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Bönte, Werner; Wiethaus, Lars

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Why powerful buyers finance suppliers' R&D

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Why Powerful Buyers finance Suppliers' R&D

Werner Bönte
Lars Wiethaus

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Why Powerful Buyers finance Suppliers' R&D

Werner Bönte* and Lars Wiethaus†

October 21, 2008

Abstract

It is a common concern that pricing pressure by powerful buyers discourages suppliers' R&D investments. Employing a simple monopsonist - competitive upstream industry - framework, this paper qualifies this view in two respects. First, the monopsonist has an incentive to subsidize upstream R&D which yields more upstream R&D and higher profits in both industries than the monopsonist's commitment to higher prices. Secondly, in the presence of *intra*-industry R&D spillovers between upstream firms, the monopsonist has an even stronger incentive to finance upstream R&D. If the monopsonist finances more than fifty percent of suppliers R&D efforts, R&D investments in upstream industry will be higher than in the case of buyer competition.

JEL Classification: O31, O32, L13, L20

Keywords: Vertical Relationships; Monopsony; Buyer Power; R&D, Knowledge Spillovers..

*Corresponding author: Schumpeter School of Business and Economics, University of Wuppertal, Gaußstraße 20, D-42097 Wuppertal, Fon: +49 202 439 2446, Fax: +49 0202 439 3852, Email: boente@wiwi.uni-wuppertal.de

†ESMT Competition Analysis, Email: lars.wiethaus@esmt.org.

1 Introduction

This paper is motivated by two patterns prevalent for buyer-supplier-relationships. First numerous industries are characterized by large buyer power. The Federal Trade Commission, for instance, discusses monopsony in e-commerce, health care, petroleum and more generally in merger enforcement (Noll 2005) whereas the European Commission seems particularly concerned about monopsonistic power in retail industries[1]. While it is well established that monopsonistic power leads to reduced input purchases as compared to the competitive level and to allocative inefficiencies respectively (Blair and Harrison 1992 and 1993), more recently, the distortion of suppliers' innovation incentives due to low input prices has gained increased interest (see below). Alongside we observe an increased tendency towards R&D outsourcing and contracting. This second pattern is often viewed as evidence for a growing importance of external knowledge sources for firms' innovation activities (e.g. Quinn 2000, Zhao and Calantone 2003, