] Ellis and McGuire (1990) develop a model where patients and doctors bargain on the level of intensity of treatment when the payment system induces their desired quantities to diverge. Brooks, Dor and Wong (1997) focus on price bargaining between private insurers and providers. They test their theoretical predictions using data from the provision of appendectomies. They estimate that hospitals hold in average 65% of the relative bargaining power, although this proportion has fallen over the period of the study.[2] More recently, Barros and Martinez-Giralt (2000a and 2000b) have analysed different aspects of the provision of health care services. They focus particularly on the elements that influence the decision of purchasers on how to negotiate with provider professional organizations, like medical associations. In their model the purchaser can choose among different negotiation mechanisms, including whether to negotiate with each provider separately or to conduct negotiations with associations of providers. Barros and Martinez-Giralt (2000a) consider providers with different degrees of efficiency in the provision of services. They show that in this case the purchaser will act strategically by taking into account that the subset of more efficient providers holds a more favourable outside option. Hence the purchaser will prefer to bargain with the association of providers in order to avoid the strengthening of the more efficient providers. In the related paper, Barros and Martinez-Giralt (2000b) show that the pur-

[1] For a recent and more comprehensive survey of the literature on the applications of bargaining theory to the health care sector please see Barros and Martinez-Giralt (2006).

[2] Dor and Watson (1995) evaluate how different payment mechanisms affect the incentives in the relationship between hospitals and physicians.

chaser's choice is also influenced by the surplus at stake in the negotiation. With relatively high surplus the purchaser implements the system of "any willing provider", whilst a low surplus favours traditional negotiations, either joint or with the association of providers. Barros and Martinez-Giralt (2005) present a model that explores the implications of the coexistence of a public and a private sector in a country. They argue that the public sector may choose to hold idle capacity in order to extract more beneficial conditions in the bargaining with the private sector for the provision of services. Clark (1995) uses the axiomatic approach to examine the problem of how to divide a budget between two patients with different health conditions, and different capacity to benefit from treatment. Pecorino (2002) studies the potential implications of drug reimports from Canada for the profitability of US domestic pharmaceutical companies. When reimports are not allowed domestic companies hold the monopoly of the drug in the domestic market. The foreign price is determined by a Nash bargaining game between the foreign government (which is concerned with the consumer surplus in its own country) and the monopolist. If reimports are allowed, the foreign price is assumed to prevail in the domestic market as well. Assuming two types of demand functions (linear and with constant elasticity), he shows that the profit of the firms always increase if reimports are allowed. The reason is that in this case the pharmaceutical company will make fewer concessions in the bargaining game.[3] All the above studies use Nash axiomatic bargaining.

[3] The Nash bargaining solution has been extensively been utilised in the labour economics to examine the negotiations between trade unions and firms with respect to wages and employment. See for example Oswald (1985) for a survey of the literature, Manning (1987), McDonald and Solow (1981), Bulkley (1992), Sampson (1993) and Bulkley and Myles (1997).

We use the same approach.

The paper is organised as follows. Section 2 presents the model. Section 3 conducts comparative statics. Section 4 extends the model with quality and effort. Section 5 offers concluding remarks.

2 The model

This paper models the interaction between three agents: a welfare maximising government (or regulator), a purchaser of health services (for example a health authority) and a provider (a hospital).

Define y as the number of patients treated and p as the price that the provider receives for each patient treated. The hospital's utility U is given by its surplus:

$$U(p, y) = py - C(y) \tag{1}$$

where $C(y)$ is the cost function of the provider, which satisfies $C_y > 0$, $C_{yy} > 0$ (increasing marginal cost).

The purchaser's utility (or health authority utility) is given by the difference between the benefit of the patients $B(y)$ and the transfer to the provider:

$$V(p, y) = B(y) - py \tag{2}$$

The benefit function satisfies $B_y > 0$ and $B_{yy} \leq 0$.

The regulator (or the government) maximises welfare, given by:

$$B(y) - (1 + \lambda)py + \alpha U(p, y) \tag{3}$$

where λ denotes the opportunity cost of public funds, and $\alpha \in [0, 1]$ is the weight that the government attaches to the utility of the provider (if

$\alpha = 1$ we have a utilitarian welfare function; if $\alpha = 0$ the government cares only about the net consumer surplus).

We analyse three different regulatory setting:

1) Activity bargaining (a): regulator sets the price but the activity is bargained between the purchaser and the provider;

2) Price bargaining (p): price is bargained between the purchaser and the provider, activity is chosen by the provider;

3) Efficiency bargaining (e): price and activity are bargained simultaneously between the purchaser and the provider.

Notice that in regimes 2) and 3) the regulator has a passive role.

For notational simplicity let: $V^i = V(p^i, y^i), U^i = U(p^i, y^i)$, where $i = a, p, e$.

