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Does the waterbed effect harm consumers?

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Abstract

In this paper I analyze how the exercise of buyer power by one firm can lower the price of its input good and raise the price of the input good of the rival firms (the so-called waterbed effect). In particular, I consider an economy with two markets: in the wholesale market an upstream firm sells an intermediate good to two downstream firms. These firms use the input to produce a final good that they sell to the consumers in the the final consumption market. The price of the intermediate good is the outcome of simultaneous negotiations between the upstream and each downstream firm. I consider both symmetric and asymmetric negotiations. I find under which conditions an increase of the efficiency of one downstream firm provokes a decrease of the price of the input good paid by this firm and an increase of the price of the input good for its rival. I find this effect in a very general setting where the parties negotiate the price of the good and have an endogenous outside option. I consider both cases of downstream competition over prices and quantities. Furthermore, I analyze the welfare consequences.

1 Introduction

Usually a good reaches the final consumer after passing through many intermediaries and distributors, and at each of these levels of distribution, buyers and sellers determine the price of the product. The traditional vision of a market when a unique price for input

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is fixed may not be appropriate to describe such trade relations. For example, recently the United Kingdom Competition Commission attempted to investigate these kind of relationships in the inquiries (Commision UK, 2007a) and (Commision UK, 2007b) into the grocery retailing sector. One part of this investigation was about the complaints of small distributors against the price manipulation induced by the large distributor chains. The former complained that the discount obtained by the latter (in particular Tesco) resulted in higher supplier prices for the small grocery retailers.

This inquiry driven by the Competition Commission analyzing these complaints, led to coin the term “waterbed effect”. To have an intuition of it, imagine two people seated on a bed mattress filled with water. If one person puts on weight he goes down because he becomes heavier and the other person goes up, even if he doesn't put on any weight. In the same way one firm when becomes larger or, in a wider sense, more powerful, may lower its wholesale price and this discount may result in a higher input price for the other firms.

To define this effect, consider an economy with several downstream and upstream firms. Downstream firms buy an input from upstream firms that is used to produce a consumption good. The price of such input is the outcome of a negotiation between an upstream and a downstream firm. The waterbed effect refers to the phenomenon by which the large downstream firms manage to obtain the input at a discount price. In turn, this induces a (negative) externality on the smaller downstream firms in the form of a higher price of the input.

In the UK grocery market the small distributors claimed that suppliers overcharged them, because they needed to make up margins lost to the big distributors. In other words, they claimed that the large retailers obtained a price reduction of the price of the good bought from the suppliers, and that this discount resulted in an higher price for them. That is, the waterbed effect occurred.

At first glance, this effect may not be intuitive, because even if a downstream firm obtains a discount, it does not imply that the negotiated prices should change. In fact, if it would possible for the supplier to raise its price to other downstream firms, the supplier would have already done so.

At the end of the inquiry, the UK Competition Commission didn't find evidence of the relationship between these discounts and the higher prices.

This paper contains an attempt to inquire into the rationale of this phenomenon. I present a model in which the waterbed effect is a result of the strategic features of the negotiation processes. This point of view is supported by some papers that explain how such effect arises from the interaction of the firms involved in the downstream market and in the negotiations. The main contribution of this paper to this literature is to generalize the distribution of the bargaining power between the firms involved in the negotiation process and to endogenize the value of the outside options.

I propose a simple framework with one upstream firm and two downstream firms in an economy with two markets. In the wholesale market the upstream firm sells an intermediate good to the two downstream firms. Downstream firm D_i buys the input good at price w_i, $i = 1, 2$. The prices of this input good are determined by two simultaneous negotiation processes between the upstream firm and each downstream firm. In the consumption good market the downstream firms compete for consumers.

The rationale is the following. I argue that if a downstream firm obtains a discount in the price negotiated with the supplier, then this firm can lower the price of its final good and increase the quantity of good sold in the final consumption market. On the one hand, the decrease of the input price makes this downstream firm more aggressive in the final market and the tougher competition harms the rival. As consequence, the latter will be weaker when it negotiates the price of its input good. On the other hand, the upstream firm is harmed as well, and it will charge an higher price to the other downstream firm in order to recover the profits it losts in the former negotiation.

2 Literature

2.1 Bargaining

There is a recent literature studying the price formation between suppliers and retailers using a simultaneous negotiation mechanism. Chae and Heidhues (1999) study the effects of downstream coalitions on the bargaining power of a single downstream firm and on the number of varieties that the upstream firm will supply. They show that the bargaining power of the downstream firms increases with respect to the bargaining power of the upstream firms and this lowers the incentives for entry in the upstream production industry. Chae and Heidhues (1999) consider two markets (each one with one supplier and one retailer) and investigate the effect of buyers' alliances on the outcome of the negotiation between the supplier and the retailer to determine the price of the traded good. They find conditions under which the alliance benefits the buyers. To solve their problem Chae and Heidhues use the Zeuthen-Nash solution that extend the Nash solution in two directions: it extends it to situations where a player bargains with multiple players simultaneously and to situations where a negotiation party is a coalition of agents.
Inderst and Wey (2003) study the incentives for horizontal merger in a model of multilat-

eral bargaining. In their model there are two suppliers and two downstream firms. They propose a particular bargaining procedure and they show that this procedure generates the Shapley value. They investigate the distribution of the profits of the upstream and downstream firms under different industry structures. Furthermore, they study how the horizontal merger decision changes with different types of technologies. Raskovich (2007) presents a model of ordered bargaining where buyers choose the order in which they bargain with suppliers of known characteristic. This is different from the common assumption that meetings between traders are generated randomly. He presents a static model with a finite number of suppliers with no capacity constraints. All players have full information and the game is common knowledge. One party makes a take-it-or-leave-it-offer.If an offer p is accepted, they trade and the game finishes for the buyer. If the offer is rejected, the two parties don't trade and the buyers bargain with another supplier. Raskovich finds that the strategic bargaining outcome is equivalent to the generalized Nash bargaining solution and he proves that a buyer starts bargain with the supplier that gives him the expected highest payoff.

Sandonís and Faulí-Oller (2006) analyze the optimal two-part tariff that a research laboratory should propose to sell a patented innovation to two downstream firms. The innovation will be used by two firms that produce differentiated goods. They analyze whether the research laboratory prefers to sell the innovation or to merge with one of the firms in the downstream industry. Faulí-Oller and Sandonís (2003) also consider one firm willing to transfer technological knowledge. This firm has two different alternatives: licensing or merging. They show that when both per-unit price and fixed fees are feasible, merger should not be allowed.

2.2 The waterbed effect

The literature about the waterbed effect is scarce, probably because people paid attention to the waterbed effect only after that the UK Competition Commission started investigating it.

Inderst and Mazzarotto (2006) present a survey of models of buyer power. They define bargaining power as the bargaining strength that a buyer has with respect to the seller with whom it trades. They also present a section on the waterbed effect, considered as a consequence of the exercise of buyer power. They consider a monopolistic supplier producing an input good at marginal cost k and selling it at a wholesale price w to a retailer that sells the final good at price p. If the supplier has all the bargaining power and the retailer has no alternative supply sources, the supplier will choose w to maximize its profits and the retailer chooses p. This price will exceed the price chosen by a vertically integrated firm. There is the double marginalization problem. If the supplier's marginal cost is increasing this problem is mitigated. If the retailer has all the bargaining power, the wholesale price w is equal to the marginal cost of the supplier: $w = k$. To eliminate the double marginalization problem they could use two-part tariffs. But such contracts have no impact on the retail price. Furthermore, if the downstream demand is perfectly elastic, no pass-through to consumers occur, as no market power could be exerted. If a powerful retailer obtains a discount that is passed through into lower retail prices, this should benefit its own customers. Authorities are worried about what such a process would entail for the future structure of retail market. That is, if this effect could result in higher concentration and prices when less powerful retailers exit the market. It may be the case that less powerful retailers don't lower prices in response to competition. This could happen if suppliers raise wholesale prices for the other retailers. One possible argument for the existence of this waterbed effect can be linked to changes in upstream market. If the suppliers must decrease the wholesale price, their profits decrease, and may be forced to exit. The remaining suppliers have more power and can charge an higher price. The increase of the buyer power can compensate the powerful retailer.

Another possibility is linked to changes in the downstream market. Majumdar (2007) considers a set-up in which there are two upstream firms and several downstream firms that operate in different local markets. He shows that a downstream firm can have an incentive to merge horizontally and that the wholesale price for the new entity will decrease and the wholesale price for the other downstream firms will increases. He shows that a merger may cause the waterbed effect.

Inderst and Valletti (2009a) present a two stage model where the growth of one firm causes the waterbed effect. In the second stage two downstream firms compete in the final consumption market. In the first stage there is a monopolist that makes a take-it-or-leave-it offer and the retailers decide whether to accept the offer or switch to another supply source paying a fixed cost. Finally, they show that with linear demand, low fixed cost and other conditions, the waterbed effect exists and harms consumers.

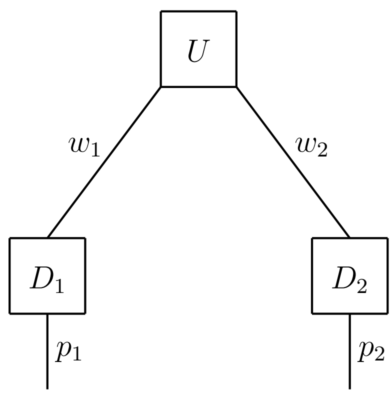
Inderst (2007) analyzes also how the exercise of buyer power can trigger and accelerate concentration in the downstream industry. He shows how the existence of discount induces incentives for the big buyers to grow even further.

Finally, Genakos and Valletti (2007) document empirically the existence of the waterbed effect in the mobile telephony market.

