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Bargaining and the Provision of Health Services

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Abstract

We model and compare the bargaining process between a purchaser of health services, such as a health authority, and a provider (the hospital) in three plausible scenarios: a) the purchaser sets the price, and activity is bargained between the purchaser and the provider: *activity* bargaining; b) the price is bargained between the purchaser and the provider, but activity is chosen unilaterally by the provider: *price* bargaining; c) price and activity are simultaneously bargained between the purchaser and the provider: *efficient* bargaining. We show that: 1) if the bargaining power of the purchaser is high (low), *efficient* bargaining leads to higher (lower) activity and purchaser's utility, and lower (higher) prices and provider's utility compared to *price* bargaining. 2) In *activity* bargaining, prices are lowest, the purchaser's utility is highest and the provider's utility is lowest; activity is generally lowest, but higher than in price bargaining for high bargaining power of the purchaser. 3) If the purchaser has higher bargaining power, this reduces

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prices and activity in *price* bargaining, it reduces prices but increases activity in *activity* bargaining, and it reduces prices but has no effect on activity in *efficient* bargaining.

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1 Introduction

Prospective payment systems are used widely to remunerate health care providers. They usually take the form of Diagnosis Related Groups (DRGs) pricing or similar methods, such as Healthcare Resource Groups (HRGs) in the United Kingdom or Group Homogenes de Maladie (GMC) in France. Depending on the institutional context, purchasers and providers bargain on price, activity, or both. For example, in the US, Health care Maintenance Organisations (HMOs) or private health insurers bargain on price, and seldom activity, with the hospitals (Barros and Martinez-Giralt, 2006; Brooks, Dor and Wong, 1997). In the UK, Health Authorities and Primary Care Trusts have been negotiating price and activity with NHS Trusts under "cost and volume" or "sophisticated" contracts. The government has recently implemented a policy known as "Payment by Results", where prices are regulated, but activity is negotiated between the Primary Care Trust and the NHS Trust. Within the Medicare Programme in the US, prices are chosen by the purchaser (Medicare), while activity is either chosen or bargained with the provider. Similar arrangements exist throughout Europe (Figueras et al., 2005, p. 243-245; Le Grand and Mossialos, 1999, ch.1).

Although we observe a substantial amount of bargaining between purchasers and providers, the theoretical literature on the relative merits of prospective payment systems normally assumes that payers are able to set the prices, and often activity, unilaterally, while providers choose the amount of quality and cost-containment effort (see, for example, Ma, 1994; Chalkley and Malcomson, 1998a and 1998b; Mougeot and Haegelen, 2005; De Fraja, 2000). This implies that purchasers have all the bargaining power, which is a simplifying assumption, as the empirical evidence suggests that providers may hold at least some of it. Propper (1996) shows that in England purchasers with higher bargaining power could secure lower prices. Brooks, Dor and Wong (1997) estimate that US hospitals hold on average 65% of the bargaining power when negotiating with private insurers. Melnick et al (1992) find a negative association between purchasers with greater market shares and prices charged by the providers.

This study models the bargaining process between a purchaser of health services (a health authority) and a provider (a hospital) in three plausible institutional settings: a) the purchaser sets the price (stage 1), and the activity is bargained between the purchaser and the provider (stage 2): *activity* bargaining; b) the price is bargained between the purchaser and the provider (stage 1), and the activity is chosen unilaterally by the provider (stage 2): *price* bargaining; c) price and activity are bargained simultaneously between the purchaser and the provider: *efficient* bargaining.

The first two models (activity and price bargaining) are two-stage models. For both models prices are decided before activity takes place. This is a reasonable assumption. Prices are normally set at the beginning of each financial year, before the hospitals start to treat the patients. In the third model (efficient bargaining), both prices and activity are decided at the beginning of the financial year, and the model has then one stage only.

Our main objective is to compare prices, activity and the utility of provider and purchaser in each of the three different institutional settings. We obtain three main results.

1) First, if the bargaining power of the purchaser is higher than a certain threshold and the marginal benefit of activity is strictly decreasing, *efficient* bargaining leads to higher activity and lower prices compared to *price* bargaining. As a consequence, the purchaser's utility is higher under *efficient*

bargaining than under *price* bargaining, while provider's utility is lower. The results are reversed if the bargaining power of the purchaser is below a certain threshold: the activity is higher and the price are lower under *price* bargaining rather than *efficient* bargaining. Therefore, the purchaser's utility is higher under *price* bargaining than under *efficient* bargaining, while provider's utility is lower.

This result is surprising, as one would expect the purchaser to be better off when she can bargain with both instruments, price and activity. This intuition proves correct only when the bargaining power of the purchaser is high. When it is low, the purchaser would be better off contracting on prices only: having more instruments is not useful, and actually is counter-productive. This is because when the bargaining power of the purchaser is very low, the provider will bargain a very high price, which under *price* bargaining will be accompanied by a large volume of activity. In contrast the level of activity under *efficient* bargaining is always determined such that the marginal benefit of quantity is equal to the marginal cost, regardless of the price: therefore under efficient bargaining when the purchaser is weaker, she will pay a higher price without obtaining any extra activity.

Interestingly, the threshold level of bargaining power of the purchaser over which the purchaser is better off, depends critically on the shape of the marginal benefit curve. The threshold is higher when the marginal benefit function is steeper (ie the benefit function is more concave) and when the marginal cost function is flatter (ie the cost function is less convex).

Also, the threshold is strictly positive only when the marginal benefit of activity is decreasing: if the marginal benefit is constant (and equal to the average benefit), the purchaser is always better off regardless of its bargaining power (the threshold is zero in this case). Intuitively, this arises because if the marginal benefit is constant, activity is always higher under *efficient* bargaining than under *price* bargaining, while the price is the same.

Activity under *efficient* bargaining is always determined such that the marginal benefit is equal to the marginal cost. If the marginal benefit is strictly decreasing and the purchaser has low bargaining power, activity under *price* bargaining can be such that the marginal benefit is below the marginal cost but the average benefit is above the price, so that the purchaser's utility is positive. If the marginal (and average) benefit is constant, and the marginal benefit is below the cost, then the average benefit will be below the price, which implies a negative utility of the purchaser, which can never arise (as under Nash Bargaining both parties always end up with positive utilities). Therefore, the activity under price bargaining will be always lower than under efficient bargaining if the marginal benefit is constant.

2) Our second main result is that under *activity* bargaining, price and the provider's utility are lowest and the purchaser's utility is highest. The level of activity in *activity* bargaining is always lower than in *efficient* bargaining. It is also lower than in *price* bargaining, but only if the bargaining power of the purchaser is below a certain value (which, according to our numerical simulations is at least 0.59). If the bargaining power of the purchaser is high, then the level of activity is higher under activity bargaining than under price bargaining.

Even if activity is generally lower under *activity* bargaining, the lower price more than compensates for the reduction in the benefit for the patients from the lower activity, so that the purchaser is overall better off. The analysis therefore supports policies such as "payment by results" in the UK, where prices are fixed by the purchaser or the regulator.

One less intuitive implication of our results is that by shifting from *ef-*

ficient and *price* bargaining (as in "cost and volume" or "sophisticated" contracts) to *activity* bargaining (as in "payment by results"), the level of activity is likely to decrease. This is in contrast to what is normally thought, ie that "payment by results" will encourage activity. However, our results are consistent with recent empirical evidence (Farrar et al., 2006) which finds that the introduction of "payment by results" in 2003-2005 generally did not lead to any subsequent significant increase in the volume of activity in England.

3) Our third result is that under *price* bargaining, higher bargaining power of the purchaser reduces prices and activity; in *activity* bargaining it reduces prices, but increases activity; and in *efficient* bargaining it reduces prices but has no effect on activity. Therefore, when the bargaining power of the purchaser increases, price and activity are positive correlated under price bargaining, negatively correlated under activity bargaining; have no correlation under efficient bargaining.

