STRATEGIC INDUSTRIAL POLICIES

WHEN A FIRM HAS BARGAINING POWER

Carlo Scarpa*
Dipartimento di Scienze Economiche
Piazza Scaravilli 2
40100 BOLOGNA - Italy

April 1990

* This is a revised version of a chapter of my D.Phil. Thesis, written at Nuffield College, Oxford. I am very grateful to Meg Meyer, John Vickers and George Yarrow for helpful comments to a previous draft.

JEL Classification nrs.: 026, 612, 619.

keywords: regulation, bargaining

ABSTRACT

This paper studies the optimal behavior of a regulator facing two markets monopolized by two firms; one of them has bargaining power, while the other can be forced to accept any regulatory constraint, and can be thus treated as a public firm. The interaction between the strategic choices of the public firm and the regulation of the other one is analyzed. It is shown that regulating prices is better than regulating output levels, and that the optimal strategy is to fix the price of the public firm before bargaining with the private one. This suggests also an argument in favour of centralizing regulation, instead of having separate regulatory bodies.

1. Introduction

Most contributions in the theory of regulation assume that the regulator deals with only one industry at a time. This is not completely satisfactory, as regulation often affects industries which are closely related, and it seems natural to look at their regulation as a unique problem. Examples may be found, for instance, in the British privatizations, where gas and electricity are substitutable goods, whose production is strictly regulated. On the other hand, oil refinement and car manufacturing are major cases of industries producing complementary goods, which are subject to some regulation in many industrialized countries.

In this paper, we focus on a case where the public authority regulates two firms, which are monopolists in different, related markets. The problem is relevant if the regulation of one industry depends significantly on other sectors' situations, and we believe that this link - although not obvious - is often quite important. In particular, if regulation is the outcome of a bargaining between the regulator and a firm, there are strategic considerations that should induce to analyze public interventions in a coordinated way.

Indeed, this seems a fairly natural way to look at regulation, as in many cases, especially as regards public utilities, the relationship between the regulator and the firm is one of *bilateral monopoly*[1]. For this reason, even welfare-maximizing regulatory bodies often have to deal with firms having a well defined *bargaining power*. The recent British experience offers several examples of such a situation, that often leads to some bargaining. For instance, the percentage of real annual price reductions for the services offered by British Telecom was the outcome of negotiations between the company and the Government (Vickers and Yarrow, 1985, p.41).

As argued in Scarpa (1989), several theoretical arguments suggest that bargaining may be a relevant issue to study when analyzing regulation. Among them, the more important are the difficulty of writing complete contracts, the existence of major informational asymmetries between the regulator and the firm, and the presence of turnover costs, which make this situation very close to the one analyzed in models of insider-outsider in the labour market. In this paper we want to develop the latter argument.

Indeed, turnover costs are potentially relevant whenever th regulator is faced by a firm which is already active in the market; for instance, with learning-by-doing the incumbent's costs are significantly lower than a potential entrant's. The incumbent firm can thus enjoy an economic *rent*, and this forces the regulator to bargain with the insider firm for any form of regulation. If the incumbent is not willing to accept the regulatory policy, the threat to replace it with an "outsider" is severely limited in its scope. In particular, in this case the incumbent would make a counteroffer, which the regulator, due to the higher efficiency of the firm, will have to take it into account.

If one accepts this view, the connection between the negotiations becomes clear. The regulatory constraint will depend on the regulator's bargaining power, which in turn is affected by the value of his outside option (the payoff he gets if no agreement is reached). Because this payoff is the welfare level generated in other markets, there is a strategic linkage between the regulatory interventions, and this requires an "integrated" analysis of regulation. For instance, consider how the regulator's bargaining power in a negotiation with the electricity industry may be affected by the prices of alternative sources of energy.

We focus particularly on three factors:

1) the existence of substitutability or complementarity among the goods;

2) whether the markets are regulated simultaneously or sequentially;

3) the choice between price and output regulation.

Our aim is to study the optimal forms of public intervention. This is because we assume that the regulator, although forced to negotiate on regulatory measures, is still able to dictate "the rules of the game". In particular, we assume that it is possible to decide *which variable* to focus upon, and *when* each market should be dealt with. Of course, if firms were able to affect these aspects as well, our results can at least suggest what the Government's target should be.

We consider a situation in which two markets are monopolized by different firms. In particular, we assume that only firm 1 has bargaining power, while the regulator is free to decide the output or price level in the second market. Firm 2 may thus be considered as a public firm, and this allows one to re-interpret our paper as an analysis of the interaction between different instruments of industrial policy: a public firm and regulation of output or price.

In this context, we first investigate whether the regulator can increase welfare by pre-committing himself in market 2, before bargaining with firm 1. The answer depends on the variable chosen by the regulator. When price can be fixed, an optimal pre-commitment pays off, while when the regulator can only fix output, he should determine its level *after* bargaining with the other firm. It is also shown that price regulation should be preferred to output regulation, in close analogy with standard results in oligopoly theory, where we know that price competition tends to yield a larger welfare level than output competition.

The paper is organized as follows. In the next section, we introduce the model, which is used in sections 3 to 5 to examine the effects of output pre-commitments, their credibility and the welfare properties of the different equilibria. In section 6 we examine price regulation, comparing it to output regulation. Section 7 is devoted to the issue of the optimal structure of regulatory bodies, stressing how our framework suggests a new argument in favour of centralizing regulatory power. Section 8 offers some suggestions for further extensions of this work.

2. The model

Given the complexity of the problem, we use the simple scheme with linear demand and costs, which was used, for instance, by Singh and Vives (1984). Consider two markets (1 and 2), each monopolized by a different firm. Firm 1 produces good x, while firm 2 produces good y. If C(.) is the cost function of each firm, the aggregate net welfare function (W) is

(1) $W(x, y) = a(x + y) - (bx^2 + 2sxy + by^2)/2 - C(x) - C(y)$

Thus, the demand functions in the two markets are, respectively:

(2) $p_1 = a - bx - sy$ and

(3) $p_2 = a - by - sx$

Both a and b are positive parameters. As regards s, we can distinguish between two cases. When $s > 0$ the two goods are substitutes, and $s = b$ characterizes perfect substitutability. When $s < 0$, x and y are complementary goods, and when $s = -b$ we have the extreme case of perfect complementarity. Thus, we assume $-b < s \leq b$. The firms have identical cost functions with constant returns to scale: $C(x) = cx$ and $C(y) = cy$.

The profit functions of the two firms are

(4) $\pi^1 = (a - bx - sy)x - cx$ and

(5) $\pi^2 = (a - by - sx)y - cy$

As we are in a highly non-competitive situation, the case for output or price regulation in both markets is quite clear. Suppose (at least) one firm has the power to reject the Government's regulation, forcing it to bargain on output.

The problem we want to tackle is to find the optimal way for the regulator to negotiate with the firm(s). An interesting issue is the role of pre-commitments. More precisely, we study whether the regulator should regulate the two markets simultaneously or sequentially, and in the latter case, whether the level of y (or its price) should be fixed before bargaining with firm 1. We also want to characterize the optimal level of y or p_2, which the regulator may use as a pre-commitment. It is also interesting to investigate whether regulating the output level is equivalent to regulating the price, and, if the answer is negative, which of these variables should be chosen by the regulator.

An alternative interpretation may be the following. Firm 2 may be thought as a state owned company, that operates to maximize welfare. Thus, the results that follow may indicate the optimal policy of such public firm when competing with a private one (firm 1) which has some bargaining power.

We adopt the Nash Bargaining Equilibrium (NBE) as our solution concept. As regards the outside options of the two players (i.e., the utility levels they can gain by rejecting the bargaining), we introduce the following assumptions. The outside options of firm 1 is $\pi_0 = 0$: its resources are immobile, and it can only have positive profits in market 1. As regards the regulator's outside option (W_0), we introduce the extreme assumption that if a firm has bargaining power, it cannot be substituted by any other one: only firm i can serve market i. Thus, the regulator's outside option is only the welfare level it can obtain in market 2 in the hypothetical case that no agreement is reached in market 1 ($x = 0$).

3. The effect of pre-commitments on output levels

Let us first assume that the public authority regulates the quantities supplied by each firm, leaving price determination to the market. Although we show in the next section that this is not an optimal strategy, the analysis of output regulation is nonetheless useful, as its simplicity allows a more intuitive understanding of the key features of the model.

Assuming that the Government maximizes (1) and may choose the order in which regulation is decided, we address the following issues:

- Does the regulator increases his bargaining power if he "ties his hands", by deciding the level of y before negotiating with firm 1 the level of x?
- If this is the case, what is the optimal pre-commitment on y?
- Moreover, is the improvement in the result of the bargaining enough to compensate for the distortion possibly introduced in market 2?

We start from the case, labelled as N, where *no commitment* is possible, so that bargaining occurs at the first stage, before the regulator fixes the level of y. Both the regulator and firm 1, however, will correctly anticipate what will happen in the second stage, in which marginal cost pricing will determine the level of y:

$$y^N = \frac{k - sx}{b} \tag{6}$$

where $k \equiv (a-c)$ and a superscript N characterizes the equilibrium level of the variables in the case of no commitment. If at the first stage firm 1 rejects any agreement with the regulator, it exits the market and the value of y^N will thus be k/b. Consequently, the regulator's outside option is $W_o \equiv W(0;\ k/b) = k^2/2b$.

The value of x^N is determined maximizing the function $H \equiv \Delta\pi^1\Delta W$, the product of the gains from trade of the two players. The firm's gain is:

$$\Delta\pi^1 = \pi^1 = kx - bx^2 - sx(k - sx)/b \tag{7}$$

As regards the regulator, we have $\Delta W = W(x,\ y^N) - W_o$, which, using (6), can be written as

$$kx - \frac{bx^2}{2} + \frac{k(k-sx)}{b} - \frac{b(k-sx)^2}{2b^2} - \frac{sx(k-sx)}{b} - \frac{k^2}{2b}$$

Therefore, we have

$$\Delta W = (1 - \frac{s}{b})kx - \frac{bx^2}{2} + \frac{s^2x^2}{2b} \tag{8}$$

From the Pareto-optimality of the Nash Bargaining Equilibrium, we know that $W_x > 0$ and $\pi_x < 0$, so that the output level is too low from the viewpoint of the regulator and "too large" from the firm's. The SOC is certainly met by the concavity of π and W in x. Therefore, the first order condition ($H_x = 0$) can be written as:

$$-[k(b-s) - 2(b^2-s^2)x][k(b-s) - (b^2-s^2)/2]x = x[k(b-s) - x(b^2-s^2)]^2 \tag{9}$$