2.1 Activity bargaining

We assume that the purchaser and the provider bargain on activity, while the price is chosen by the regulator.[4] Define with γ the bargaining power of the purchaser. For a given price p, the purchaser-provider Nash bargaining problem can be stated as follows:

$$\max_{y} \Omega = \left[B(y) - py - \bar{V}\right]^{\gamma} \left[py - C(y) - \bar{U}\right]^{1-\gamma} \tag{4}$$

The FOC is:[5]

$$y^a : \quad \frac{\gamma}{V - \bar{V}} (B_y - p) = \frac{1-\gamma}{U - \bar{U}} (C_y - p) \tag{5}$$

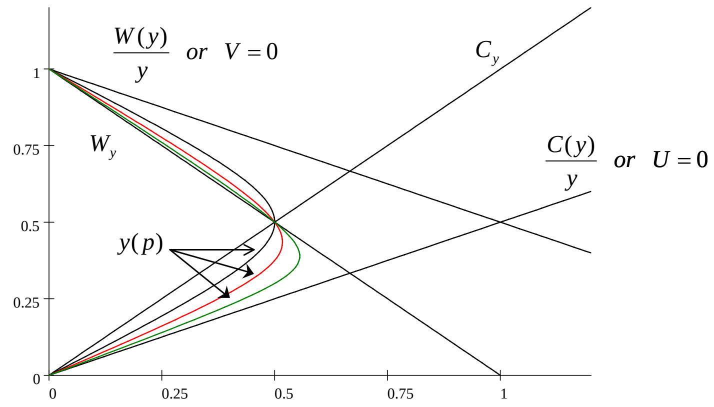
[4] For example the Department of Health fixes the price at the national level, and the Health Authorities bargain the level of activity at the local level with each hospital independently.

[5] Differentiating $\log \Omega = \gamma \log \left[B(y) - py - \bar{V}\right] + (1-\gamma) \log \left[py - C(y) - \bar{U}\right]$ with respect to y the result is obtained.

We can distinguish two cases. 1) The exogenous price p is low, so that the optimal activity for the purchaser is *higher* than the optimal activity for the provider. In this case $B_y \geq p$ and $C_y \geq p$. The bargained activity lies somewhere in between the desired activity of the two agents. The LHS is the net marginal benefit of activity for the purchaser weighted for her utility and her bargaining power. The RHS is the marginal cost for the provider also weighted for his utility and his bargaining power. 2) The exogenous price p is high, so that the optimal activity for the purchaser is *lower* than the optimal activity for the provider. In this case $p \geq B_y$ and $p \geq C_y$. The FOC can be rewritten as $\frac{\gamma}{V-\bar{V}}(p-B_y) = \frac{1-\gamma}{U-\bar{U}}(p-C_y)$. The weighted marginal benefit of activity for the provider is equal to the marginal cost for the purchaser. Finally notice that in equilibrium it is always the case that $U \geq 0$ and $V \geq 0$. Also notice that the equilibrium lies in the area between the average and marginal benefit, and the area between the average and marginal cost.

Figure 1 illustrates different bargained activity levels for three different values of the bargaining power.

Figure 1. Bargaining on activity



The second-order condition is:

$$\Gamma = \gamma \frac{B_{yy}V - (B_y - p)^2}{V^2} - (1-\gamma)\frac{C_{yy}U + (p - C_y)^2}{U^2} < 0$$

which is always satisfied.

Comparative statics. We explore how the bargained activity is influenced by changes in the parameters of the model. Differentiating Eq.(5), we obtain:

$$\frac{dy^a}{d\gamma} = \frac{(B_y - p)U - (p - C_y)V}{VU}\frac{1}{-\Gamma} > 0 \text{ if price is low}$$

and viceversa ($\frac{dy^a}{d\gamma} < 0$ if price is high).

The effect of a change in price on activity is:

$$\frac{dy^a}{dp} = \left((1-\gamma)\frac{C_y - \frac{C}{y}}{U^2} - \gamma \frac{\frac{B}{y} - B_y}{V^2} \right) \frac{1}{-\Gamma} \lesseqgtr 0$$

which in general is indeterminate. Notice that under our assumptions, it is always the case that $C_y > \frac{C}{y}$ and $\frac{B}{y} > B_y$ (in words the marginal cost is always higher than the average cost; the average benefit is higher than the marginal benefit). However, for low levels of p the provider utility U is very low which suggests that $\frac{dy^a}{dp} > 0$ for low p. Similarly for high levels of p the purchaser utility V is very low which suggests that $\frac{dy^a}{dp} < 0$ for low p. This is consistent with the example shown in figure 1. Finally notice that if $p = B_y = C_y$ (i.e. when the marginal benefit curve crosses the marginal cost curve), there is no disagreement between purchaser and provider so that y^a is such that $B_y = C_y$.

The above analysis assumes that prices are exogenous. We now analyse the optimal prices determined by the regulator.

Optimal price. The regulator sets the price to maximize:

$$\max_p B(y(p)) - \alpha C(y(p)) - (1 + \lambda - \alpha)\, py(p) \tag{6}$$

The first order condition is:

$$p^a: \quad B_y y_p = (1 + \lambda - \alpha)\,(y + py_p) + \alpha C_y y_p \tag{7}$$

The LHS is the marginal benefit from higher activity. The RHS is the marginal cost.

The second order condition is: $(B_{yy} - \alpha C_{yy})\, y_p^2 + (B_y - \alpha C_y)\, y_{pp} - (1 + \lambda - \alpha)\,(2y_p + p)\, y_{pp}$.

2.2 Price bargaining

We assume that the purchaser and the provider bargain on price, while activity is chosen unilaterally by the provider.[6] By backward induction, for

[6] This setup is analogous to the model of sequential bargaining between a firm and a union over wage and employment (McDonald, Solow,1981; Manning, 1987; Alexander, 1992; Bulkley,1992). In that case the firm sets the employment, while the wage is bargained with the union.

a given price the hospital chooses activity maximising $U = py - C(y)$, which leads to

$$y^p: \qquad p = C_y \tag{8}$$

with $\frac{dy^p}{dp} = \frac{1}{C_{yy}}$.