The intuition for these results is the following. Under *price* bargaining, the optimal activity is chosen by the provider such that the price is equal to the marginal cost. Therefore, whenever the price increases, as a result of a stronger purchaser, activity follows. Under *efficient* bargaining, the optimal activity is such that it maximises the sum of the purchaser and provider utility. Since purchaser's utility is given by the benefit minus the transfer to the provider, while provider's utility is given by the transfer minus the cost, this is equivalent to maximise the difference between benefit and cost. The optimal activity is chosen such that the marginal benefit is equal to the marginal cost of activity, regardless of the bargaining power. Therefore, a stronger purchaser will obtain a lower price but not a lower activity, so that the correlation between activity and price is zero. Under *activity* bargaining, a stronger purchaser is able to agree with the provider a higher volume of activity for a given price; if the marginal benefit of activity is decreasing, the higher agreed activity reduces the marginal benefit for the purchaser from fixing a higher price, so that the price is lower and activity is higher when the purchaser is stronger.

The above results are derived in sections 2 and 3 and focus on price and activity only. In Section 4 we extend the analysis by adding quality and cost-containment effort as choice variables of the provider. This makes activity bargaining a three-stage model, and efficient and price bargaining a two-stage model. Cost-containment effort is always decided by the provider in the last stage of the game, as realistically, effort takes place after the negotiation stage, which is at the beginning of the financial year. We assume that demand responds positively to quality. Therefore, the quality decisions always happen when decisions on activity take place. This is because by committing or deciding on a certain level of activity, indirectly the provider commits as well to a certain level of quality.

We show that under this more general setting, the main results of the analysis in terms of regime comparison still hold. The only difference is that the marginal cost is now interpreted as the marginal cost and disutility of activity *and* quality; similarly, the marginal benefit includes the marginal benefit of activity *and* quality. For what concerns cost-containment effort, since the provider is residual claimant in the three different settings, effort is always set such that marginal benefit from lower cost is equal to the marginal disutility of effort, regardless of the institutional setting. Therefore, adding effort to the analysis does not alter the main results.

This study contributes to the literature on purchaser-provider bargaining in healthcare (for a recent survey see Barros and Martinez-Giralt, 2006).

Ellis and McGuire (1990) develop a model in which patients and doctors bargain about the intensity of treatment, and derive the optimal combination of patient's insurance and reimbursement for the provider which maximises consumer welfare.[1] Barros and Martinez-Giralt (2005a) show that, when bargaining with providers, purchasers may prefer to bargain with a professional association rather than a subset of more efficient providers. Barros and Martinez-Giralt (2000) analyse the bargaining process, in which the purchaser can choose whether to negotiate with each provider separately or jointly, or announce a contract that any provider is free to sign (the "any willing provider" clause). They show that if the total surplus is high, the purchaser prefers the system of "any willing provider", but if it is low she prefers either joint or separate negotiations. Gal-Or (1997) shows that purchasers (private insurers) might be willing to sign exclusive contracts with a subset of providers in order to secure more favourable terms during bargaining. Gal-Or (1999a) studies whether vertical mergers between hospitals and physician practices might enhance their bargaining power with the insurers (see also Gal-Or, 1999b). Barros and Martinez-Giralt (2005b) explore the implications of the coexistence of a public and a private sector in the provision of health services. They argue that the public sector might choose to hold idle capacity in order to extract more beneficial conditions when bargaining with the private sector for the provision of services. There are other applications of bargaining in the health economics literature. Clark (1995) examines how to divide a budget between two patients with different health conditions and capacity to benefit. Pecorino (2002) models the effects of drug reimports from Canada on the profitability of US domestic

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

pharmaceutical companies.[2]

The study is organised as follows. Section 2 presents the model. Section 3 provides a comparison of the different scenarios. Section 4 extends the model by adding quality and cost-containment effort. Section 5 offers concluding remarks and policy implications.

2 The model

We model the bargaining process between a purchaser of health services, such as a health authority, and a provider (a hospital). Define y as the number of patients treated and p as the price the provider receives for each patient treated. The provider's utility U is given by its surplus $U(p, y) = py - C(y)$, 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 for the patients $B(y)$ and the transfer to the provider: $V(p, y) = B(y) - py$. The benefit function satisfies $B_y > 0$ and $B_{yy} \leq 0$.[3]

We analyse three plausible scenarios. 1) *Activity* bargaining: the purchaser sets the price (stage 1), and activity is bargained between the purchaser and the provider (stage 2). 2) *Price* bargaining: the price is bargained

[2] See also Wright (2004) for a model of price regulation in the pharmaceutical sector where the regulator and the pharmaceutical company bargain over a subsidy.

[3] A more general objective function for the purchaser is $B(y) - (1 + \lambda)py + \delta U$, where λ is the opportunity cost of public funds and δ is the weight attached to the utility of the provider. The main results of the analysis with this more general specification would be qualitatively similar as long as either $\lambda > 0$ or $\delta < 1$. We therefore focus on the special case where $\lambda = \delta = 0$.

between the purchaser and the provider (stage 1), but activity is chosen by the provider (stage 2). 3) *Efficient* bargaining: price and activity are bargained simultaneously between the purchaser and the provider.

Define γ, with $0 \leq \gamma \leq 1$, as the bargaining power of the purchaser, $(1-\gamma)$ as the bargaining power of the provider, $\overline{V}$ and $\overline{U}$ as the outside options for the purchaser and the provider respectively, and $\widetilde{V} = V - \overline{V}$ and $\widetilde{U} = U - \overline{U}$. For notational simplicity let $V^i = V(p^i, y^i), U^i = U(p^i, y^i)$, where $i = a, p, e$ denotes respectively activity, price and efficient bargaining. In all the sections below we use Nash bargaining to solve for optimal conditions (Nash, 1950, 1953; Kalai, 1977; Osborne and Rubinstein, 1990).[4]

2.1 Activity bargaining

In the first scenario, we assume that first the purchaser chooses the price (stage 1), then the purchaser and the provider bargain on activity (stage 2).[5] We solve by backward induction. For a given price p, the bargained activity can be determined by solving:

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

The First Order Condition (FOC) is:

$$y^a: \quad \frac{\gamma}{\widetilde{V}}\left(B_y - p\right) = \frac{1-\gamma}{\widetilde{U}}\left(C_y - p\right) \tag{2}$$

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

[5] A different interpretation is that the Department of Health fixes the price, then the Health Authority and provider bargain on activity. The implicit assumption is that the Department of Health and the Health Authority share the same objective function.

(See appendix 7.1 for proof). To interpret the optimal condition on the bargained activity it is useful to distinguish two cases, low price and high price (see Figure 1). 1) If the exogenous price p is low ($B_y(y^a) > p$ and $C_y(y^a) > p$), the desired activity for the purchaser is *higher* than the desired activity for the provider. The bargained activity lies somewhere between the desired activity of the two parties. The LHS of Eq.(2) is the net marginal benefit of activity for the purchaser, weighted by her utility and her bargaining power. The RHS is the net marginal cost for the provider, also weighted by his utility and his bargaining power. 2) If the exogenous price p is high ($p > B_y(y^a)$ and $p > C_y(y^a)$), the desired activity for the purchaser is *lower* than the desired activity for the provider. The FOC can be rewritten as $\frac{\gamma}{\widetilde{V}}(p - B_y) = \frac{1-\gamma}{\widetilde{U}}(p - C_y)$. Again, the bargained activity lies between the desired activity of the two parties.

Figure 1 illustrates different bargained activity levels ($y^a(p)$) for three different values of the bargaining power of the purchaser, equal to 0.3, 0.5 and 0.7 respectively. In equilibrium it is always the case that $\widetilde{U} \geq 0$ and $\widetilde{V} \geq 0$, so that the equilibrium lies in the area between the average and marginal benefit, and the area between the average and marginal cost.

[Figure 1]

Finally if $p = B_y(y^a) = C_y(y^a)$ (i.e. where the marginal benefit curve crosses the marginal cost curve), there is no disagreement between purchaser and provider, so that y^a is such that $B_y = C_y$.