The paper is organized as follows. I present the model and discuss the assumptions in section 3. I find the conditions such that the waterbed effect arises in a symmetric bargaining setting in Section 4 and I check the robustness of the result extending the model in Section 5. Section 6 presents the welfare analysis and Section 7 concludes.

3 The model

Now I introduce the model and explain its added value. Consider a two stage model with two downstream firms D_1 and D_2 and an upstream firm U: in the first stage, U sells an intermediate good to D_1 and D_2. Each equilibrium input price is determined by a negotiation between U and each downstream firm. Thus, there are two negotiations and the outcomes will be two wholesale prices w_1 and w_2, one for each downstream firm. In the second stage, D_1 and D_2 compete in a final consumption market and sell their final goods to consumers at price p_1 and p_2, respectively.



3.1 The negotiations

The solution concept I use to find the price of the input good is that of Nash bargaining solution. Consider the negotiation between U and D_i. Profits of U are Π_U, derived from selling the input good to both D_1 and D_2. Its outside option is $\Pi_U^{d_i}$ and represents the profits of U when the negotiation with D_i fails and it sells the input good only to D_j. Furthermore, D_i makes profits Π_i from selling the final good to consumers. When the negotiation breaks down, D_i has the possibility to buy the input good in another market at a price w_c, exogenously determined. In this latter case D_i makes profits $\Pi_{D_i}^d$. All the different elements of the negotiation will be explained in details in subsection 4.2.

3.2 The final consumption market

Two downstream firms are situated at the extreme points of a Hotelling line, with D_1 at point 0 and D_2 at point 1. Downstream firm D_i produces at constant marginal cost $c_i + w_i$ (where c_i is the marginal transformation cost and w_i is the unit price of the intermediate good). If a consumer buys a unit of the final good from firm D_1, he pays a price p_1 and his net utility is $u - p_1 - tx$ where x is the distance from the consumer to D_1, tx is the cost at which the consumer incurs and u is the utility he gets from consuming the good. If a consumer buys from firm D_2, he pays p_2 and obtains utility $u - p_2 - t(1 - x)$. The indifferent consumer is given by:

$$q_1(p_1, p_2) \equiv x = \frac{1}{2} + \frac{p_2 - p_1}{2t}.$$

Downstream firms D_1 and D_2 maximize their profits over the prices p_1 and p_2 respectively. In this setting, the waterbed effect refers to the situation in which one firm obtains a discount on the wholesale price and this discount induces that the upstream firm charges a higher price to the other downstream firm. The discount can arise because of many reasons. In section 4 I consider two symmetric negotiation processes and the effects of an increase in the efficiency of one downstream firm.

The added value of this model is that it considers a general bargaining power distribution instead of the extreme case where the upstream firm concentrate all bargaining power (see Inderst (2007), Majumdar (2007) and Inderst and Valletti (2009a)). Another important feature of my model is that I endogenize the value of the outside option that is almost always taken as exogenous (with the exception of the unique papers that I know where the outside option is endogenous are Raskovich (2007) and Inderst (2007)). In particular, the outside option is composed of a fixed cost and of the profits that the firm obtains when the negotiation fails. These profits still depend on the wholesale price of the other firm through the final consumption market.

4 The equilibrium

In this section I derive conditions for the existence of the waterbed effect when downstream firm D_1 increases his efficiency.

I look for the subgame perfect equilibrium of the two-stage game. In the first stage the upstream firm U produces an input good at marginal cost k and it sells it to D_1 and to D_2 at prices w_1 and w_2 respectively. These prices are determined through two simultaneous negotiations, one for each price. In the second stage, D_1 and D_2 transform the input good into the final good and sell the final goods in the final consumption market at price p_1 and p_2, respectively. The technology allows both donwstream firms to produce one unit of the final good with one unit of the input good.

The model is solved by backward induction: first I solve the competition in the final consumption market and I obtain the equilibrium quantities and profits as function of the input prices w_1 and w_2, and second I solve the bargaining games between the upstream firm and each downstream firm.

Define the waterbed effect as follows:

Definition 4.1. *The waterbed effect exists if and only if:*

$$\frac{\partial w_i}{\partial c_i} > 0 \quad and \quad \frac{\partial w_j}{\partial c_i} < 0.$$

This means that the firm who becomes more efficient pays a lower wholesale price, and these reductions in its own marginal cost and in its own wholesale price induce an increase of the wholesale price of its rival.

4.1 2nd stage: final consumption market

In the final consumption market D_1 and D_2 compete à la Hotelling selling a good taking the input prices (w_1, w_2) as given. Firm D_i chooses the price p_i that maximizes its profits. The maximization problem of downstream firm i is:

$$\Pi_{D_i} = \max_{p_i} \quad (p_i - c_i - w_i)q_i(p_i, p_j).$$

The equilibrium quantity for D_i is:

$$q_i = \frac{c_j - c_i + 3t - w_i + w_j}{6t} \tag{1}$$

and its profits are

$$\Pi_{D_i} = \frac{(c_j - c_i + 3t - w_i + w_j)^2}{18t} \tag{2}$$

for $i, j = 1, 2$ and $i \neq j$. Notice that profits of D_i are convex in c_i and w_i.