Now we need to determine the outcome of the price bargaining, taking into account that it will affect the activity chosen by the hospital:

$$\max_p \left[B(y^p(p)) - py^p(p) - \overline{V}\right]^\gamma \left[py^p(p) - C(y^p(p)) - \overline{U}\right]^{1-\gamma} \tag{9}$$

Notice that thanks to the envelope theorem, $U_p = y$. The first order condition for the bargained price is:

$$p^p: \quad \frac{\gamma}{V - \overline{V}} B_y y_p + \frac{(1-\gamma)}{U - \overline{U}} y = \gamma \frac{y + py_p}{V - \overline{V}} \tag{10}$$

Proof. The log of the objective function is $\gamma \log\left(B(y(p)) - py(p) - \overline{V}\right) + (1-\gamma)\log\left(py(p) - C(y(p)) - \overline{U}\right)$. Differentiating we obtain

$$\gamma \frac{B_y y_p - y(p) - py_p}{V - \bar{V}} + (1-\gamma)\frac{y(p) + py_p - C_y y_p}{U - \overline{U}} = 0.$$

Recall from the FOC for utility maximisation of the provider that $C_y = p$. Then rearranging the equation above yields the expression for the optimal price: $\gamma \frac{B_y y_p - y(p) - py_p}{V - \bar{V}} + (1-\gamma)\frac{y(p)}{U - \overline{U}} = 0$. ■

The LHS is the marginal benefit from a higher price and includes the marginal benefit for the purchaser from higher activity (weighted by the bargaining power, the utility of the purchaser and the responsiveness of supply) and the marginal benefit for the provider from a higher surplus.

The RHS is the marginal cost for the purchaser from a higher price and overall transfer (also weighted).

If the purchaser holds all the bargaining power then price is such that: $B_y y_p = y + p y_p$. On the other hand for the provider the optimal price is the highest possible compatibly with the purchaser having a positive utility. The bargained price is an intermediate level between these two extreme values.

The Second order condition is $\Gamma = \gamma \frac{[(B_y - p)y_{pp} - 2y_p](V - \overline{V}) - (B_y y_p - y(p) - p y_p)^2}{(V - \overline{V})^2} + (1-\gamma) \frac{[2y_p + (p - C_y) y_{pp}](U - \overline{U}) - y(p)^2}{(U - \overline{U})^2}$.

2.3 Bargaining on activity and price (efficient bargaining)

An alternative regulatory setting is when parties bargain simultaneously on activity *and* price. This is also called "efficient bargaining" because it reduces the potential for unexplored opportunities from mutual gain.[7] The bargaining problem is defined as:

$$\max_{p,y} \Omega = \left[B(y) - py - \bar{V}\right]^{\gamma} \left[py - C(y) - \bar{U}\right]^{1-\gamma} \tag{11}$$

$$y^e : B_y = C_y \tag{12}$$

$$p^e = (1-\gamma) \frac{B(y^e) - \bar{V}}{y^e} + \gamma \frac{C(y^e) + \bar{U}}{y^e} \tag{13}$$

Proof. The first order conditions are given by:

$$\frac{\partial \log \Omega}{\partial p} = -\gamma \frac{y}{B(y) - py - \bar{V}} + (1-\gamma) \frac{y}{py - C(y) - \bar{U}} = 0.$$

$$p = \frac{\gamma \left[C(y) + \bar{U}\right] + (1-\gamma) \left[B(y) - \bar{V}\right]}{y}. \tag{14}$$

$$\frac{\partial \log \Omega}{\partial y} = \gamma \frac{B_y - p}{B(y) - py - \bar{V}} + (1-\gamma) \frac{p - C_y}{py - C(y) - \bar{U}} = 0. \tag{15}$$

[7]The outcome achieved under the previous setup is not efficient. As remarked by Aronsson and others, in that situation "there are unexplored profits and/or utility gains from bargaining" (Aronsson, Lofgren, Wikstrom, 1993).

Substituting (14) into (15) yields: $B_y = C_y$. ■

The optimal level of activity is such that maximises the sum of the surplus for the purchaser and for the provider $U + V = B(y) - C(y)$. In this respect, the optimal activity is "efficient", although this activity may not be efficient for the regulator perspective (for example if the opportunity cost of public funds is positive, then activity under "efficient bargaining" is going to be too high).

The optimal price is a weighted average between the average cost of the provider and the average welfare of the purchaser.[8]

3 An example with constant marginal benefit

To gain some insights on how the different settings relate to each other, we consider the following functional forms: a) the benefit function is linear in activity: $B(y) = ay$, so that the marginal benefit is constant $B_y = a$; b) the cost function is quadratic: $C(y) = \frac{c}{2}y^2$ with $C_y = cy$; c) the outside options are normalised to zero ($\bar{V} = \bar{U} = 0$); d) $\alpha = 1$. Then, the equilibrium for the five regimes are reported in the following table. Proofs are in the appendix.

[8] This result is in line with the model of employment-wage sequential bargaining analysed by Manning (1987) in the context of firm-union negotiations. The intuition behind it is simple. The activity level does not depend on the pay-offs to the hospital and the purchaser. Consequently, as remarked by (Manning, 1987, p.131), the hospital and the purchaser "can agree on this level [of activity] and then bargain about the distribution of the rents".