By differentiating Eq.(2) with respect to γ we obtain $\frac{\partial y^a}{\partial \gamma} = \frac{(B_y - p)\widetilde{U} - (p - C_y)\widetilde{V}}{\widetilde{V}\widetilde{U}(-\Gamma)}$. If the price is low, a higher bargaining power of the purchaser increases activity ($\frac{\partial y^a}{\partial \gamma} > 0$). If the price is high it reduces activity ($\frac{\partial y^a}{\partial \gamma} < 0$).

The effect of a change of price on activity is:

$$\frac{\partial y^a}{\partial p} = \frac{1}{-\Gamma}\left((1-\gamma)\frac{C_y - C/y}{\widetilde{U}^2} - \gamma\frac{B/y - B_y}{\widetilde{V}^2}\right) \tag{3}$$

which in general is indeterminate. According to our assumptions, it is always the case that $C_y > C/y$ and $B/y > B_y$, since the marginal cost is higher than the average cost, and the average benefit is higher than the marginal benefit. For low levels of p the provider utility $\widetilde{U}$ is low (and the purchaser utility $\widetilde{V}$ is high) so that $\frac{\partial y^a}{\partial p} > 0$. Similarly, for high levels of p the purchaser utility $\widetilde{V}$ is low (and the provider utility $\widetilde{U}$ is high) so that $\frac{\partial y^a}{\partial p} < 0$ for low p. This result is consistent with the example shown in Figure 1.

The above analysis holds for a given price. The purchaser chooses the price to maximize:

$$\max_p \; B(y^a(p)) - py^a(p) \tag{4}$$

The FOC is:

$$p^a: \quad B_y y_p = y + p y_p \tag{5}$$

The optimal price is determined such that the marginal benefit of higher activity equals the marginal cost. The SOC is: $B_{yy}y_p^2 + B_y y_{pp} - 2y_p - py_{pp}$. Dividing both terms of Eq.(5) by y_p, straightforward manipulations lead to

$$p^a: \quad B_y = p\left(1 + \frac{1}{\epsilon_p^y}\right)$$

where $\epsilon_p^y = y_p p/y$ is the elasticity of activity with respect to price. The optimal price is such that the marginal benefit from activity is equal to the price, weighted by inverse of the elasticity of activity with respect to price: a higher elasticity implies a lower marginal cost from an increase in price, as intuitive.

2.2 Price bargaining

In the second scenario, we assume that first the purchaser and the provider bargain on price (stage 1), then the activity is chosen unilaterally by the provider (stage 2).[6] By backward induction, for a given price the hospital chooses the level of activity, which maximises $U = py - C(y)$, leading to the FOC:

$$y^p : \qquad p = C_y \tag{6}$$

with $\frac{\partial y^p}{\partial p} = \frac{1}{C_{yy}} > 0$ and $\frac{\partial^2 y^p}{\partial p^2} = 0$ (the SOC is $-C_{yy} < 0$). The bargained price can be determined by solving:

$$\max_p \; \left[B(y^p(p)) - py^p(p) - \overline{V}\right]^{\gamma} \left[py^p(p) - C(y^p(p)) - \overline{U}\right]^{1-\gamma} \tag{7}$$

Thanks to the envelope theorem, $U_p = y^p(p)$. The FOC for the bargained price is:

$$p^p : \quad \frac{\gamma}{\widetilde{V}} B_y y_p + \frac{(1-\gamma)}{\widetilde{U}} y = \gamma \frac{y + py_p}{\widetilde{V}} \tag{8}$$

(See appendix 7.1 for proof). The LHS of Eq.(8) is the marginal benefit of a higher price, and includes the marginal benefit for the purchaser of higher activity (weighted by her bargaining power, her utility and the responsiveness of supply) and the marginal benefit for the provider of a higher surplus (also weighted by his bargaining power and utility). The RHS is the marginal cost for the purchaser of a higher price and overall transfer (also weighted).

If the purchaser holds all the bargaining power ($\gamma = 1$), the optimal price is such that: $B_y y_p = y + py_p$. If the provider holds all the bargaining power

[6] This setup is analogous to the model of bargaining between a firm and a union over wage and employment (McDonald and Solow, 1981; Manning, 1987), where the firm sets the employment, but the wage is bargained with the union.

($\gamma = 0$), the optimal price is the highest possible compatible with the purchaser having a non-negative utility. The bargained price is an intermediate level between these two extremes.

2.3 Efficient bargaining

In the third scenario, purchaser and provider bargain simultaneously on activity *and* price. This setting is called *efficient* bargaining, because it reduces the potential for unexplored opportunities from mutual gain.[7] The bargaining problem is:

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

After obtaining the FOCs and rearranging, we obtain:

$$y^e : \; B_y = C_y \tag{10}$$

$$p^e = (1-\gamma)\frac{B(y^e) - \overline{V}}{y^e} + \gamma\frac{C(y^e) + \overline{U}}{y^e} \tag{11}$$

(See appendix 7.1 for proof). The negotiated level of activity maximises the sum of the surplus for the purchaser and for the provider $U + V = B(y) - C(y)$. In this respect the level of activity is *efficient*. The optimal price is a weighted average of the average cost of the provider and the average benefit for the patients.[8] If the purchaser holds all the bargaining power ($\gamma = 1$), the price is equal to the average cost: the purchaser extracts all the

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

[8] This result is in line with the model of employment-wage bargaining analysed by Manning (1987) in the context of firm-union negotiations. The level of employment does not depend on the payoffs of firm and union. Consequently, they "can agree on this level and then bargain about the distribution of the rents" (Manning, 1987, p.131).

surplus from the provider. If the provider holds all the bargaining power ($\gamma = 0$), the price is equal to the average benefit: the provider extracts all the surplus from the purchaser.

3 Regime comparison

3.1 Constant marginal benefit

To gain some insights into how the different scenarios relate to each other, we consider the following functional forms: a) the benefit function is linear in activity: $B(y) = ay$; 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 ($\overline{V} = \overline{U} = 0$).

The equilibrium for the three scenarios is reported in Table 1 (See appendix 7.2 for proof).

Table 1. Equilibrium with constant marginal benefit

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

The following proposition compares prices, activity and utility under different regimes.

Proposition 1 *(a)* $p^e = p^p \geq p^a$*; (b)* $y^e \geq \{y^p; y^a\}$*,* $y^p \geq y^a$ *if* $\gamma \leq 0.59$*; (c)* $V^a \geq V^e \geq V^p$*; (d)* $U^p \geq U^e \geq U^a$*.*

(See appendix 7.2 for proof). The price in *efficient* bargaining is equal to the price in *price* bargaining, which is higher than or equal to the price in *activity* bargaining. The activity in *efficient* bargaining is the highest. The activity in *price* bargaining is higher than in *activity* bargaining when the bargaining power of the purchaser is below 0.59.

The purchaser weakly prefers *activity* bargaining to *efficient* bargaining, and *efficient* bargaining to *price* bargaining. The provider weakly prefers *price* bargaining to *efficient* bargaining, and prefers *efficient* bargaining to *activity* bargaining.

In summary, the purchaser is better off in activity bargaining and the provider is better off in price bargaining. Activity is highest in efficient bargaining and prices are highest in efficient or price bargaining.

Figure 2 below displays the solution under different regimes. An arrow indicates increasing bargaining power of the purchaser. In *efficient* bargaining, a higher bargaining power of the purchaser reduces prices but has no effect on the level of activity. In *activity* bargaining, higher bargaining power of the purchaser induces higher activity, but has no effect on prices. In *price* bargaining, higher bargaining power of the purchaser reduces both prices and activity.

Interestingly, the solution in price bargaining, where the purchaser holds all the bargaining power, coincides with the solution in activity bargaining, where the provider has all the bargaining power (point A). The solutions in price and efficient bargaining coincide when the provider holds all the bargaining power (point B). The solutions in activity and efficient bargaining coincide when the purchaser holds all the bargaining power (point C). Finally, the activity in *price* bargaining is higher than in *activity* bargaining only for low bargaining power of the purchaser.