4.2 1st stage: bargaining

The wholesale prices are the outcomes of the negotiation processes between the upstream firm and each downstream firm. There are two simoultaneous negotiations. To characterize these prices, I use the Nash bargaining solution concept. The upstream firm produces at constant marginal cost k (that I normalize to 0) and sells the intermediate good to D_i at prices w_i. The quantity demanded by the downstream firms is q_i found in (1).
The bargaining problem between U and D_i is the following:

$$\max_{w_i} \ N_i = \left[\Pi_U(w_i, w_j) - \Pi_U^{d_i}(w_c, w_j)\right]\left[\Pi_{D_i}(w_i, w_j) - \Pi_{D_i}^{d}(w_c, w_j) - F\right] \tag{3}$$

where:

- Π_U are the profits of the upstream firm when both negotiations succeed,

$$\Pi_U = w_i q_i(w_i, w_j) + w_j q_j(w_i, w_j).$$

w_i is the price of the input good negotiated by downstream firm D_i, and q_i is the optimal quantity in the final market found in (1).

- $\Pi_U^{d_i}$ are the profits of the upstream firm when the negotiation with D_i fails, then it sells the input good only to downstream firm j,

$$\Pi_U^{d_i} = w_j q_j^d(w_c, w_j).$$

Let denoted by q_j^d the quantity that D_j sells when it competes against D_i when the latter buys its input good in an alternative market at price w_c, exogenously determined:

$$q_j^d = \frac{c_i - c_j + 3t + w_c - w_j}{6t}.$$

- Π_{D_i} are the profits of downstream firm D_i if its negotiation succeeds.

- $\Pi_{D_i}^d - F$ are the profits of downstream firm D_i when the negotiation breaks down. In this case it has the possibility to buy the input good in an alternative market at a price w_c. The profits in this case are:

$$\Pi_{D_i}^d(w_c, w_j) = \frac{(c_j - c_i + 3t - w_c + w_j)^2}{18t}.$$

In order to have access to the alternative market, it has to pay a fixed cost F.

Assumption 4.1. *F is a fixed cost that D_i must pay in order to enter in the alternative market.*

The classical interpretation following the contribution of Katz (1987) is to suppose that a downstream firm has the alternative to integrate backwards. Alternatively, one can suppose that another supplier bids against the incumbent, and in this case F would be interpreted as a fixed switching cost or a cost of searching a new supplier.

- First I consider the case where the parties have the same bargaining power. In the next section I extend the analysis and I consider an asymmetric bargaining game.

Horn and Wolinsky (1988) build a similar bargaining structure with an unique supplier and two downstream firms. When they solve the bargaining problem, they assume that the believes of the downstream firms are passive, in the sense that downstream firms i doesn't realize that negotiation between the supplier and downstream firm j breaks

down, then D_i continues to produce the same equilibrium quantity. In my setting both downstream firms know whether the other negotiation breaks down or not, and then they know whether the input price of the rival is w_j or w_c.
Remember that w_c is exogenously determined, then the case $w_c = w_j$ coincides with the assumption of passive beliefs used, for example, by Horn and Wolinsky (1988) (the model is still different because they don't consider the outside optionn for the downstream firms).

The first order conditions for (3) can be written as follows:

$$\left[q_i + w_i \frac{\partial q_i}{\partial w_i} + w_j \frac{\partial q_j}{\partial w_i}\right] \left[\Pi_{D_i} - \Pi^d_{D_i} - F\right] + \left[w_i q_i + w_j q_j - w_j q^d_j\right] \frac{\partial \Pi_{D_i}}{\partial w_i} = 0, \qquad i = 1, 2. \quad (4)$$

4.3 The waterbed effect

Proposition 4.1 (The waterbed effect)**.** *The waterbed exists when $w_c = w$ and:*

$$0 < w < 1, \quad 0 < F < \frac{2-w}{4}, \quad \frac{1}{2}(4F + w) < t \tag{5}$$

Proof. See Appendix □

Notice that the solution exits for all values of the parameters in (5).

4.4 Discussion

We can decompose the waterbed effect into two parts. One can distinguish an effect throught the downstream market and one throught the upstream market.

First, consider the effect in the downstream market. Let me analyse two moments: the effect of the decrease of the marginal transformation cost c_i on the bargaining strenght of D_i and the effect of the total marginal cost $c_i + w_i$ on the bargaining strenght of D_j.

Following Inderst (2007), let me consider the first effect described in Lemma 4.1:

Lemma 4.1. *If $w_c < w_i$*

$$\left|\frac{\partial \Pi^d_{D_i}}{\partial c_i}\right| > \left|\frac{\partial \Pi_{D_i}}{\partial c_i}\right|.$$

Notice that the profits are convex in the marginal costs. A reduction in own marginal costs has a larger inpact on profits if marginal costs are already low. It follows that when D_i increases its efficienty, the increase of the outside option is bigger of the increase of its profits, then its bargaining position gets better and he obtains a better deal.