Table 1: Comparison of equilibrium outcomes for alternative regimes

Activity bargaining	Price bargaining	Efficient bargaining
$p^a = \frac{1}{2}\frac{a(2-\gamma)}{1+2\lambda-\lambda\gamma}$	$p^p = \frac{a(2-\gamma)}{2}$	$p^e = \frac{a(2-\gamma)}{2}$
$y^a = \frac{a}{c(1+2\lambda-\lambda\gamma)}$	$y^p = \frac{a(2-\gamma)}{2c}$	$y^e = \frac{a}{c}$
$V^a = \frac{a^2}{2c}\frac{4\lambda+\gamma-2\lambda\gamma}{(1+2\lambda-\lambda\gamma)^2}$	$V^p = \gamma\frac{a^2(2-\gamma)}{4c}$	$V^e = \frac{\gamma a^2}{2c}$
$U^a = \frac{a^2}{2c}\frac{1-\gamma}{(1+2\lambda-\lambda\gamma)^2}$	$U^p = \frac{a^2(2-\gamma)^2}{8c}$	$U^e = \frac{a^2(1-\gamma)}{2c}$
$W^a = \frac{a^2}{2c(1+2\lambda-\lambda\gamma)}$	$W^p = \frac{a^2(2-\gamma)(\gamma(1+2\lambda)+2-4\lambda)}{8c}$	$W^e = \frac{a^2(2+\lambda\gamma-2\lambda)}{2c}$

The following propositions compare prices, activity, utilities and welfare under different regulatory settings.

Proposition 1 $p^e = p^p > p^a$.

The price under "efficient bargaining" is equal to the price under "price bargaining", which is always higher than the price under "activity bargaining".

Proof. Recall that $p^e = \frac{a(2-\gamma)}{2}$, $p^p = \frac{a(2-\gamma)}{2}$, $p^a = \frac{1}{2}\frac{a(2-\gamma)}{(2-\gamma)(1+\lambda)+\alpha(\gamma-1)}$, Clearly $p^e = p^p$.

$p^p = \frac{a(2-\gamma)}{2} > p^a$ if $\frac{a(2-\gamma)}{2} > \frac{1}{2}\frac{a(2-\gamma)}{(2-\gamma)(1+\lambda)+\alpha(\gamma-1)}$ or

$(2-\gamma)(1+\lambda) + \alpha(\gamma-1) > 1$;

If $\alpha = 1$, the above implies $(2-\gamma)(1+\lambda) + \gamma - 2 = 2\lambda - \lambda\gamma > 0$ ■

Proposition 2 *(a)* $y^e \geq \{y^p; y^a\}$ *;(b)* $y^p > y^a$ *if* $\lambda > \frac{\gamma}{4(1-\gamma)+\gamma^2}$.

The activity under "efficient bargaining" is always larger than activity under "price bargaining" or under "activity bargaining". Activity under "price bargaining" may be higher or lower than activity under "activity bargaining". If the provider has all the bargaining power ($\gamma = 0$), then activity under "price bargaining" is always higher. If the purchaser has all the bargaining power ($\gamma = 1$), then the activity under "price bargaining" is lower than the activity under "activity bargaining" (we assume $\lambda < 1$). Suppose that $\lambda = 0.3$, then $y^p > y^a$ if $\gamma > 0.59$.

Proof. Recall that $y^e = \frac{a}{c}$, $y^p = \frac{a(2-\gamma)}{2c}$, $y^a = \frac{a}{c(2-\gamma)(1+\lambda)-\alpha c(1-\gamma)}$.

a) Notice that $y^e \geq y^p$ if $\frac{a}{c} \geq \frac{a(2-\gamma)}{2c}$ or $\gamma \geq 0$ which is always satisfied.

$y^e \geq y^a$ if $\frac{a}{c} \geq \frac{a}{c(2-\gamma)(1+\lambda)-\alpha c(1-\gamma)}$ or $(1-\gamma)(1+\lambda) + \lambda - \alpha(1-\gamma) \geq 0$.
If $\alpha = 1$, $(1-\gamma)(1+\lambda) + \lambda - (1-\gamma) = 2\lambda - \lambda\gamma > 0$

b) Compare y^p and y^a: $y^p > y^a$ if $\frac{a(2-\gamma)}{2c} > \frac{a}{c(2-\gamma)(1+\lambda)-\alpha c(1-\gamma)}$ or

$(2-\gamma)((2-\gamma)(1+\lambda) - \alpha(1-\gamma)) > 2$

If $\alpha = 1$, then $(2-\gamma)((2-\gamma)(1+\lambda) - (1-\gamma)) - 2 =$

$4\lambda - \gamma - 4\lambda\gamma + \lambda\gamma^2 > 0$ or $\lambda > \frac{\gamma}{4(1-\gamma)+\gamma^2}$. ■

Proposition 3 *$U^p \geq U^e > U^a$.*

Proof. *a) $U^p \geq U^e$ if $\frac{a^2(2-\gamma)^2}{8c} \geq \frac{a^2}{2c}(1-\gamma)$ or $\gamma^2 \geq 0$, which is always satisfied.*

b) $U^e > U^a$ if $\frac{a^2}{2c}(1-\gamma) > \frac{a^2}{2c}\frac{1-\gamma}{[(2-\gamma)(1+\lambda)-\alpha(1-\gamma)]^2}$ or

$[(2-\gamma)(1+\lambda) - \alpha(1-\gamma)]^2 > 1$ or $(2-\gamma)(1+\lambda) - \alpha(1-\gamma) > 1$ or

$(1-\gamma)(1+\lambda) + \lambda - \alpha(1-\gamma) > 0$, which is always satisfied.