Figure 2 also compares the solution when both parties have the same bargaining power ($\gamma = 0.5$). Prices are higher in *efficient* and *price* bargaining (points $E^{\gamma=0.5}$ and $P^{\gamma=0.5}$ respectively). Activity is highest in efficient bargaining and lowest in activity bargaining (point $A^{\gamma=0.5}$).

[Figure 2]

3.2 Decreasing marginal benefit

We extend the previous analysis, and assume a more general specification of the benefit function: $B(y) = ay - \frac{b}{2}y^2$, with decreasing marginal benefit, while we maintain the other assumptions: $C(y) = \frac{c}{2}y^2$, $\overline{V} = \overline{U} = 0$. Table 2 reports the solution in *price* and *efficient* bargaining. Proofs are in the appendix 7.3. The solution for *activity* bargaining is more involved, and is derived separately in section 3.2.1.

Table 2. Equilibrium with decreasing marginal benefit

Price bargaining	Efficient bargaining
$p^p = \frac{ac(2-\gamma)}{b+2c}$	$p^e = \frac{a((1-\gamma)b+(2-\gamma)c)}{2(b+c)}$
$y^p = \frac{a(2-\gamma)}{b+2c}$	$y^e = \frac{a}{b+c}$
$V^p = \frac{\gamma a^2(2-\gamma)}{2(b+2c)}$	$V^e = \frac{\gamma a^2}{2(b+c)}$
$U^p = \frac{a^2c(2-\gamma)^2}{2(b+2c)^2}$	$U^e = \frac{(1-\gamma)a^2}{2(b+c)}$

The following proposition compares the two regimes.

Proposition 2 *If $\gamma > \frac{b}{b+c}$, then (a) $p^p > p^e$, (b) $y^e > y^p$, (c) $U^p > U^e$, (d) $V^e > V^p$.*

If the bargaining power of the purchaser is sufficiently high ($\gamma > \frac{b}{b+c}$) prices are higher in *price* bargaining, activity is lower, the provider is better off and the purchaser is worse off than under *efficient* bargaining. If the bargaining power of the purchaser is sufficiently low ($\gamma < \frac{b}{b+c}$) all the results are reversed. The threshold $\frac{b}{b+c}$ increases with b and decreases with c. Note that if $b = 0$ we are back to the results of proposition 1. Therefore, if the purchaser has low bargaining power, *efficient* bargaining yields a lower utility for the purchaser than in *price* bargaining. This is a surprising result: we would expect the purchaser to be better off when she can bargain with more instruments, ie both prices and activity. But this holds true only if her bargaining power is high. If her bargaining power is low, having more instruments is counterproductive. The purchaser is better off when she cannot bargain on activity.

Figure 3 below displays the solution under the two regimes. The solutions in efficient and price bargaining are depicted by line BC and AD respectively. An arrow indicates increasing bargaining power of the purchaser. As before, in *efficient* bargaining activity is constant, irrespective of the distribution of bargaining power, and the price decreases as the bargaining power of the purchaser increases. In *price* bargaining, both prices and activity decrease as the bargaining power of the purchaser increases.

It is useful to compare these results with those obtained in the previous section by assuming constant marginal benefit. When the bargaining power of the purchaser is low, the activity in *efficient* bargaining is lower than in *price* bargaining but with constant marginal benefit it is always higher.

If the marginal benefit is constant (and equal to the average benefit), the purchaser is always better off regardless of its bargaining power, because activity is always higher under *efficient* bargaining than under *price* bargaining, while the price is the same. Activity under *efficient* bargaining is always determined such that the marginal benefit is equal to the marginal cost. If the marginal benefit is strictly decreasing and the purchaser has low bargaining power, activity under *price* bargaining can be such that the marginal benefit is below the marginal cost (so that activity is higher than under efficient bargaining) but the average benefit is above the price, so that the purchaser's utility is positive. If the marginal (and average) benefit is constant, and the marginal benefit is below the cost, then the average benefit will be below the price, which implies a negative utility of the purchaser, which can never arise under Nash Bargaining as both parties always have positive utilities in equilibrium. Therefore, the activity under price bargaining will be always lower than under efficient bargaining if the marginal benefit is constant.

[Figure 3]

3.2.1 Decreasing marginal benefit and activity bargaining

In this section we derive the solution in activity bargaining. For a given price, the optimal bargained activity is:

$$y^a(p) = \frac{\left(\frac{2-\gamma}{2}c(a-p) + bp\frac{1+\gamma}{2}\right) - \sqrt{\left(\frac{2-\gamma}{2}c(a-p) + bp\frac{1+\gamma}{2}\right)^2 - 2bcp(a-p)}}{bc} \quad (12)$$

See appendix 7.4 for the proof. The optimal price is given by the price which maximises $V = ay^a(p) - \frac{b}{2}y^a(p)^2 - py^a(p)$. Given the complexity of the solution, it is not possible to derive manageable expressions for price and activity. To compare the solutions for the three scenarios we resort to numerical simulations. Our strategy is to specify a grid of values for all the parameters of the model (a, b, c and γ), and compute the solution numerically. We fix $a = 1$, and specify a grid for $b \in \{0, 0.5, 1, 1.5, ..., 30\}$, $c = \{0, 0.5, 1, 1.5, ..., 30\}$ and $\gamma = \{0, 0.1, ..., 0.9, 1\}$.

For example, supposing that $a = b = c = 1$ and $\gamma = 0.5$, then $y^a(p) =$

$\frac{3}{4} - \sqrt{(p-1)\,2p + \frac{9}{16}}$ and

$$V = (1-p)\left(\frac{3}{4} - \sqrt{(p-1)\,2p + \frac{9}{16}}\right) - \frac{1}{2}\left(\frac{3}{4} - \sqrt{(p-1)\,2p + \frac{9}{16}}\right)^2$$

the solution of which is $p^a = 0.29$ and $y^a = 0.36$. Table 3 reports the solution for $a = b = c = 1$ and $\gamma = \{0, 0.1, 0.25, 0.5, 0.75, 0.9, 1\}$. The tables for the other values of b and c are omitted, but are available from the authors.

Overall, the numerical simulations suggest that in *activity* bargaining prices are lowest, the purchaser's utility is highest and the provider's utility is lowest (note the similarity with proposition 1). Activity is lower than in *efficient* bargaining. It is lower than in *price* bargaining when the bargaining power of the purchaser is below a certain threshold, which is between 0.7 and 0.95 in our simulations.

The solution in *activity* bargaining is displayed in Figure 3, on the line AC which was derived by plotting the numerical solution a thousand times. In contrast to the solution with constant marginal benefit, in *activity* bargaining the price is not fixed any longer. As the bargaining power of the purchaser increases, the price decreases and activity increases.

As in the previous section, the solution in *price* bargaining with $\gamma = 1$ coincides with *activity* bargaining when $\gamma = 0$ (point A), and the solution in *activity* and *efficient* bargaining coincide when $\gamma = 1$ (point C). However, when $\gamma = 0$ (points B and D) *efficient* and *price* bargaining yield different solutions. Finally, when both parties have the same bargaining power, the solutions in *efficient* bargaining and *price* bargaining coincide at the point where marginal cost equals marginal benefit.

Finally, in *price* bargaining an increase in the bargaining power of the purchaser reduces prices and activity, but in *activity* bargaining it reduces prices but *increases* activity.