This expression can be reduced to a second order equation in x; using the SOC, one root can be eliminated, so that the equilibrium value of x is

$$x^N = \frac{\alpha k}{b+s} \tag{10}$$

where α lies within the interval (0, 1), and is defined, more precisely as $(9 - \sqrt{17})/8$. Thus, substituting (10) into (6), we get

$$y^N = \frac{k[b+s(1-\alpha)]}{b(b+s)} \tag{11}$$

Now, we can consider the opposite case, where *irreversible commitments are possible*, and the Government determines the level of y before negotiating x with firm 1. We analyze here only commitments that cannot be modified if the bargaining breaks down. Although x = 0 will never be an equilibrium, this can be an important assumption, as the regulator's outside option depends on the output level firm 2 supplies in case of disagreement with firm 1. We postpone for the moment the discussion of this credibility problem.

As y is predetermined at the moment of bargaining, the outside option of the regulator is:

$$W(0, y) = ky - by^2/2 \tag{12}$$

so that the gains from trade of the regulator can be written as:

$$\Delta W = kx - bx^2/2 - sxy \tag{13}$$

Following the same procedure as before, we can determine explicitly the equilibrium value of x in the case of pre-commitment (x^C):

$$x^C = \frac{\alpha(k-sy^C)}{b} \tag{14}$$

Notice that when $s = 0$ the value of x in the two cases is the same, because, quite obviously, if the markets are independent any pre-commitment is irrelevant. In general, however, we want to know whether a commitment on y will allow the Government to increase the value of x agreed upon through the bargaining. Using (10), (11) and (14), it can be easily seen that $x^C > x^N$ if and only if:

$$s[k - (b+s)y^C] > 0 \tag{15}$$

This can be synthesized in the following Lemma.

<u>LEMMA 1</u>. By pre-committing itself to a certain value of y before bargaining on x with firm 1, the regulator can increase the equilibrium level of x if and only if condition (15) is met. Thus, in order to improve on x^N, the regulator must set $y^C > k/(b+s)$ if and only if the goods are complementary.

It is interesting to note that the sign of the expression in square brackets in (15) depends on whether y^C is above or below the output level (y^F) which would maximize welfare in a first-best situation. Furthermore, by comparing the gains from trade of the two players in the two situations examined so far, it is easy to show that condition (15) is indeed necessary and sufficient for a pre-commitment on y to increase the relative bargaining power of the regulator[2].

Therefore, Lemma 1 can be interpreted as follows. To improve the outcome of bargaining, the regulator must commit himself to a level of y, such that his gains from trade in the bargaining are reduced relative to the profit level, thus increasing his relative bargaining power. This occurs if the pre-commitment increases the marginal profitability of x more than its marginal social desirability. From the viewpoint of bargaining, a pre-commitment of $y^C = y^F$ is equivalent to allowing marginal cost pricing to be decided after the negotiation is concluded. Thus, to increase x, y^C must be above y^F in the case of complementary goods ($s < 0$), while the opposite must be done if the goods are substitutes. This is quite intuitive, if we consider that in the case of complementary goods, the larger y is, the larger are social and private marginal benefits from x.

Before determining the optimal level of y^C, it is interesting to consider first what happens if the regulator fixes y at the level (y^M) that, in equilibrium yields $p_2 = c$:

(16) $$y^M = \frac{k - sx^C}{b}$$

Substituting this expression into (15), it is easy to see that in this case x^C would be lower than x^N. By pre-committing to the output level corresponding to marginal cost pricing, the regulator has reduced his bargaining power relative to case N. In fact, the bargaining game is exactly the same as before, apart from the regulator's outside option, which is lower due to the pre-commitment. Indeed, if y is determined by (16) and afterwards the firm chooses the outside option ($x = 0$), the regulator is bound to make a "mistake", and his outside option will be

(17) $$W_o = [k^2 - (sx^C)^2]/2b$$

and no longer $k^2/2b$.

The next step is now to try and characterize more precisely the *optimal pre-commitment*. To this end, let us consider the strategic effect of the choice of y in the first stage of the game the regulator is playing with the two firms. At the second stage, as we have seen, x^C is determined as a function of y, so that y must be chosen to maximize $W[x^C(y), y]$. The first order condition is:

$$(18) \qquad \frac{dW}{dy} \equiv \frac{\partial W}{\partial y} + \frac{\partial W}{\partial x^C}\frac{dx^C}{dy} = 0$$

It is easy to see that an optimal commitment requires a departure from marginal cost pricing in market 2, to compensate the departure from optimality in market 1, due to bargaining. Welfare maximization yields:

$$(19) \qquad W_y = - W_x(dx^C/dy) = W_x H_{xy}/H_{xx}$$

Because $W_x > 0$ in a NBE, p_2 will be set above marginal cost ($W_y > 0$) if and only if a reduction in y raises the equilibrium level of x. Thus, it is crucial to determine the sign of dx^C/dy, which has the same sign as H_{xy} (given $H_{xx} < 0$). The expression for H_{xy} is:

$$H_{xy} = \pi_{xy}\Delta W + \pi_x(\Delta W)_y + (\Delta W)_{xy}\pi + (\Delta W)_x\pi_y$$

where π refers to firm 1's profit. Notice first that $\pi_{xy} = W_{xy} = -s$. As regards $(\Delta W)_y$, it is easy to check that $\partial W_0/\partial y = (\partial W/\partial y) + sx$, so that $(\Delta W)_y = sx$. Therefore, H_{xy} has the opposite sign to s, and (19) becomes:

$$(20) \qquad W_y = \frac{sW_x}{-[W_{xx}\pi + \pi_{xx}\Delta W]}[\Delta W + \pi + x(W_x + \pi_x)]$$