If $\alpha = 1$, $(1-\gamma)(1+\lambda) + \lambda - (1-\gamma) = 2\lambda - \lambda\gamma > 0$. ■

The provider strictly prefers price bargaining over efficient bargaining. He also prefers efficient bargaining over activity bargaining. An interesting result is that the "efficient bargaining" equilibrium is not so efficient, in the sense that the provider is better off with price bargaining rather than activity bargaining (although activity is higher under activity bargaining, the price is the same and profits are higher).

Proposition 4 *(a) $V^e \geq V^p$; (b) $V^a > V^e$ if $\lambda < \frac{2(1-\gamma)}{\gamma(2-\gamma)}$; (c) $V^a \lesseqgtr V^p$.*

The utility of the purchaser is higher under "efficient bargaining" compared to "price bargaining". The utility under "activity bargaining" is higher only when the bargaining power of the provider is low. For example if $\lambda = 0.3$, then $V^a > V^e$ if $\gamma < 0.85$.

Proof. a) $V^e \geq V^p$ if $\frac{\gamma a^2}{2c} > \gamma \frac{a^2(2-\gamma)}{4c}$ if $\gamma > 0$, which is always the case.

b) $V^a \geq V^e$ if $\frac{a^2}{2c}\frac{4\lambda+\gamma-2\lambda\gamma}{(1+2\lambda-\lambda\gamma)^2} > \frac{\gamma a^2}{2c}$ or

$f(\lambda) = 4\lambda + \gamma - 2\lambda\gamma - \gamma(1+2\lambda-\lambda\gamma)^2 =$

$-\lambda^2\gamma^3 + 4\lambda^2\gamma^2 - 4\lambda^2\gamma + 2\lambda\gamma^2 - 6\lambda\gamma + 4\lambda > 0$, whose solution is: $\lambda = \left\{0, \frac{2(1-\gamma)}{\gamma(2-\gamma)}\right\}$. Notice that $f_\lambda(\frac{2(1-\gamma)}{\gamma(2-\gamma)}) = 2(\gamma-2)\left(\gamma + \frac{2(1-\gamma)}{\gamma(2-\gamma)}(2\gamma-\gamma^2) - 1\right) < 0$ for $0 < \gamma < 1$.

c) $V^a \geq V^p$if $\frac{a^2}{2c}\frac{4\lambda+\gamma-2\lambda\gamma}{(1+2\lambda-\lambda\gamma)^2} > \gamma\frac{a^2(2-\gamma)}{4c}$. ■

Proposition 5 *(a)* $W^a > \{W^e, W^p\}$; *(b)* $W^e > W^p$ *if* $\gamma > \frac{4\lambda}{1+2\lambda}$ *or* $\lambda < \frac{\gamma}{2(2-\gamma)}$.

Welfare is highest under "activity bargaining". Welfare under efficient bargaining is higher only for high bargaining power. For example if $\lambda = 0.3$ then $W^e > W^p$ if $\gamma > 0.75$.

Proof. a) $W^a > W^e$ if $\frac{a^2}{2c(1+2\lambda-\lambda\gamma)} > \frac{a^2}{2c}(1+\lambda\gamma-2\lambda)$ or $\frac{1}{1+2\lambda-\lambda\gamma} > (1+\lambda\gamma-2\lambda)$

$1-(1+\lambda\gamma-2\lambda)(1+2\lambda-\lambda\gamma) = \lambda^2\gamma^2 + 4\lambda^2(1-\gamma) > 0.$

b) $W^e > W^p$ if $\frac{a^2}{2c}(1+\lambda\gamma-2\lambda) > \frac{a^2(2-\gamma)}{8c}(\gamma(1+2\lambda)+2-4\lambda)$

or $4(1+\lambda\gamma-2\lambda) > (2-\gamma)(\gamma(1+2\lambda)+2-4\lambda)$

$4(1+\lambda\gamma-2\lambda) - (2-\gamma)(\gamma(1+2\lambda)+2-4\lambda) =$

$\gamma(\gamma-4\lambda+2\lambda\gamma)$. Solving we obtain $\gamma > \frac{4\lambda}{1+2\lambda}$ or $\lambda < \frac{\gamma}{2(2-\gamma)}$.

c) $W^a > W^p$ if $\frac{a^2}{2c(1+2\lambda-\lambda\gamma)} > \frac{a^2(2-\gamma)}{8c}(\gamma(1+2\lambda)+2-4\lambda)$

or $\frac{4}{(1+2\lambda-\lambda\gamma)} > (2-\gamma)(\gamma(1+2\lambda)+2-4\lambda)$

$4-(2-\gamma)(\gamma(1+2\lambda)+2-4\lambda)(1+2\lambda-\lambda\gamma) =$

$$-2\lambda^2\gamma^3 + 12\lambda^2\gamma^2 - 24\lambda^2\gamma + 16\lambda^2 - \lambda\gamma^3 + 4\lambda\gamma^2 - 4\lambda\gamma + \gamma^2 =$$
$$2\lambda^2\gamma^2 + 10\lambda^2 (1-\gamma)^2 + \gamma^2(1-\lambda\gamma) + 2\lambda^2 \left(1-\gamma^3\right) + 4(1-\gamma)\lambda^2 - 4(1-\gamma)\lambda\gamma.$$

■

In summary, welfare is highest and prices are lowest under "activity bargaining". Providers have higher utility under "price bargaining". Activity is highest under efficient bargaining.