Table 3: Numerical simulation of equilibrium with decreasing marginal benefit

Simulation based on the parameters $a = 1, b = 1, c = 1$

	$\gamma = 0$	$\gamma = 0.1$	$\gamma = 0.25$	$\gamma = 0.5$	$\gamma = 0.75$	$\gamma = 0.9$	$\gamma = 1$
y^a	0.33	0.33	0.34	0.36	0.40	0.44	0.50
y^e	0.50	0.50	0.50	0.50	0.50	0.50	0.50
y^p	0.67	0.63	0.58	0.50	0.42	0.37	0.33
p^a	0.33	0.32	0.31	0.29	0.27	0.25	0.25
p^e	0.75	0.70	0.63	0.50	0.38	0.30	0.25
p^p	0.67	0.63	0.58	0.50	0.42	0.37	0.33
V^a	0.17	0.17	0.18	0.19	0.21	0.23	0.25
V^e	0	0.03	0.06	0.13	0.19	0.23	0.25
V^p	0	0.03	0.07	0.13	0.16	0.17	0.17
U^a	0.06	0.05	0.05	0.04	0.03	0.02	0
U^e	0.25	0.23	0.19	0.13	0.06	0.03	0
U^p	0.22	0.20	0.17	0.13	0.09	0.07	0.06

4 Adding quality and effort

In this section we extend the model by introducing quality and cost containment effort, and we show that the results using this more general specification are qualitatively similar to the ones obtained above. We follow the approach suggested by Ma (1994) and Chalkley and Malcomson (1998b). 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: $C(y,q,e)$, with $C_y > 0, C_q > 0$ and $C_e < 0$. φ is the non-monetary cost, or disutility, which increases with activity, quality and effort: $\varphi(y,q,e)$, with $\varphi_y > 0, \varphi_q > 0$ and $\varphi_e > 0$.

We also assume that the demand for treatment depends positively on quality so that $y = y(q)$ with $y_q > 0$. 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 $B_q > 0$. Since quality is a positive function of activity, we can also write $B = B(y,q(y))$ with $\frac{\partial B}{\partial y} = \frac{\partial B}{\partial y} + \frac{\partial B}{\partial q}\frac{\partial q}{\partial y} > 0$. The provider's utility is given by the surplus: $U = py - C(y,q(y),e) - \varphi(y,q(y),e)$. The purchaser's utility is $V = B(y,q(y)) - py$.

4.1 Activity bargaining

We assume that first, the purchaser sets the price (stage 1); second, the purchaser and provider bargain on activity (stage 2); third, the provider chooses effort (stage 3). We solve by backward induction. For a given price and activity (stage 3), the provider maximises the surplus U with respect to effort so that:

$$U_e\left(e^*\right) = 0 : -C_e(y,q(y),e^*) = \varphi_e(y,q(y),e^*) \tag{13}$$

The optimal effort for the provider $e^*(y)$ is such that the marginal benefit of lower cost is equal to the marginal disutility of effort. The indirect utility function of the provider is $U(p,y,q(y),e^*(y)) = py - C(y,q(y),e^*(y)) - \varphi(y,q(y),e^*(y))$.

For a given price (stage 2), the activity bargaining problem between purchaser and provider is:

$$\max_{y} \left[V(p,y,q(y)) - \overline{V}\right]^{\gamma}\left[U(p,y,q(y),e^*(y)) - \overline{U}\right]^{1-\gamma} \tag{14}$$

whose FOC is:

$$y^a: \; \gamma \frac{B_y + B_q q_y - p}{\widetilde{V}} = (1-\gamma) \frac{C_y + \varphi_y + (C_q + \varphi_q)\, q_y - p}{\widetilde{U}} \qquad (15)$$

The volume of activity is such that the difference between the marginal benefit and the price (weighted by the relevant factors) equals the difference between the marginal cost and the price (also weighted by the relevant factors). The condition is analogous to Eq.(2). However, the marginal benefit and marginal cost also include the additional benefit and cost from higher quality. The marginal cost includes both the monetary and non-monetary cost.

In stage 1 the purchaser sets the price to maximise:

$$\max_p \; B(y^a(p), q(y^a(p))) - p y^a(p) \qquad (16)$$

The FOC is:

$$p^a: \quad B_y y_p + B_q q_y y_p = y + p y_p \qquad (17)$$

The optimal price is such that the marginal benefit of higher activity and quality induced by a higher price is equal to the marginal cost.

4.2 Price bargaining

First the purchaser and the provider bargain on price (stage 1), and then the provider chooses the level of activity and cost-containment effort (stage 2). We solve by backward induction. For a given price (stage 2) the provider maximises the surplus U with respect to activity and effort, so that:

$$U_y(y^*, e^*) = 0: \quad p = C_y + \varphi_y + (C_q + \varphi_q)\, q_y \qquad (18)$$

$$U_e(y^*, e^*) = 0: \quad -C_e = \varphi_e \qquad (19)$$

The provider chooses the level of activity which equates the price to the marginal monetary and non-monetary cost. The marginal cost also takes into account the indirect effect of activity caused by increased quality, which is captured by the last term on the RHS. The optimal effort is such that the marginal benefit of lower cost is equal to the marginal disutility of effort. The indirect utility function of the provider is $U(p, y^*(p), q(y^*(p)), e^*(p))$. Note that $\frac{\partial y^*}{\partial p} = \frac{-U_{ee}}{U_{yy}U_{ee}-U_{ye}^2} > 0$, $\frac{\partial e^*}{\partial p} = \frac{U_{ye}}{U_{yy}U_{ee}-U_{ye}^2} \gtrless 0$ and $\frac{\partial U}{\partial p} = y^*$ (by the envelope theorem). The price bargaining problem (stage 1) is given by:

$$\max_p \left[\begin{array}{c} B(y^*(p), q(y^*(p))) \\ -py^*(p) - \overline{V} \end{array} \right]^\gamma \left[\begin{array}{c} py^*(p) - C(y^*(p), q(y^*(p)), e^*(p)) \\ -\varphi(y^*(p), q(y^*(p)), e^*(p)) - \overline{U} \end{array} \right]^{1-\gamma} \tag{20}$$

The FOC is:

$$p^p: \ \frac{\gamma}{\widetilde{V}} \left(B_y + B_q q_y\right) y_p + \frac{(1-\gamma)}{\widetilde{U}} y = \frac{\gamma}{\widetilde{V}} \left(y + p y_p\right) \tag{21}$$

The optimal price is such that the weighted marginal benefit for the purchaser of higher activity and quality, plus the weighted marginal benefit for the provider in terms of higher surplus, is equal to the weighted marginal cost for the purchaser.

4.3 Efficient bargaining

First the purchaser and the provider bargain on price and activity (stage 1), then the provider chooses the cost-containment effort (stage 2). By backward induction, for a given activity and price (stage 2) the supplier maximises the surplus U with respect to effort,

$$U_e(e^*) = 0: \quad -C_e = \varphi_e \tag{22}$$

which provides $e^*(y)$. The bargaining problem is:

$$\max_{p,y} \left[B(y,q(y)) - py - \bar{V}\right]^{\gamma} \left[\begin{array}{c} py - C(y,q(y),e^*(y)) \\ -\varphi(y,q(y),e^*(y)) - \overline{U} \end{array}\right]^{1-\gamma} \tag{23}$$

whose FOCs are:

$$y^e : B_y + B_q q_y = C_y + \varphi_y + q_y\left(C_q + \varphi_q\right) \tag{24}$$

$$p^e = (1-\gamma)\frac{B - \overline{V}}{y} + \gamma\frac{C + \varphi + \overline{U}}{y} \tag{25}$$

The price equals the weighted sum of the average benefit to the purchaser and the average cost to the provider, which includes the non-monetary cost. The optimal activity balances the purchaser's marginal benefit with the provider's marginal cost.

4.4 Regime comparison

Suppose that the benefit and cost functions are separable in activity, quality and effort, and that demand is linearly increasing in quality: a) $B(y,q) = \alpha_1 y - \frac{\beta_1}{2}y^2 + \alpha_2 q - \frac{\beta_2}{2}q^2$; b) $y = \theta q$; $C(y,q,e) = F + \frac{\gamma_1}{2}y^2 + \frac{\gamma_2}{2}q^2 - \gamma_3 e$, where F is a fixed cost; c) $\varphi(y,q,e) = \frac{\delta_1}{2}y^2 + \frac{\delta_2}{2}q^2 + \frac{\delta_3}{2}e^2$. α_i, β_i, δ_i and θ are all positive parameters.