The denominator of the RHS is always positive because of the concavity of π and W, while in a NBE $W_x > 0$ and $\pi_x < 0$. Thus, if $W_x + \pi_x$ is positive, W_y must have the same sign as s. This is always true, because in a NBE the absolute value of the ratio W_x/π_x must be equal to the ratio $\Delta W/\Delta\pi$. As $\Delta W > \Delta\pi$, then we must have $W_x > |\pi_x|$. This leads to the following

PROPOSITION 1. If a pre-commitment on y is possible, the regulator must allow p_2 to be above marginal cost if and only if the two goods are substitutes. The optimal departure from marginal cost pricing in market 2 is given by expression (20).

In other terms, the output level corresponding to marginal cost pricing is not an optimal commitment. The regulator should increase output beyond the level given by $p_2 = c$ if and only if this increases the demand function for good 1, i.e., if and only if the two goods are complements. In this way it may be possible, if condition (15) is also met, to increase x^C relative to the case of no commitment.

Remark 1. If $s < 0$, the regulator should force the firm to price below average cost, so that a transfer to firm 2 would be necessary in order to cover the loss. Of course, if transferring resources has a social cost because non-distortionary taxes are not available, this conclusion should be modified. Therefore, we should have $p_2 < c$ if and only if the cost of public funds is less than the gain obtained in the bargaining process.

Remark 2. It is interesting to see what happens in the different cases when $s = b$, i.e., when we have *homogeneous goods*. In the absence of commitments, $x^N = \alpha k/2b$ and $y^N = (2-\alpha)k/2b$. Thus, $x^N + y^N = k/b$ and price is equal to marginal cost: as expected, when x and y are homogeneous goods, no asymmetry in bargaining power between the firms is possible, and $\pi^1 = \pi^2 = 0$. The same thing occurs when commitments are indeed possible, but now the optimal commitment is $y^C = k/b$, so that $x^C = 0$: given constant returns to scale, firm 2 can serve the whole market, and firm 1 is excluded[3].

4. Commitments and welfare

We can now turn to the main question we asked, i.e., *is a pre-commitment on y beneficial from a social viewpoint?* Indeed, so far we have focused our attention only on the stage of bargaining, considering the effects of different pre-commitments on the equilibrium level of x. However, by fixing output so that p_2 is above or below marginal cost, we impose a distortion in market 2, and it is far from obvious that the gain in the bargaining can compensate the welfare loss in the other market (indeed, it is easy to provide examples of commitments that raise x and at the same time reduce aggregate welfare).

In the case with no commitments, the equilibrium levels of x and y are given by (10) and (11). Substituting these expressions into the welfare function (1) yields the welfare level in the case of no commitment:

$$W^N = \frac{k^2[b^2(1+\theta) + 2bs + s^2(1-\theta)]}{2b(b+s)^2} \tag{21}$$

where $\theta \equiv \alpha(2-\alpha) < 1$. On the other hand, in the case where commitments are possible, the welfare level is a function of the commitment on y that the regulator has chosen before bargaining. Using (14) and (1), we get:

$$W^C = \frac{k^2\theta + 2ky(b-s\theta) - (b^2-s^2\theta)y^2}{2b} \tag{22}$$

The optimal commitment is the level of y which maximizes (22), i.e.:

$$y^* = \frac{k(b-s\theta)}{b^2-s^2\theta} \tag{23}$$

It is easy to see that $p_2(y^*) > 0$. In the same way, one can check that, in line with Proposition 1, $W_y(y^*) = sk(\theta-\alpha)(b-s)/(b^2-\theta s^2)$, which has the same sign as s. Substituting back into (22), it is possible to show that with an optimal commitment the welfare level is:

$$(22') \qquad W^C(y^*) = \frac{bk^2[b(1+\Theta)-2s\Theta]}{2b(b^2-s^2\Theta)}$$

Comparing (21) and (22') and simplifying, we can show that:

$$(24) \qquad W^C - W^N = \frac{-\Theta(1-\Theta)k^2s^2(b^2-s^2)}{2b(b+s)^2(b^2-s^2\Theta)} \leq 0$$

This result can be summarized in the following Proposition:

PROPOSITION 2. A pre-commitment to y before bargaining on x with firm 1 is ***never beneficial*** to the regulator.

Remark 3. When s = 0, expression (24) holds as an equality, because when the markets are independent any commitment on y is irrelevant. The same is true also when the goods are homogeneous, so that the firm has no bargaining power.

To understand fully this result, it is useful to observe the effect of the optimal commitment y^* on x^C. Substituting (23) into (15), we see that $x^C(y^*) > x^N$ if and only if:

$$(15') \qquad \frac{s^2kb(\Theta-1)}{b^2-\Theta s^2} > 0$$

which is never met, because $\Theta < 1$. Therefore, it is never optimal for the regulator to pre-commit to a level of y such to increase the equilibrium level of x^C above x^N. The intuition supporting this result can be found in expression (14), which defines the relationship between x^C and y. The first derivative of x^C with respect to y is $-\alpha s/b$, which is less than unity in absolute value. Thus, loosely speaking, the effect of the pre-commitment on the equilibrium value of x is less than proportional to the effort exercised (in terms of departure from marginal cost pricing in market 2).