Figure 2 below displays the possible outcomes under activity bargaining (y^a, p^a), price bargaining (y^a, p^a) and efficient bargaining for the case of constant marginal benefit. In each case the outcome depends on the bargaining power of the parties. Notice that under efficient bargaining the distribution of bargaining power changes the price, but has no effect on the level of activity.

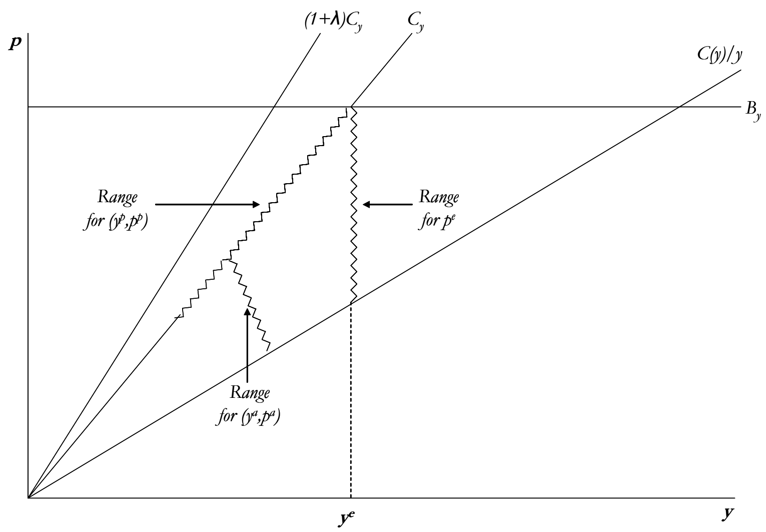


Figure 2

Figure 3 depicts the outcome in each regime (denoted by A, P, E) for given levels of bargaining power $\gamma = \{0, 0.5, 1\}$. Clearly, higher bargaining power of the purchaser reduces the price in all three regimes. The effect on activity, however, is different in each case. As noted above, under efficient bargaining the distribution of bargaining power has no effect on activity. Interestingly, under price bargaining the purchaser would prefer to reduce activity, while under activity bargaining he/she would prefer to increase it. The reason is that for any given bargaining power the price is always lower under activity bargaining compared to the other two regimes. Finally, notice that price bargaining and efficient bargaining yield the same outcome if $\gamma = 0$.

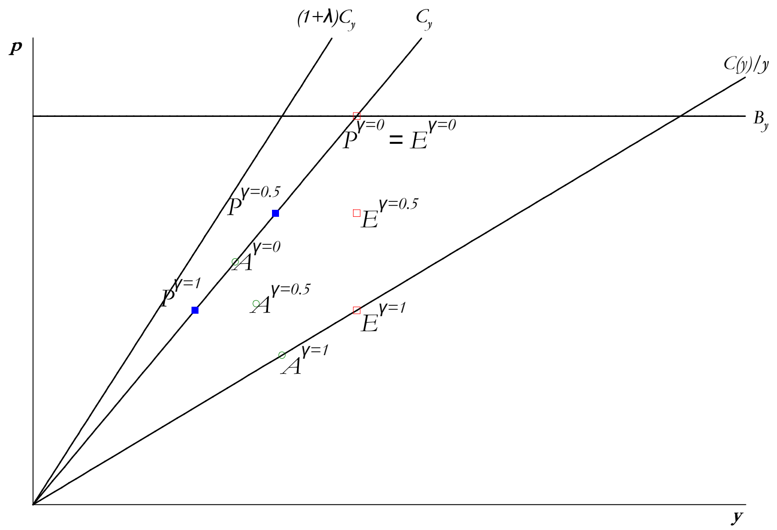


Figure 3

4 Adding quality and effort

In this section we extend the model by introducing quality and cost-containment effort. We follow the approach suggested by Ma (1994) and Chalkley and Malcomson (1998). Define q as the quality generated by the provider and e as the cost-containment effort.

The cost function of the provider is $C(y, q, e) + \varphi(y, q, e)$. C includes the monetary cost, which increases with quality and activity, but decreases with effort: $C(y, q, e), C_y > 0, C_q > 0$ and $C_e < 0$. φ includes then non-monetary cost φ, which is increasing in activity, quality and effort: $\varphi(y, q, e), \varphi_y > 0, \varphi_q > 0$ and $\varphi_e > 0$.

We also assume that the demand of treatment depends positively on quality so that $y = y(q)$ with $y_q > 0$. Notice that this assumption implies: $y = y(q) \Leftrightarrow q = q(y)$, $q_y > 0$. Therefore, by contracting activity, the purchaser can implicitly contract the level of quality.

The benefit function of the patients is $B = B(y, q)$ with $B_y > 0$ and $B_q > 0$. However, since quality is a positive function of activity, then we can also write $B = B(y, q(y))$ with $\frac{dB}{dy} = \frac{\partial B}{\partial y} + \frac{\partial B}{\partial q}\frac{\partial q}{\partial y} > 0$.

The provider's utility is given by the surplus:

$$U = py - C(y, q(y), e) - \varphi(y, q(y), e) \tag{16}$$

The purchaser's utility is:

$$V = B(y, q(y)) - py \tag{17}$$

The regulator's utility is:

$$B(y, q(y)) - (1 + \lambda)py + \alpha U \tag{18}$$

4.1 Activity bargaining

The timing is the following. At t=1 the regulator sets the price. At t=2 the purchaser and provider bargain on activity. At t=3 the provider chooses effort. We solve by backward induction.