Now consider the following Lemma 4.2:

Lemma 4.2. *Define $k_i \equiv c_i + w_i$. If $w_c < w_j$*

$$\left|\frac{\partial \Pi^d_{D_j}}{\partial k_i}\right| > \left|\frac{\partial \Pi_{D_j}}{\partial k_i}\right|.$$

A firm loses more from a reduction of its competitor's marginal costs if the firm has itself lower marginal costs. Athey and Schmutzler (2001) discuss these conditions that are not specific of the Hotelling model and hold for example also in the Cournot model. From this, it follows that after a decrease of the total marginal cost of firm D_i, the outside option of D_j decreases more than its profits. Hence, the bargaining position of D_j gets worse and then it has to pays a higher price for the input good.

Second, consider the effect in the upstream market.

Lemma 4.3.

$$\frac{\partial\left(\Pi_U - \Pi_U^{d_i}\right)}{\partial c_i} < 0.$$

If the efficiency of D_i increases, the bargaining position of the upstream firm in the negotiation of w_i improves. Indeed, when c_i decreases, q_i increases and q_j decreases. When the negotiation fails, q_j decreases of the same amount. The net effect is that the quantity sold to D_i increases that the profits of U in this negotiation increase.

Lemma 4.4. *Define* $k_i \equiv c_i + w_i$.

$$\frac{\partial\left(\Pi_U - \Pi_U^{d_j}\right)}{\partial k_i} > 0.$$

When the marginal cost of D_i increases, the bargaining position of the upstream firm in the negotiation of w_j gets worse.

Summarizing, when a firm increases its efficiency reducing the its marginal costs, it becomes stronger in the downstream market (it will sell a bigger quantity of final product) and in the relashionship with the supplier. Then it obtains a discount in the price of the input good. Its rival are harmed because now they compete against a more efficient firm and it sells a smaller quantity of final good and its profits decreases. This makes it weaker in the relationship with the supplier that charges ah higher price for the input good.

In the particular case where $w_i = w_j = w_c$, there is no effect downstream and the waterbed effect arises only because of the change in the profits and in the outside option of the upstream firm. More in general, the bigger w_c, the more difficult is the waterbed effect to arise.

4.5 Comparative statics

Let me analyze the effect of t and F on the waterbed effect.

First, remember that t represents the degree of differentiation of the final goods (the bigger is t the more differentiated are the goods) or the intensity of the competition (the smaller is t the tougher is competition). The derivative with respect to t are the followings:

$$\frac{\partial\left(\frac{\partial w_2}{\partial c_1}-\frac{\partial w_1}{\partial c_1}\right)}{\partial t}\bigg|_{w_c=w}=\frac{4(3F+2w)}{3(4F-2t+w)^2}.$$

This means that the more the competition is relaxed, the bigger is the differential between the input prices caused by the increase of the efficiency of D_i.

Second, taking the derivatives with respect to the fixed cost F follows:

$$\frac{\partial\left(\frac{\partial w_2}{\partial c_1}-\frac{\partial w_1}{\partial c_1}\right)}{\partial F}\bigg|_{w_c=w}=-\frac{2(6t+5w)}{3(4F-2t+w)^2}.$$

This means that the less attractive is the outside option (for both downstream firms), the smaller will be the differential caused by the waterbed effect.

5 Extensions

In this section I check the robustness of the result changing some assumption. I will consider several cases: first I add an uptream firm in the setting of section 4, second I analyse the situation in which downstream firms compete over quantities, and finally I also consider the case of asymmetric negotiations, in which I allow the parties to have different bargaining power.

5.1 Negotiation with two upstream firms

The waterbed effect is not specific of this particular setting. Indeed it's possible to consider a setting with two downstream firms (D_1 and D_2) that compete à la Hotelling and two upstream firms (U_1 and U_2) that sell the input good. Upstream firm i negotiates the price of the input good with downstream firm i, and it sells the input good only to downstream firm i, for $i = 1, 2$. In this case, when the negotiation breaks down the upstream firm upstream firm U_i doesn't produce the input good and the value of its outside option is zero.

In particular one can write the maximization problems as follows:

$$\max_{w_i} N_i=\Big[\Pi_{U_i}(w_i,w_j)\Big]\Big[\Pi_{D_i}(w_i,w_j)-\Pi^d_{D_i}(w_c,w_j)-F\Big] \tag{6}$$

The first order conditions for (6) are:

$$\Big[q_i+w_i\frac{\partial q_i}{\partial w_i}\Big]\Big[\Pi_{D_i}-\Pi^d_{D_i}-F\Big]+\Big[w_iq_i\Big]\frac{\partial \Pi_{D_i}}{\partial w_i}=0, \qquad i=1,2. \tag{7}$$

Also in this case the waterbed effect arises.