We can now turn to the case of simultaneous regulation, in which the levels of x and y are determined at the same time but "playing on different tables". In this scheme, which we will label with S, each output level is fixed, taking the other one as given. Therefore, as regards market 1 the situation is similar to the one with commitment, as y does not depend on x, while it is completely analogous to case N from market 2's viewpoint.

Thus, y will be determined by (6), while the equilibrium level of x will be determined by (14). The equilibrium levels are:

$$x^S = \frac{\alpha k(b-s)}{b^2-\alpha s^2} \tag{25}$$

$$y^S = \frac{k(b-\alpha s)}{b^2-\alpha s^2} \tag{26}$$

It is easy to ascertain that $x^S < x^N$ because $\alpha < 1$, while $y^S > y^N$ if and only if $s > 0$. The same is true as regards the comparison with the case of optimal commitment. The welfare level is:

$$W^S = \frac{k^2[b^3(1+\Theta)-2\Theta sb^2-2\alpha^2s^2b+2\alpha^2s^3]}{2(b^2-\alpha s^2)^2} \tag{27}$$

It is possible to see that

$$W^C(y^*) - W^S = \frac{\alpha^2k^2b(b-s)^2(1-\Theta)}{2(b^2-s^2\Theta)(b^2-\alpha s^2)^2} > 0 \tag{28}$$

As we know that $W^N > W^C(y^*)$, the case of simultaneous regulation turns out to be the worst one from the regulator's viewpoint. To illustrate these results, it is convenient to use the following graphical representation, in terms of "reaction functions" of one output level relative to the other. This is possible, as all solutions have similar structures. In market 2, the objective function of the regulator is always (1), and this determines a relationship between y and x such that $W_y = 0$. On the other hand, the first order conditions of the bargaining games are completely analogous in the different cases, and yield the reaction function of x to y, explicitly given by (14). As intuition suggests, the slopes of the reaction functions have the opposite sign to s, so that when the goods are complements the reaction functions are upward sloping, as in Figure 1, and conversely when x and y are substitutes (Figure 2).

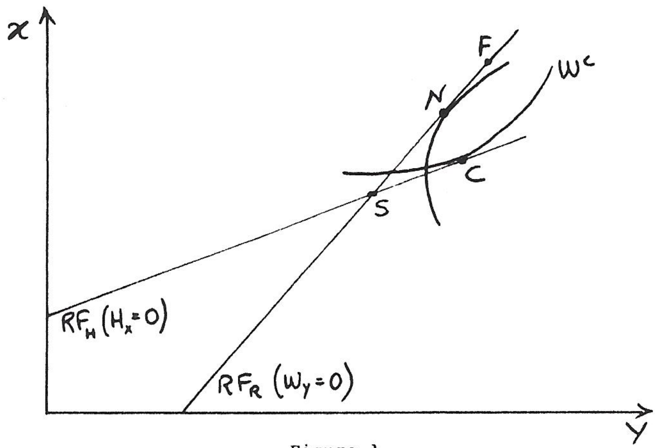

Figure 1

The first best (F) is at the intersection between the bisector (because the markets are completely symmetric) and the line where $W_y = 0$. Notice that from (15) we know that when $y = y^F$, the levels of x in situations with and without commitment must be equal: this allows us to determine the position of point N. We also know that when the commitment is optimally chosen, $x^C < x^N$, and this indicates in what region the optimal commitment point, C, must be found.

It is possible to give an interpretation of these figures using the familiar terminology of duopoly theory, thinking of y as determined by the regulator (player R), and of x as if it were decided by a hypothetical player H. The reaction functions are denoted by RF_R and RF_H, respectively, whose expressions are given by the first order conditions for W and H.

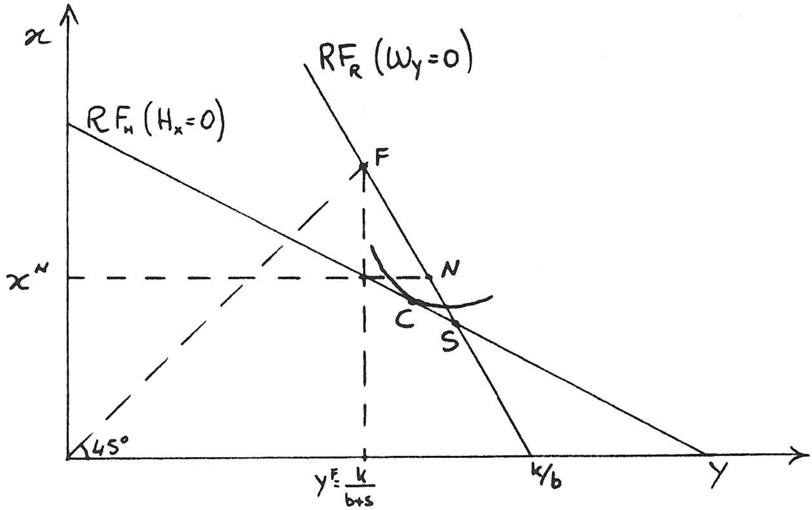

Figure 2

The equilibrium indicated by S corresponds to the (non-cooperative) Nash equilibrium, as output levels are determined simultaneously by different players. The cases in which output levels are determined sequentially are analogous to situations of Stackelberg leadership, in which the regulator can be either leader (case C) or follower (case N). Our result can thus be interpreted by stating that the position of Stackelberg follower should be preferred by the regulator.