Stage 3. For a given price and activity, the provider maximises U so that:

$$U_e = 0 : -C_e(y, q(y), e^*) = \varphi_e(y, q(y), e^*) \tag{19}$$

which determines the optimal effort for the hospital $e^* = e^*(y)$, and therefore allows us to obtain the indirect utility function of the provider $U(p, y, q(y), e^*(y)) = py - C(y, q(y), e^*(y)) - \varphi(y, q(y), e^*(y))$.

Stage 2. For a given price and anticipating the effect of activity on effort, the activity bargaining problem between purchaser and provider is:

$$\max_{y} \Omega = \left[V(p, y, q(y)) - \bar{V}\right]^{\gamma} \left[U(p, y, q(y), e^*(y)) - \bar{U}\right]^{1-\gamma}$$

whose FOC is:

$$y^a : \ \gamma \frac{B_y + B_q q_y - p}{V - \bar{V}} = (1-\gamma) \frac{C_y + \varphi_y + \left(C_q + \varphi_q\right) q_y - p}{U - \bar{U}}$$

The volume of activity is such that the difference between the marginal welfare and the price (weighted by the relevant factors) equals the difference between the marginal cost and the price (also weighted by the relevant factors). However, in this case it is necessary to take into account that quality affects the demand for services. Hence both welfare and cost are adjusted for the additional effect of quality.

The second order condition is:

$$\begin{aligned} \Gamma &\equiv \gamma \left[B_{yy} + B_q q_{yy}\right] U - (1-\gamma) \left[C_{yy} + \varphi_{yy} + \left(C_q + \varphi_q\right) q_{yy}\right] V \\ &+ \left[B_y + B_q q_y - p\right] \left[p - C_y - \varphi_y - \left(C_q + \varphi_q\right) q_y\right] < 0 \end{aligned}$$

The total differential with respect to y and γ yields: $\frac{dy}{d\gamma} = -\frac{V_y\left(U-\bar{U}\right)-U_y\left(V-\bar{V}\right)}{\Gamma} \lesseqgtr 0$. Hence, when the price is low, higher bargaining power for the purchaser increases activity, while when the price is high the effect is opposite (add effect on quality).

Stage 1. Anticipating the effect of prices on activity and effort, the regulator chooses price to maximise:

$$\max_p B(y(p), q(y(p))) - \alpha \left[\begin{array}{c} C(y(p), q(y(p)), e(y(p))) \\ +\varphi(y(p), q(y(p)), e(y(p))) \end{array} \right] - (1 + \lambda - \alpha)\, py(p) \tag{20}$$

The first order condition is:

$$p^a : \quad B_y y_p + B_q q_y y_p = (1 + \lambda - \alpha)(y + py_p) + \alpha \left(\begin{array}{c} C_y y_p + C_q q_y y_p + C_e e_y y_p \\ +\varphi_y y_p + \varphi_q q_y y_p + \varphi_e e_y y_p \end{array} \right) \tag{21}$$

4.2 Price bargaining

For a given price, the hospital maximises U with respect to activity and effort, so that:

$$U_y = 0 : \quad p = C_y + \varphi_y + \left(C_q + \varphi_q\right) q_y \tag{22}$$

$$U_e = 0 : \quad - C_e = \varphi_e \tag{23}$$

The hospital chooses to provide activity up to the point where the price equals the marginal cost, both monetary and non-monetary. The marginal cost also takes into account the indirect effect of activity through increased quality, which is captured by the last term in the RHS. The optimal effort is such that the marginal benefit of effort (given by the marginal reduction in cost) is equal to the marginal non-monetary cost.

Given the optimal choices of activity, quality and effort we may recover the indirect utility function of the hospital $U(p, y(p), q(y(p)), e(p))$, which we will then use in order to solve the price bargaining between the purchaser and the provider. Notice that $\frac{dy}{dp} = \frac{p+U_{ey}}{-U_{yy}} > 0$, $\frac{de}{dp} = \frac{U_{ey}}{-U_{ee}} \gtrless 0$ and $\frac{dU}{dp} = y$ (using the envelope theorem). The price bargaining problem is given by:

$$\max_p \Omega = \begin{bmatrix} B(y(p), q(y(p)))- \\ py(p) - \bar{V} \end{bmatrix}^{\gamma} \begin{bmatrix} py(p) - C(y(p), q(y(p)), e(p))- \\ \varphi(y(p), q(y(p)), e(p)) - \bar{U} \end{bmatrix}^{1-\gamma}. \quad (24)$$

p^p is such that:

$$\gamma \frac{(B_y + B_q q_y) y_p}{V} + (1-\gamma) \frac{y}{U} = \gamma \frac{y + p y_p}{V} \quad (25)$$

4.3 Bargaining on activity and prices (efficient bargain)

For a given activity and price, the supplier chooses a level of cost-containment effort which maximises the surplus: $U = py - C(y, q(y), e) - \varphi(y, q(y), e)$, which yields the following first-order condition:

$$U_e = 0 : -C_e = \varphi_e. \quad (26)$$

Equation (26) determines the hospital's optimal choice of effort for a given activity ($e^*(y,p)$).