Define: $\widehat{B}(y) = \left(\alpha_1 + \frac{\alpha_2}{\theta}\right)y - \left(\frac{\beta_1}{2} + \frac{\beta_2}{2\theta^2}\right)y^2$; $\widehat{C}(y) = \left(\frac{\gamma_1+\delta_1}{2} + \frac{\gamma_2+\delta_2}{2\theta^2}\right)y^2$; $\widehat{V}(y) = \widehat{B}(y) - py - \overline{V}$; $\widehat{U}(y) = py - \widehat{C}(y) - F - \frac{\gamma_3}{2\delta_3} - \overline{U}$, where $-\frac{\gamma_3}{2\delta_3} = \frac{\delta_3}{2}\left(e^*\right)^2 - \gamma_3 e^*$ and e^* is such that $-C_e = \varphi_e$.

Now, define: $a = \left(\alpha_1 + \frac{\alpha_2}{\theta}\right)$, $b = \left(\frac{\beta_1}{2} + \frac{\beta_2}{2\theta^2}\right)$, $c = \left(\frac{\gamma_1+\delta_1}{2} + \frac{\gamma_2+\delta_2}{2\theta^2}\right)$, and assume $\overline{V} = 0$ and $\overline{U} = F + \frac{\gamma_3}{2\delta_3}$.

Compare this formulation with section 3.2. It is straightforward that all the results contained in that section also hold for the more general formulation developed in section 4.

Intuitively, since activity is an increasing function of quality, by choosing or agreeing a certain level of activity, the provider also determines the level of quality. Therefore, adding quality adds complexity to the model but does not alter the main incentives. The only difference is that the marginal cost is now interpreted as the marginal cost of activity and quality; similarly, the marginal benefit includes the marginal benefit of activity and quality. For what concerns effort, since the provider is residual claimant in all the scenarios, effort is set such that marginal benefit from lower cost is equal to the marginal disutility of effort, regardless of the specific institutional setting. Therefore, also adding this variable does not alter the main results of the analysis.

5 Conclusions

Different countries have different institutional and bargaining settings for purchasers and providers. They usually follow one of three scenarios: the purchaser first sets the price (stage 1), and activity is then bargained between purchaser and provider (stage 2): *activity* bargaining; the price is first bargained between purchaser and provider (stage 1), but activity is then chosen unilaterally by the provider (stage 2): *price* bargaining; and price and activity are bargained simultaneously between purchaser and provider: *efficient* bargaining. We find that if the bargaining power of the purchaser is low, *efficient* bargaining leads to higher prices and provider's utility, and lower activity and purchaser's utility, compared to *price* bargaining. This result seems surprising, as one would expect the purchaser to be better off when she can bargain with more instruments, ie both price and activity. However, this intuition holds true only if the bargaining power of the purchaser is high. If her bargaining power is low, having more instruments is counterproductive. One policy implication is that purchasers with low bargaining power may be better off if restricted to bargaining on prices only, and not on price and activity. Future empirical work might quantify the bargaining power of the purchaser and the provider in health care markets. This might help governments to decide whether to encourage purchasers to bargain on prices only, or on price and activity simultaneously.

The analysis also confirms the intuition that if purchasers can set prices (*activity* bargaining), net consumer welfare (patient benefit, net of transfer to the provider) is highest. This result holds for any level of bargaining power of the purchaser. The analysis therefore supports policies such as "payment by results" in the UK, where prices are fixed by the purchaser or the regulator.

One less intuitive result is that by shifting from *efficient* and *price* bargaining (as in "cost and volume" or "sophisticated" contracts) to *activity* bargaining (as in "payment by results"), the level of activity is likely to decrease. More precisely, this study predicts that moving from efficient to activity bargaining will certainly reduce activity. This is in contrast to what is normally thought, ie that "payment by results" will encourage activity. When moving from *price* to *activity* bargaining, activity will decrease (increase) if the bargaining power of the purchaser is low (high). These results are consistent with recent empirical evidence (Farrar et al., 2006) which shows that the introduction of "payment by results" in England did not lead to any significant increase in activity. Further empirical work might test whether policies such as "payment by results" are likely to increase or decrease activity compared to previous policies.

Finally, most of the empirical work focuses on the effect of bargaining power on prices (Barros and Martinez-Giralt, 2006). This study provides clear predictions of the effect of the bargaining power on activity as well as price. More precisely, under *price* bargaining a higher bargaining power of the purchaser reduces activity; under *activity* bargaining it increases activity; and under *efficient* bargaining it has no effect on activity. Further empirical work might test such predictions.

6 References

Aronsson, T., Lofgren, K. and Wikstrom, M., 1993, "Monopoly union versus efficient bargaining: Wage and employment determination in the Swedish construction sector", *European Journal of Political Economy*, 9, 357-370.

Barros, P. P. and Martinez-Giralt, X., 2006, "Models of negotiation and bargaining in health care", in A. Jones (ed.), The Elgar Companion to Health Economics, 1st edn, Edward Elgar Publishing Limited, Cheltenham, UK, chapter 21.

Barros, P. P. and Martinez-Giralt, X., 2005a, "Negotiation advantages of professional associations in health care", *International Journal of Health Care Finance and Economics*, 5(2), 191-204.

Barros, P. P. and Martinez-Giralt, X., 2005b, "Bargaining and idle public sector capacity in health care", *Economics Bulletin*, 9(5), 1-8.

Barros, P. P. and Martinez-Giralt, X., 2000, "Selecting negotiation processes with health care providers", mimeo.

Brooks, J., Dor, A. and Wong, H., 1997, "Hospital-insurer bargaining: An empirical investigation of appendectomy pricing", *Journal of Health Economics*, 16, 417-434.

Bulkley, G. and Myles, G., 1997, "Bargaining over effort", *European*

Journal of Political Economy, 13, 375-384.

Chalkley, M. and Malcomson, J., 1998a, "Contracting for health services when patient demand does not reflect quality", *Journal of Health Economics*, 17, 1-19.

Chalkley, M. and Malcomson, J., 1998b, "Contracting for health services with unmonitored quality", *Economic Journal*, 108, 1093-1110.

Clark, D., 1995, "Priority setting in health care: An axiomatic bargaining approach", *Journal of Health Economics*, 14, 345-360.

De Fraja, G., 2000, "Contracts for health care and asymmetric information", *Journal of Health Economics*, 19(5), 663-677.

Dor, A. and Watson, H., 1995, "The hospital-physician interaction in US hospitals: Evolving payment schemes and their incentives", *European Economic Review* 39, 795-802.

Ellis, R. and McGuire, T., 1990, "Optimal payment systems for health services", *Journal of Health Economics*, 9, 375-396.

Farrar, S., Yi, D., Scott, T., Sutton, M., Sussex, J., Chalkley, M., Yuen, P., 2006, "National Evaluation of Payment by Results Interim Report: Quantitative and qualitative analysis", October, Report to the Department of Health; available at http://www.aberdeen.ac.uk/heru/research/bpoc

/projects/performance/bpoc_ongo_po2.php.

Figueras, J., McKee, M., Mossialos, E., Saltman, R.B, 2005, "Purchasing to improve health systems performance", European Observatory on Health Systems and Policies Series, Open University Press, UK.

Gal-Or, E., 1997, "Exclusionary equilibria in health care markets", *Journal of Economics and Management Strategy*, 6(1), 5-43.

Gal-Or, E., 1999a, "The profitability of vertical mergers between hospitals and physician practices", *Journal of Health Economics*, 18(5), 621-652.

Gal-Or, E., 1999b, "Mergers and exclusionary practices in health care markets", *Journal of Economics and Management Strategy*, 8(3), 315-350.

Kalai, E., 1977, “Nonsymmetric Nash Solutions and Replications of 2-Person Bargaining”, *International Journal of Game Theory*, 6, 129-133.

Le Grand, J., Mossialos, E., 1999, "Health Care and Cost Containment in the EU", Ashgate.