This is no surprise with complementary goods (Figure 1), because we find the same result that we have in oligopoly models when the reaction functions are upward sloping. The analogy is strict, because in this case, as in the case of oligopoly, the point of maximum utility for player R lies above the reaction function of the other player.

In the case of substitutes, analyzed in Figure 2, we have an opposite situation because there is a substantial difference between the case we examine and a duopoly. Player R does not get the maximum payoff for $x = 0$, as he would in the case of an oligopoly, but when $x = k/(b+s)$, at point F. Unlike the case of oligopoly, player R has an interest in inducing player H to *increase* the level of x relative to the Nash equilibrium (point S). This is why the optimal commitment is *not* to a level of y to the *right* of the reaction function, as we would have if the players were oligopolistic firms, but to a level that makes x more profitable at the margin [see (20)]. Our result suggests that the target of increasing the level of x is achieved more "economically" if the regulator is a Stackelberg follower.

5. The issue of credibility

As we already mentioned, a pre-commitment may not be optimal, once the bargaining has come to an end. A departure from marginal cost pricing is not optimal ex-post, and thus a commitment to y which does not lead to marginal cost pricing may not be credible, unless, for instance, the agreement on x is made conditional to the commitment to y being respected. Moreover, an irreversible commitment may not always be sensible. Indeed, no agreement is reached with firm 1, the regulator would have no reason not to set $y = k/b$, unless production in market 2 has already taken place.

In some situations a fully credible commitment must be flexible, *conditional* to x being positive. If we allow for this kind of conditional commitment, y may be determined by (20) if x is positive, and equal to k/b in case of disagreement. The outside option does not depend on the commitment, and is equal to $k^2/2b$, as the regulator will not be forced to make any mistake in case of disagreement. His gains from trade are:

(29) $$\Delta W = kx - bx^2/2 - sxy - s^2x^2/2b$$

Following the usual procedure we find the equilibrium value of x for the case of conditional commitment, x^{CC}. Setting $z \equiv s/b$, this value is:

(30) $$x^{CC} = \tau \frac{k - sy}{b}$$

where $\tau \equiv [9 + z^2 - (17 - 14z^2 + z^4)^{1/2}]/4(2 + z^2)$. As $z^2 \leq 1$, we can easily see that $\alpha \leq \tau \leq 2/3$. Thus, x^{CC} is certainly larger than x^C: independently of the value of y, *a conditional, flexible commitment must be preferred to a completely rigid one*. This is of course no surprise, as we have seen that the only difference between the two cases is that in the case just considered the regulator's outside option is larger.

The comparison between x^{CC} and x^N is of course dependent on the value of y^{CC}. The general condition for $x^{CC} > x^N$ is the following:

(31) $$kb(\tau - \alpha) + s\tau[k - (b+s)y] > 0$$

The interpretation is analogous to the one of condition (15), although now the result is less clear cut. To make things more precise, assume first that the only credible commitment is the one corresponding to marginal cost pricing, so that $y^{CC} = (k-sx)/b$. In this case, by substituting this expression into (31), it is trivial to ascertain that $x^{CC} > x^N$ if and only if:

(32) $$\tau[1-z^2(1-\alpha)] - \alpha > 0$$

Unfortunately, the complex relationship between τ and z^2 endangers conclusions based on the analytical study of this condition. However, a simple numerical investigation reveals that condition (32) is *never met*, so that even a conditional pre-commitment leading to marginal cost pricing turns out to have a negative effect on the outcome of bargaining, relative to the case of no-commitment.

In the same way, let us examine the effects of an optimal commitment on y when we allow for "conditionality". The optimal commitment is

$$y^{**} = \frac{k(b-s\Phi)}{b^2-s^2\Phi} \tag{33}$$

where $\Phi \equiv \tau(2-\tau) < 1$, and $\Phi \geq \theta$. It is easy to check that $y^{**} > y^{*}$ if and only if the goods are complements ($s < 0$). The reason is that $x^{CC} > x^{C}$, which gives the regulator an incentive to impose a larger level of y if and only if the goods are complements, as the larger output level in market 1 will cause an increase in the demand for y.

Going back to condition (31) and using (33), we can see that an optimal commitment increases the equilibrium level of x relative to the case of no commitment if and only if:

$$z^2 < \frac{\tau - \alpha}{\tau - \alpha\Phi} \tag{34}$$

As $\Phi < 1$, the RHS of (34) is also less that unity. Numerical investigation indicates that $x^{CC} \leq x^{N}$, with the equality holding if and only if $s = 0$. The intuition is completely analogous to the one used in comparing x^{C} and x^{N}. Indeed, the structures of the two problems are extremely similar. In both cases, [see equations (14) and (30)], by increasing y the regulator increases x less than proportionately. Therefore, by committing himself (even if "optimally") to a departure from marginal cost pricing the regulator does not improve his bargaining power.

At this point, the following finding on the comparison between W^{CC} and W^{N} is no surprise. Necessary and sufficient for $W^{CC} \geq W^{N}$ is :

$$z^2 \leq \frac{\Phi - \Theta}{\Phi - \Phi\Theta} \tag{35}$$

which is never met for $s \neq 0$, as can be ascertained numerically.