In the first stage the parties bargain on price and activity, anticipating the effect of activity and price on optimal effort. The bargaining problem is:

$$\max_{p,y} \Omega = \left[B(y, q(y)) - py - \bar{V}\right]^{\gamma} \left[py - C(y, q(y), e^*(y)) - \varphi(y, q(y), e^*(y)) - \bar{U}\right]^{1-\gamma} \quad (27)$$

$$p^e = (1-\gamma) \frac{B - \bar{V}}{y} + \gamma \frac{C + \varphi + \bar{U}}{y} \quad (28)$$

$$y^e \text{ is such that } B_y + B_q q_y = C_y + \varphi_y + q_y \left(C_q + \varphi_q\right) \quad (29)$$

The price equals the weighted sum of the average welfare and the provider's average cost (including non-monetary costs). The optimal activity balances the purchaser's marginal welfare gain against the provider's marginal cost reduction.

5 Conclusions

We have analysed and compared three different regulatory settings: a) the regulator sets the price but the activity is bargained between the purchaser (a health authority) and the provider (activity bargaining); b) price is bargained between the purchaser and the provider, activity is chosen by the provider (price bargaining); c) price and activity are bargained between the purchaser and the provider (efficient bargaining).

The main results are the following. Welfare is highest and prices are lowest under "activity bargaining". Providers have higher utility under "price bargaining". Activity is highest under efficient bargaining.

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7 Appendix

Bargaining on activity.

$$p^a = \frac{1}{2}\frac{a(2-\gamma)}{1+2\lambda-\lambda\gamma};\ y^a = \frac{a}{c\,(1+2\lambda-\lambda\gamma)} \tag{30}$$

$$V^a = \frac{a^2}{2c}\frac{4\lambda+\gamma-2\lambda\gamma}{(1+2\lambda-\lambda\gamma)^2};\ U^a = \frac{a^2}{2c}\frac{1-\gamma}{(1+2\lambda-\lambda\gamma)^2} \tag{31}$$

$$W^a = \frac{a^2}{2c\,(1+2\lambda-\lambda\gamma)} \tag{32}$$

Proof. The rule determining activity is, for a given price: $\gamma\frac{a-p}{(a-p)y} + (1-\gamma)\frac{p-cy}{(p-\frac{c}{2}y)y} = 0$, from which $y = \frac{2p}{c(2-\gamma)}$. The FOC for price is: $\left(a - \alpha c\frac{2p}{c(2-\gamma)}\right)\frac{2}{c(2-\gamma)} - (1+\lambda-\alpha)\frac{4p}{c(2-\gamma)} = 0$, from which: $p^a = \frac{a}{2(1-\alpha+\lambda)+\frac{2\alpha}{2-\gamma}}$. The bargained activity is therefore: $y^a = \frac{a}{c(2-\gamma)(1+\lambda)-\alpha c(1-\gamma)}$. The utility of the purchaser and the provider are: $V = (a-p)\,y = \frac{a^2}{2c}\frac{(2-\gamma)(2\lambda+1)-2\alpha(1-\gamma)}{[(2-\gamma)(1+\lambda)-\alpha(1-\gamma)]^2}$ and $U = \left(p - \frac{c}{2}y\right)y = \frac{a^2}{2c}\frac{1-\gamma}{[(2-\gamma)(1+\lambda)-\alpha(1-\gamma)]^2}$. ■

Bargaining on price.

$$p^p = \frac{a(2-\gamma)}{2}, y^p = \frac{a(2-\gamma)}{2c}, V^p = \gamma\frac{a^2(2-\gamma)}{4c}, U^p = \frac{a^2(2-\gamma)^2}{8c} \tag{33}$$

$$W^p = \frac{a^2(2-\gamma)}{8c}\left(\gamma\left(1+2\lambda\right)+2-4\lambda\right) \tag{34}$$

Proof. Since $y = \frac{p}{c}$ with $y_p = \frac{1}{c}$, the FOC for the bargained price is: $\gamma\frac{(a-p)\frac{1}{c}-\frac{p}{c}}{\frac{ap}{c}-\frac{p^2}{c}} + (1-\gamma)\frac{\frac{p}{c}}{\frac{p^2}{c}-\frac{p^2}{2c}} = 0$, which gives: $p = \frac{a(2-\gamma)}{2}$. Hence $y^p = \frac{a(2-\gamma)}{2c}$, $V = (a-p)\,y = \gamma\frac{a^2(2-\gamma)}{4c}$ and $U = \left(p - \frac{c}{2}y\right)y = \frac{a^2(2-\gamma)^2}{8c}$. ■

Efficient bargaining.

$$p^e = \frac{a\,(2-\gamma)}{2}, y^e = \frac{a}{c}, V^e = \frac{\gamma a^2}{2c}, U^e = \frac{a^2}{2c}\left(1-\gamma\right) \tag{35}$$

$$W^e = \frac{a^2}{2c}\left(2+\lambda\gamma-2\lambda\right) \tag{36}$$

Proof. The FOC with respect to price implies: $p = (1-\gamma)\,a + \gamma\frac{c}{2}y$. The FOC with respect to activity implies: $y = \frac{a}{c}$.Therefore $p = \frac{a(2-\gamma)}{2}$ and $V = (a-p)\,y = \frac{\gamma a^2}{2c}$ and $U = \left(p-\frac{c}{2}y\right)y = \frac{a^2}{2c}\left(1-\gamma\right)$. $W = ay - (1+\lambda)py + U = a\frac{a}{c} - (1+\lambda)\frac{a(2-\gamma)}{2}\frac{a}{c} + \frac{a^2}{2c}\left(1-\gamma\right) = \frac{a^2}{2c}\left(1+\lambda\gamma-2\lambda\right)$. ■