Proposition 5.1. *The waterbed exists when* $w_c = w$ *and:*

$$0 < w < 1, \quad 0 < F, \quad t > \frac{1}{6}(9F + 5w) \tag{8}$$

Notice that in this case the solution exits for all values of the parameters that satisfy (8).

Proof. The proof follows very closely the case with only one upstream firm. □

5.2 Competition à la Cournot

In this subsection I consider the case in which the downstream firms compete over the quantities in the downstream market. In this case we consider both the cases of symmetric and asymmetric negotiations. In the latter case, I allow for any distribution of bargaining power between the two parties. I will consider the extreme case in which the bargaining power is held only by the upstream firm. I show that the case where the upstream firm has all the bargaining power and then can freely decide the price of the input good coincides with Inderst and Valletti (2009b) and the waterbed effect still arises.

5.2.1 Symmetric negotiations

It's possible to obtain the waterbed effect also when the downstream firms compete over the quantities. To make the computations easier, I consider a particular case of the linear demand function:

$$P = 1 - Q,$$

where $Q = \sum q_i \; i = 1, 2$ and q_i is the quantity sold by D_i. When they compete à la Cournot the equilibrium quantities and profits in the downstream market are:

$$q_i = \frac{1}{3}(1 - 2c_i + c_j - 2w_i + w_j) \tag{9}$$

$$\Pi_{D_i} = \frac{1}{9}(1 - 2c_i + c_j - 2w_i + w_j)^2. \tag{10}$$

I consider the case where there is only one upstream firm, and I obtain the following result:

Proposition 5.2. *The waterbed exists when* $w_c = w$ *and:*

$$0 < w < \frac{1}{4}, \quad c + 4w < 1, \quad 0 < F < \frac{1}{27}(4 - 8c + 4c^2 - 20w + 20cw + 16w^2) \tag{11}$$

Proof. The proof follows very closely the previous one. [1] □

[1] Notice that in this case the solution exits for all values of the parameters in (11).

5.2.2 Asymmetric negotiations

In this subsection I analyze an asymmetric bargaining problem and I consider some extreme case for particular values of the bargaining power α.

Let me consider the Cournot competition in the downstream market and only one upstream firm. In the previous subsection I derived the equilibrium quantity in (9) and the equilibrium profits in (10). The bargaining game between U and D_i is the following:

$$\max_{w_i} N_i = \Big[\Pi_U(w_i, w_j) - \Pi_U^{d_i}(w_c, w_j)\Big]^{\alpha}\Big[\Pi_{D_i}(w_i, w_j) - \Pi_{D_i}^{d}(w_c, w_j) - F\Big]^{1-\alpha} \tag{12}$$

It is the same bargaining game as in (3) with the introduction of the bargaining powers. In this setting, α represents the bargaining power of U and $1-\alpha$ is the bargaining power of D_i.

Let me consider the extreme case where $\alpha = 1$. Remember that $\alpha = 1$ means that U has all the bargaining power and makes take-it-or-leave-offers. In this case the model coincide with Inderst and Valletti (2009b) and the waterbed effect still arises. [2] Indeed, the upstream firm will offer the input price that makes the downstream firm indifferent between buying the input good or going to the alternative market. The optimal input prices w_i^* satisfy:

$$\Pi_{D_i}(w_i, w_j) - \Pi_{D_i}^{d}(w_c, w_j) - F = 0.$$

One can easily notice that w_1^* is increasing in c_1 and w_2^* is decreasing in c_1. Similarly as in Inderst and Valletti (2009b) the rationale is the following: when one firm becomes more efficient, it sells a bigger quantity of final good and makes the outside option more attractive, because the fixed cost can be spread over a larger volume; on the contrary, the rival sells a smaller quantity and its outside option becomes less attractive.

6 Welfare analysis

In this section I analyze how the welfare changes when the waterbed effect arises. I analyze both Hotelling and Cournot competition.

[2] Notice that when $\alpha = 1$ and there is not the possibility for the downstream firms to buy the input good in an alternative market (that means that their outside option is equal to zero), my model coincides with DeGraba (1990). In his paper he shows that an increase of the efficiency of D_1 implies a higher input price for D_1 and a lower input price for its rival. This is because the downstream firm with a lower marginal cost has the more inelastic demand for the input, which cause the upstream firm to charge him a higher price.

6.1 Downstream Hotelling competition

In both cases with one or two upstream firms, the effect on the industry's profits in zero. Indeed, the price for D_1 decreases in the same measure in which the price for D_2 increases as well as the respective quantities. In this way, the profits of D_1 increase and the profits of D_2 decrease of the same amount, and the profits of the upstream firm (or the sum of the profits of the upstream firms) remain constant.