Therefore, the existence of "conditionality" in the pre-commitment on y represents an improvement from the regulator's viewpoint, but does not affect substantially Proposition 2: even a "flexible" pre-commitment is not beneficial in this situation.

6. The choice of price or quantity as regulated variable

So far we have assumed that the public authority regulates the output levels, leaving the price determination to the market. In the monopoly case, regulating output is usually equivalent to regulating price because of the market clearing constraint. With two interdependent markets, things can be different[4]; however, if a market is regulated before the other, the choice in the second one is irrelevant, because only one degree of freedom is left. Let us examine the three main cases separately.

Case of no commitment (NP). At the second stage, the regulator will set $p_2 = c$. Because marginal cost pricing is a dominant strategy for the regulator in market 2 the bargaining with firm 1 has the same structure as before. Thus, the choice between price and quantity is irrelevant if the bargaining occurs before any commitment is made.

<u>The case of price commitment</u> (CP). Here, p_2 is fixed before the bargaining, and firm 2 has to serve the whole market at that price. As y can be adjusted depending on x, the outside option is different from before. In general, price commitments make firm 2 behave more aggressively, because its supply will be horizontal, and this can force the firm 1 to accept a larger output level. This can be confirmed by the following simple analysis. In the second stage, bargaining is on x, taking p_2, rather than y, as given. The demand curves can be rewritten as:

$$(3') \qquad y = (a - p_2 - sx)/b$$

and

$$(2') \qquad p_1 = [a(b-s) + sp_2 - (b^2-s^2)\, x]/b$$

Rewriting the whole problem in these terms one gets the following FOC:

$$(36) \qquad [kb - s(a-p_2) - (b^2-s^2)x]\,[k(b-s) - (b^2-s^2)x] =$$

$$= - [kb - s(a-p_2) - 2(b^2-s^2)x]\,[k(b-s) - (b^2-s^2)x/2]$$

This leads us to a first relevant conclusion. When $p_2 = c$, by definition $(a-p_2) = k$. Thus, expression (36) coincides with (9), and will obviously yield the same outcome, x^N. Therefore, when the regulator pre-commits himself to a price equal to marginal cost in market 2, he can get the same level of x as if he had bargained on x before fixing p_2. This entails a difference between this case and the one of quantity regulation, where a pre-commitment never pays off. This can be summarized as follows:

<u>**PROPOSITION 3**</u>. By pre-committing himself to a certain <u>*price*</u> in market 2 before bargaining on x, the regulator can obtain a larger welfare level than with any scheme in which output is the regulated variable.

The proof is straightforward. By pre-committing to $p_2 = c$, the regulator can exactly reproduce the outcome of situation N, which yields the larger welfare level in the case of output regulation. Moreover, marginal cost pricing is not necessarily an optimal pre-commitment for the regulator, which, as we know from Proposition 1, should set $p_2 > c$ if and only if x and y are substitute goods[5]. Thus, an optimal commitment to price would give a result strictly superior to the one obtained in case N.

<u>The case of simultaneous regulation</u> (SP). As we have already observed, the situation of simultaneous regulation is identical to the case with no commitment, from the viewpoint of market 2, and to the case of commitment, as regards firm 1. In market 2, $p_2 = c$ is a dominant strategy for the regulator, as in case NP (no commitment on price). Thus, in the other market, negotiators take for granted that $p_2 = c$, and thus it is "as if" p_2 had been set equal to marginal cost before bargaining[6]: the result is obviously the same as with a pre-commitment to $p_2 = c$.

This occurs because, if the regulator fixes p_2 and the bargaining breaks down $(x = 0)$, firm 2 will adjust its output level. Therefore, the outside options in the cases without pre-commitments are equal, as in both cases we would have marginal cost pricing. On the contrary, in case S (with output regulation) we have marginal cost pricing if and only if $x = x^S$, while if $x = 0$ the regulator is forced to make a "mistake". This reduces his bargaining power relative to case N.

It is then possible to rank all alternatives we examined. It is useful to summarize these findings in the following corollary.

<u>**COROLLARY**</u>. $W^{CP} \geq W^{SP} = W^{NP} = W^N \geq W^C \geq W^S$. Therefore, regulating price is always (weakly) preferred to regulating output.

An optimal pre-commitment to a price before bargaining is thus the best option, while regulation of price is superior to regulation of quantities. The intuition supporting this result is similar to the one offered by Singh and Vives (1984), who showed that price competition is more aggressive than quantity competition, and that the market equilibrium is in general more efficient. Here the problem of the regulator is to induce firm 1 to increase the output level, and to minimize at the same time the distortions in market 2. A behaviour "à la Bertrand" turns out to lead to a more efficient outcome.

7. The optimal structure of the regulatory authority: centralized vs decentralized bargaining

A further problem that can be analyzed within this framework is the optimal structure of regulatory authority. In particular, we want to analyze whether it is better to regulate both markets with the *same regulatory body* (same objective function), or with *two different agencies*, each having as objective function the surplus created in only one market.

On the basis of our simple model, we cannot tackle most of the relevant issues, which are analyzed in detail by Kay and Vickers (1988). However, our analysis suggests the existence of a potential *externality* between the agencies, different from those considered in the literature, which indicates a new argument in favour of centralization. The reason is that, as we have seen, an important factor in the determination of the equilibrium is the outside option the regulator(s) has (have) when bargaining with the firms. Therefore, by restricting the authority of a regulatory agency to a single market, one prevents it from making some potentially relevant strategic moves.