Ma, A., 1994, "Health care payment systems: Cost and quality incentives", *Journal of Economics and Management Strategy*, 3(1), 93-112.

Manning, A., 1987, "An integration of trade union models in a sequential bargaining framework", *Economic Journal*, 97, 121-139.

McDonald, I. and Solow, R., 1981, "Wage bargaining and employment", *American Economic Review*, 71(5), 896-908.

Melnick, G.A., Zwanziger, J., Bamezai, A., Pattison, R., 1992, "The effects of market structure and bargaining position on hospital prices", *Journal of Health Economics*, 11(3), 217-233.

Mougeot, M. and Naegelen, F., 2005, "Hospital price regulation and expenditure cap policy", *Journal of Health Economics 24*, 55-72.

Nash, J., 1950, "The bargaining problem", *Econometrica* 18, 155-162.

Nash, J., 1953, "Two-person cooperative games", *Econometrica* 21, 128-140.

Osborne, M. and Rubinstein, A., 1990, "Bargaining and Markets", 1st ed., Academic Press, Inc., San Diego.

Oswald, A., 1985, "The economic theory of trade unions: An introductory survey", *Scandinavian Journal of Economics*, 87(2), 160-193.

Pecorino, P., 2002, "Should the US allow prescription drug reimports from Canada?", *Journal of Health Economics*, 21, 699-708.

Propper, C., 1996, "Market structure and prices: The responses of hospitals in the UK national health service to competition", *Journal of Public Economics*, 61, 307-335.

Sampson, A., 1993, "Bargaining over effort and the monitoring role of unions", *European Journal of Political Economy*, 9, 371-381.

Wright, D.J., 2004, "The drug bargaining game: pharmaceutical regulation in Australia", *Journal of Health Economics*, 23(4), 785-813.

7 Appendix

7.1 The model

Proof of Eq.(2). Activity bargaining. The result is obtained by differentiating $\gamma \log \left[B(y) - py - \overline{V}\right] + (1-\gamma) \log \left[py - C(y) - \overline{U}\right]$ with respect to y. The Second Order Condition (SOC) is $\Gamma = \gamma \frac{B_{yy}V - (B_y - p)^2}{\widetilde{V}^2} - (1-\gamma) \frac{C_{yy}\widetilde{U} + (p - C_y)^2}{\widetilde{U}^2} < 0$, which is always satisfied. ■

Proof of Eq.(8). Price bargaining. By taking the log and differentiating with respect to p we obtain $\gamma \frac{B_y y_p - y(p) - p y_p}{\widetilde{V}} + (1-\gamma) \frac{y(p) + p y_p - C_y y_p}{\widetilde{U}} = 0$. From the FOC of the provider we know that $p = C_y$. By simplifying, we obtain: $\gamma \frac{B_y y_p - y(p) - p y_p}{\widetilde{V}} + (1-\gamma) \frac{y(p)}{\widetilde{U}} = 0$. The SOC is $-\frac{\gamma \widetilde{U}^2 ((B_y - p) y_p - y)^2 + (1-\gamma) \widetilde{V}^2 y^2}{\widetilde{V}^2 \widetilde{U}^2} - \frac{\gamma \left(2 - \frac{B_{yy}}{C_{yy}}\right) \widetilde{U} - (1-\gamma) \widetilde{V}}{\widetilde{V} \widetilde{U}} y_p$. ■

Proof of Eq.(11). Efficient bargaining. Define

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

Then: $\frac{\partial \log \Omega}{\partial p} = -\frac{\gamma y}{B(y) - py - \overline{V}} + \frac{(1-\gamma) y}{py - C(y) - \overline{U}} = 0$ and $\frac{\partial \log \Omega}{\partial y} = \frac{\gamma (B_y - p)}{B(y) - py - \overline{V}} + \frac{(1-\gamma)(p - C_y)}{py - C(y) - \overline{U}} = 0$. From the first equation we obtain $p = \frac{\gamma \left[C(y) + \overline{U}\right] + (1-\gamma)\left[B(y) - \overline{V}\right]}{y}$, which, substituted into the second one, yields: $B_y = C_y$. The SOCs are: $\frac{\partial^2 \log \Omega}{\partial p^2} = -y^2 \left(\frac{\gamma}{\tilde{V}^2} + \frac{1-\gamma}{\tilde{U}^2}\right) < 0$, $\frac{\partial^2 \log \Omega}{\partial y^2} = \gamma \frac{B_{yy}\tilde{V} - (B_y - p)^2}{\tilde{V}^2} - (1-\gamma) \frac{C_{yy}\tilde{U} + (p - C_y)^2}{\tilde{U}^2} < 0$, and $\frac{\partial^2 \log \Omega}{\partial p^2} \frac{\partial^2 \log \Omega}{\partial y^2} > \left(\frac{\partial^2 \log \Omega}{\partial p \partial y}\right)^2$. $\frac{\partial^2 \log \Omega}{\partial p \partial y} = -\frac{\gamma}{\tilde{V}} + \frac{1-\gamma}{\tilde{U}} + y (B_y - p) \left(\frac{\gamma}{\tilde{V}^2} + \frac{1-\gamma}{\tilde{U}^2}\right) = \frac{(1-\gamma) B + \gamma C - py}{\tilde{V} \tilde{U}} + y (B_y - p) \left(\frac{\gamma}{\tilde{V}^2} + \frac{1-\gamma}{\tilde{U}^2}\right) = y (B_y - p) \left(\frac{\gamma}{\tilde{V}^2} + \frac{1-\gamma}{\tilde{U}^2}\right)$, where the last simplification follows from the FOC for price. $\frac{\partial^2 \log \Omega}{\partial p^2} \frac{\partial^2 \log \Omega}{\partial y^2} > \left(\frac{\partial^2 \log \Omega}{\partial p \partial y}\right)^2 = -y^2 \left(\frac{\gamma}{\tilde{V}^2} + \frac{1-\gamma}{\tilde{U}^2}\right) \left[\gamma \frac{B_{yy}\tilde{V}}{\tilde{V}^2} - (1-\gamma) \frac{C_{yy}\tilde{U}}{\tilde{U}^2} - (B_y - p)^2 \left(\frac{\gamma}{\tilde{V}^2} + \frac{1-\gamma}{\tilde{U}^2}\right)\right]$
$-y^2 (B_y - p)^2 \left(\frac{\gamma}{\tilde{V}^2} + \frac{1-\gamma}{\tilde{U}^2}\right)^2 = -\gamma \frac{B_{yy}\tilde{V}}{\tilde{V}^2} + (1-\gamma) \frac{C_{yy}\tilde{U}}{\tilde{U}^2} > 0$. All three SOCs are always satisfied, since $B_{yy} \leq 0$. ■

7.2 Constant marginal benefit

Activity bargaining. $p^a = \frac{a}{2}$, $y^a = \frac{a}{c(2-\gamma)}$,$V^a = \frac{a^2}{2c(2-\gamma)}$, $U^a = \frac{a^2(1-\gamma)}{2c(2-\gamma)^2}$.

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

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

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: $p^p = \frac{a(2-\gamma)}{2}$ (the SOC is $-\frac{1}{(a-p)^2p^2}\left((a-p)^2+p^2\right) - \frac{2}{p^2}(1-\gamma) < 0$). Hence $y^p = \frac{a(2-\gamma)}{2c}$, $V^p = (a-p)\,y = \gamma\frac{a^2(2-\gamma)}{4c}$ and $U^p = \left(p-\frac{c}{2}y\right)y = \frac{a^2(2-\gamma)^2}{8c}$. ■

Efficient bargaining. $p^e = \frac{a(2-\gamma)}{2}$, $y^e = \frac{a}{c}$, $V^e = \frac{\gamma a^2}{2c}$, $U^e = \frac{a^2(1-\gamma)}{2c}$.