The surplus of the consumers that buy from D_i can be written as:

$$CS_i = \int_0^{q_i} \Big(u - p_i - tx\Big)\, dx$$

Computing the total surplus I obtain the following result:

Proposition 6.1.

$$\frac{\partial CS}{\partial c_1} = -\frac{1}{2},$$

where $CS \equiv \sum_i CS_i$

Proof. The surplus of consumers that buy from D_1 and D_2 is

$$CS_1 = -\frac{(-c_1 + c_2 + 3t - w_1 + w_2)(7c_1 + 5c_2 + 15t - 12u + 7w_1 + 5w_2)}{72t}$$
$$CS_2 = -\frac{(c_1 - c_2 + 3t + w_1 - w_2)(5c_1 + 7c_2 + 15t - 12u + 5w_1 + 7w_2)}{72t}$$

Computing the derivative with respect to c_1 and evaluating all the expressions in $c_1 = c_2 = c$ and $w_1 = w_2 = w$, one obtains the following result: $CS = CS_1 + CS_2 = -\frac{1}{2}$. □

Hence, when one downstream firm increases his efficiency the total welfare increases.

6.2 Downstream Cournot competition

It's know that total Cournot output depends negatively on the non-weighted sum of the costs. Indeed in my model:

$$Q = \frac{2 - c_1 - c_2 - w_1 - w_2}{3}. \tag{13}$$

When the waterbed effect arises, the effect on q_1 is higher than the effect on q_2. Then it results that $\left|\frac{\partial q_1}{\partial c_1}\right| > \left|\frac{\partial q_2}{\partial c_1}\right|$, that means that after a reduction of the cost of D_1 the total quantity ($Q \equiv q_1 + q_2$) increases. It follows that the consumers' welfare increases.

Obviously the profits of D_1 increases and the profits of D_2 decreases. The profits of the upstream firm always increase. The net effect on th eprofits of the industry after an increase of the efficiency of one of the downstream firm is positive. That means that when the waterbed effect arises, both industry's profits and consumers' welfare increase.

7 Conclusions

With this paper I propose a rationale for the existence of the waterbed effect. I propose a complete model that captures the main features of the strategic interactions among the upstream firm and the downstream firms and that extends some limitations of other models proposing a theory for such effect. Indeed in my paper I assume that the input prices are determinated by bilateral negotiations between upstream and downstream firms.

The rationale I propose differs from the one proposed in the papers closely related to mine (Inderst and Valletti (2009a) and Majumdar (2007)). Here the upstream firm is harmed by the strong downstream firm because of the discount that the latter obtains. For that reason, the upstream firm wants to recover the losses in the negotiation with the other downstream firm. The other downstream firm is harmed through the final consumption market and this worses its position in the negotiation with the upstream firm that can charge an higher price.

The added value of this paper is that it generalizes the distribution of bargaining power between the parties involved in the negotiations. Inderst and Valletti (2009a) assume that the upstream firm is a monopolist that makes a take-it-or-leave-it offer. Here I relax this assumption allowing for a negotiation between upstream and downstream firms and I obtain a more complete framework. Furthermore I consider endogenous outside options: in this paper when a negotiation fails there is the possibility for the downstream firm to buy the input good in an alternative market at a exogenous price w_c. The outside option in one negotiation depends on the input price derived in the other negotiation.

In the paper I consider different type of downstream competition and I find that the waterbed effect arises with both price competition and quantity competition. The total welfare in both cases increases.

A Appendix

Proof of Proposition 4.1 Denote by G^i the first order condition of negotiation problem between U and D_i with respect to w_i, and by $G^i_{w_j}$ the derivative of the first order condition of negotiation problem between U and D_i with respect to w_j, $\forall\, i, j = 1, 2$.

Substituting in $G = (G^1, G^2)$ the solution function $w^*(r) = (w_1^*(r), w_2^*(r))^T$, where r is the vector of parameters (c_1, c_2, w_c, t, F). All the parameters in r are strictly positive. One obtains the following identity:

$$G(w^*(r); r) \equiv 0 \tag{14}$$

Differentiating (14) with respect to c_1:

$$\frac{dG^i}{dc_1} = G^i_{w_1}\frac{\partial w_1^*}{\partial c_1} + G^i_{w_2}\frac{\partial w_2^*}{\partial c_1} + G^i_{c_1} = 0 \qquad \forall i = 1, 2,$$

Rewriting these conditions:

$$\begin{bmatrix} G^1_{w_1} & G^1_{w_2} \\ G^2_{w_1} & G^2_{w_2} \end{bmatrix} \begin{bmatrix} \frac{\partial w_1^*}{\partial c_1} \\ \frac{\partial w_2^*}{\partial c_1} \end{bmatrix} = - \begin{bmatrix} G^1_{c_1} \\ G^2_{c_1} \end{bmatrix} \tag{15}$$

Since the Jacobian matrix $J = D_w G(w; r)$ is invertible, [3] using Cramer's rule I obtain:

$$\frac{\partial w_i}{\partial c_i} = -\frac{|J_i|}{|J|},$$

where $|J_i|$ is the matrix obtained by replacing the ith column of the Jacobian J with the vector $(G^i_{c_i}, G^j_{c_i})$.