To illustrate this point, let us start from the case where *no commitment* is possible, so that the outside option is given by (12). If the authority is centralized, the regulator maximizes (1) having (12) as an outside option, and his gains from trade in each market are given by (13), which we rewrite for convenience:

$$\Delta W = kx - bx^2/2 - sxy \tag{13}$$

If bargaining is decentralized, the objective function of the agency dealing with firm 1 is:

$$W^1 = \int p_1 dx - cx = kx - bx^2/2 - sxy \tag{37}$$

while its outside option is obviously equal to zero, because agency 1 does not take into account the surplus generated by firm 2. As expressions (13) and (37) are identical, in this case the regulator is *indifferent* between a centralized structure and a decentralized one. Indeed, in both cases the NBE would be determined by the maximization of the same function.

In the case where the regulator may *commit* himself on a certain value of y before bargaining with firm 1, we know that a commitment to marginal cost pricing by a centralized authority is never optimal. As $p_2 = c$ would be the obvious choice for an agency dealing solely with market 2, decentralization *worsens* the situation, because it prevents the regulator making any strategic move in market 2. Thus, our approach offers a new argument against decentralizing the regulatory authority. From this viewpoint, centralization gives the regulator the chance to behave strategically, and thus should be, at least, weakly, preferred.

8. Further developments

We believe that the investigation of regulation in related markets is a field that would deserve more attention. In particular, several other problems might be tackled within this framework.

A fairly natural extension of the present framework would be to analyze the case in which all firms involved have bargaining power, as it is the case with most public utilities. As shown in Scarpa (1990) this may also enrich our understanding of the choice betweeen output and price as regulated variables.

Furthermore, so far we have assumed that the regulator can impose the "rules of the game", i.e., he can choose the regulated variable and the order in which markets must be regulated. If the firms' bargaining power is such that they can force the regulator to bargain also on these issues, the situation might be more complex. For instance, in some cases the firms and the regulator may have opposite interests as regards the regulated variable. If a compromise has to be reached between them, this may lead them to bargain on a supply function, i.e. on price/quantity pairs.

FOOTNOTES

1) For instance, Kahn (1988, vol.I, p.20) points out that "the licensure of entry in most public utility industries tends to be an infrequent, once-and-for-all or almost-all determination ... the structure of the market and identity of the firms ... remain essentially unchanging".

2) Given the structure of the NBE, a measure of the bargaining power of the regulator is the ratio of the gains from trade of the two players: $B \equiv \Delta\pi/\Delta W$. As the gain from trade of a player is a measure of his interest in reaching the agreement, the larger the value of B, the greater the relative bargaining power of the regulator. The reason is that the firm would suffer a relatively larger loss in case of disagreement, and thus it has a greater incentive to reach an equilibrium. In turn, the larger the value of B, the larger output will be, because in a NBE we have $\Delta\pi/\Delta W = |\pi_x|/W_x$, and W_x is positive. When $y^C = k/(b+s)$, the value of B is the same in both cases, and it is equal to $[k-(b+s)x]/[k-(b+s)x/2]$.

3) In this case, it could be argued that firm 1 has no bargaining power, so that the scheme in which there is an asymmetry between firms as regards bargaining power can be applied only when the two goods are at least partially differentiated.

4) Especially in conditions of uncertainty, the choice is unlikely to be neutral, as the results obtained by Weitzman (1974) in a different context suggest. It is interesting to see that uncertainty also plays an important role in the choice of the strategic variable in oligopolistic models, such as Klemperer and Meyer (1986). A thorough analysis of a similar issue in conditions of complete information is provided by Singh and Vives (1984). As we will see, this analogy can be usefully exploited in our analysis.

5) Proposition 1 refers to the case of output commitments. An extension of this proposition which allows for a commitment on price is indeed very straightforward.

6) This result depends on the assumption that in market 2 the regulator has complete bargaining power, so that $p_2 = c$ is a dominant strategy. As soon as we give the firm some bargaining power, the equivalence between cases NP and SP should disappear, because in case NP the outcome of the first stage would indeed affect the equilibrium in the second market.

BIBLIOGRAPHY

A. Kahn (1988), *The Economics of Regulation* (original edition, 1970-1971), MIT Press, Cambridge, Mass.

J. Kay and J. Vickers (1988), Regulatory Reforms in Britain, *Economic Policy*, vol.7, pp.285-351.

P. Klemperer and M. Meyer (1986), Price Competition vs. Quantity Competition: The Role of Uncertainty, *Rand Journal of Economics*, vol.17, pp.618-638.

C. Scarpa (1989), *Industry Regulation when Firms have Bargaining Power*, unpublished DPhil Thesis, Nuffield College, Oxford.

C. Scarpa (1990), An Analysis of Optimal Bargaining Strategies when Regulating Related Markets, mimeo, Dipartimento di Scienze Economiche, Bologna.

N. Singh and X. Vives (1984), Price and Quantity Competition in a Differentiated Duopoly, *Rand Journal of Economics*, vol.15, pp.546-554.

J. Vickers and G. Yarrow (1985), *Privatization and the Natural Monopolies*, Public Policy Centre, London.

M. Weitzman (1974), Prices *vs* Quantities, *Review of Economic Studies*, vol.41, pp.477-491.