Proof. The FOC w.r.t. price implies: $p = (1-\gamma)\,a + \gamma\frac{c}{2}y$. The FOC w.r.t. activity implies: $y^e = \frac{a}{c}$. Therefore $p^e = \frac{a(2-\gamma)}{2}$ and $V^e = (a-p)\,y = \gamma\frac{a^2}{2c}$ and $U^e = \left(p-\frac{c}{2}y\right)y = (1-\gamma)\frac{a^2}{2c}$. ■

Proof of Proposition 1. (a) $p^p = \frac{a(2-\gamma)}{2} \geq \frac{a}{2} = p^a$ if $\gamma \leq 1$. (b) $y^a = \frac{a}{c(2-\gamma)} \leq y^e = \frac{a}{c}$ if $\frac{a}{c(2-\gamma)} \leq \frac{a}{c}$ or $\gamma \leq 1$; $y^p = \frac{a(2-\gamma)}{2c} \leq y^e = \frac{a}{c}$ if $\gamma \geq 0$; $y^p = \frac{a(2-\gamma)}{2c} \geq y^a = \frac{a}{c(2-\gamma)}$ if $(2-\gamma)^2 \geq 2$ or $\gamma \leq 0.59$. (c) $V^a = \frac{a^2}{2c(2-\gamma)} \geq V^e = \frac{\gamma a^2}{2c}$ if $2\gamma - \gamma^2 - 1 \leq 0$ or $-(\gamma-1)^2 \leq 0$; $V^e = \frac{\gamma a^2}{2c} \geq V^p = \frac{\gamma a^2(2-\gamma)}{4c}$ if $\gamma \geq 0$. (d) $U^p = \frac{a^2(2-\gamma)^2}{8c} \geq U^e = \frac{a^2}{2c}(1-\gamma)$ if $\frac{(2-\gamma)^2}{4} \geq (1-\gamma)$ or $4+\gamma^2-4\gamma \geq 4-4\gamma$, or if $\gamma^2 > 0$; $U^e = \frac{a^2}{2c}(1-\gamma) \geq U^a = \frac{a^2}{2c}\frac{1-\gamma}{(2-\gamma)^2}$ if $(2-\gamma)^2 \geq 1$, which is always the case, since $0 \leq \gamma \leq 1$. ■

7.3 Decreasing marginal benefit

Price bargaining. $p^p = \frac{ac(2-\gamma)}{b+2c}$, $y^p = \frac{a(2-\gamma)}{b+2c}$, $V^p = \frac{\gamma a^2(2-\gamma)}{2(b+2c)}$, $U^p = \frac{a^2 c(2-\gamma)^2}{2(b+2c)^2}$.

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

Efficient bargaining. $p^e = \frac{a((1-\gamma)b+(2-\gamma)c)}{2(b+c)}$, $y^e = \frac{a}{b+c}$, $V^e = \frac{\gamma a^2}{2(b+c)}$, $U^e = \frac{a^2(1-\gamma)}{2(b+c)}$.

Proof. The FOC w.r.t. price implies: $p^e = (1-\gamma)\left(a-\frac{b}{2}y\right) + \gamma\frac{cy}{2}$. The FOC w.r.t. activity implies: $y^e = \frac{a}{b+c}$. Therefore $p^e = \frac{a((1-\gamma)b+(2-\gamma)c)}{2(b+c)}$ and $V^e = \left(a-\frac{b}{2}y-p\right)y = \frac{\gamma a^2}{2(b+c)}$ and $U^e = \left(p-\frac{c}{2}y\right)y = \frac{a^2(1-\gamma)}{2(b+c)}$. ■

Proof of Proposition 2. (a) $p^p > p^e$ if $\frac{ac(2-\gamma)}{b+2c} > \frac{a((1-\gamma)b+(2-\gamma)c)}{2(b+c)}$ or $b(c\gamma + b\gamma - b) > 0$ or $\gamma > \frac{b}{b+c}$. (b) $y^e > y^p$ if $\frac{a}{b+c} > \frac{a(2-\gamma)}{b+2c}$ or $b + 2c - (2-\gamma)(b+c) > 0$ or $\gamma > \frac{b}{b+c}$. (c) $U^p > U^e$ if $\frac{a^2c(2-\gamma)^2}{2(b+2c)^2} > \frac{(1-\gamma)a^2}{2(b+c)}$ or $b^2\gamma + bc\gamma^2 + c^2\gamma^2 - b^2 > 0$ or $\gamma = \left\{-\frac{b}{c}, \frac{b}{b+c}\right\}$. (d) $V^e > V^p$ if $\frac{\gamma a^2}{2(b+c)} > \frac{\gamma a^2(2-\gamma)}{2(b+2c)}$ or $(b+2c) - (b+c)(2-\gamma) > 0$ or $\gamma > \frac{b}{b+c}$. ■

7.4 Decreasing marginal benefit and activity bargaining

Proof. From FOC w.r.t. y we have $\gamma\frac{(a-by)-p}{ay-\frac{b}{2}y^2-py} = -(1-\gamma)\frac{p-cy}{py-\frac{c}{2}y^2}$ or $\gamma(a-by-p)\left(p-\frac{c}{2}y\right) + (1-\gamma)(p-cy)\left(a-\frac{b}{2}y-p\right) = 0$. Upon expanding, we obtain $\frac{bc}{2}y^2 - y\left(c\frac{2-\gamma}{2}(a-p) + bp\frac{1+\gamma}{2}\right) + p(a-p) = 0$, with solution $y = \frac{\left(c\frac{2-\gamma}{2}(a-p)+bp\frac{1+\gamma}{2}\right) - \sqrt{\left(c\frac{2-\gamma}{2}(a-p)+bp\frac{1+\gamma}{2}\right)^2 - 4\frac{bc}{2}p(a-p)}}{bc}$. ■

Figure 1. Activity bargaining

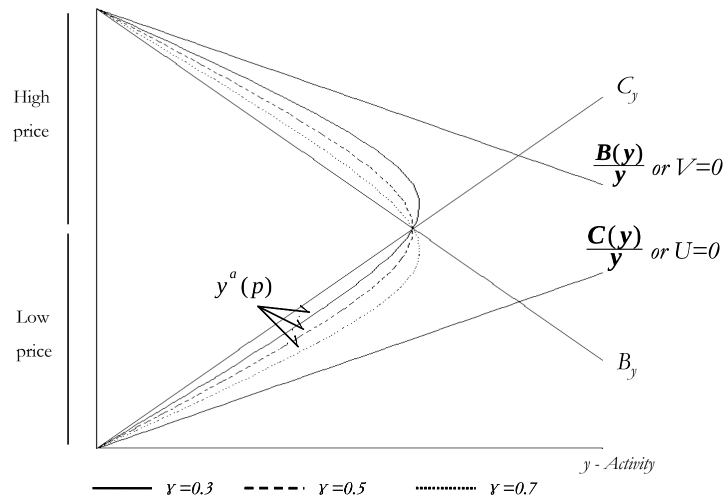

Figure 2. Comparison of scenarios with constant marginal benefit

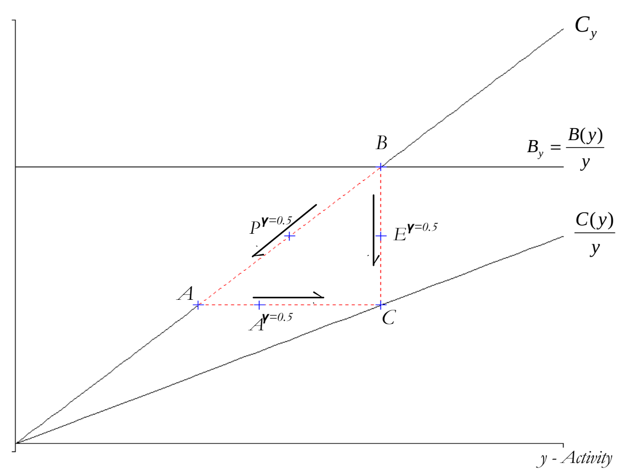

Figure 3. Comparison of scenarios with decreasing marginal benefit