$$\begin{aligned} \frac{\partial w_1^*}{\partial c_1} &= -\frac{G^1_{c_1}G^2_{w_2} - G^2_{c_1}G^1_{w_2}}{G^1_{w_1}G^2_{w_2} - G^2_{w_1}G^1_{w_2}} = -\frac{G^1_{c_1}G^2_{w_2} - G^2_{c_1}G^1_{w_2}}{D} \\ \frac{\partial w_2^*}{\partial c_1} &= -\frac{G^2_{c_1}G^1_{w_1} - G^1_{c_1}G^2_{w_1}}{G^1_{w_1}G^2_{w_2} - G^2_{w_1}G^1_{w_2}} = -\frac{G^2_{c_1}G^1_{w_1} - G^1_{c_1}G^2_{w_1}}{D}, \end{aligned}$$

where

$$D \equiv G^1_{w_1}G^2_{w_2} - G^2_{w_1}G^1_{w_2}.$$

If I compute these derivatives in the symmetric case $c_1 = c_2 = c$ and, consequently $w_1 = w_2 = w$, one obtains:

$$\begin{aligned} \frac{\partial w_1^*}{\partial c_1} &= -\frac{18Ft + 24wt + 3w^2 - 12w_c t - 4ww_c + w_c^2}{72Ft - 36t^2 + 54wt + 8w^2 - 36w_c t - 12ww_c + 4w_c^2} \\ \frac{\partial w_2^*}{\partial c_1} &= \frac{18Ft + 24wt + 3w^2 - 12w_c t - 4ww_c + w_c^2}{72Ft - 36t^2 + 54wt + 8w^2 - 36w_c t - 12ww_c + 4w_c^2} \end{aligned}$$

Notice that in the symmetric equilibrium $\frac{\partial w_2^*}{\partial c_1} = -\frac{\partial w_1^*}{\partial c_1}$. Hence, I only need to investigate the sign of the derivative of w_1 and this is positive when:

$$0 < w < 1, \quad 0 < F < \frac{2 - w}{4}, \quad \frac{1}{2}(4F + w) < t$$

[3]Notice that $|J| = G^1_{w_1}G^2_{w_2} - G^2_{w_1}G^1_{w_2} \neq 0$ for all the value of the parameters when $F \neq \bar{F} \equiv \frac{1}{36}(18 - 27w - 4w^2 + 18w_c + 6ww_c - 2w_c^2)$.

References

Athey, S. and A. Schmutzler (2001): "Investment and Market Dominance," *The RAND Journal of Economics*, 32, 1–26.

Chae, S. and P. Heidhues (1999): *The Effects of Downstream Distributor Chains on Upstream Producer Entry: A Bargaining Perspective*, Wissenschaftszentrum Berlin für Sozialforschung.

Commision UK, C. (2007a): "Grocery Market Investigation," Tech. rep., UK Competition Commision, www.competition-commission.org.uk/inquiries/ref2006/grocery/pdf/emerging_thinking.pdf.

——— (2007b): "Market investigation into the supply of groceries in the UK," Tech. rep., UK Competition Commision, http://www.competition-commission.org.uk/rep_pub/reports/2008/538grocery.htm.

DeGraba, P. (1990): "Input Market Price Discrimination and the Choice of Technology," *The American Economic Review*, 80, 1246–1253.

Faulí-Oller, R. and J. Sandonís (2003): "To merge or to license: implications for competition policy," *International Journal of Industrial Organization*, 21, 655–672.

Genakos, C. and T. Valletti (2007): "Testing the 'Waterbed' Effect in Mobile Telephony," Centre for Economic Performance, Working Paper.

Horn, H. and A. Wolinsky (1988): "Bilateral Monopolies and Incentives for Merger," *The RAND Journal of Economics*, 19, 408–419.

Inderst, R. (2007): "Leveraging buyer power," *International Journal of Industrial Organization*, 25, 908–924.

Inderst, R. and N. Mazzarotto (2006): *Buyer power in distribution.*

Inderst, R. and T. Valletti (2009a): "Buyer Power and the 'Waterbed Effect'," CEIS Tor Vergata Working Paper.

——— (2009b): "Price Discrimination in input markets," *The RAND Journal of Economics*, 40, 1–19.

Inderst, R. and C. Wey (2003): "Bargaining, Mergers, and Technology Choice in Bilaterally Oligopolistic Industries," *The RAND Journal of Economics*, 34, 1–19.

KATZ, M. (1987): "The welfare effects of third-degree price discrimination in intermediate good markets," *The American Economic Review*, 154–167.

MAJUMDAR, A. (2007): "Waterbed effects and buyer mergers," ESRC Centre for Competition Policy University of East Anglia and RBB Economics, Working Paper.

RASKOVICH, A. (2007): "Ordered bargaining," *International Journal of Industrial Organization*, 25, 1126–1143.

SANDONÍS, J. AND R. FAULÍ-OLLER (2006): "On the competitive effects of vertical integration by a research laboratory," *International Journal of Industrial Organization*, 24, 715–731.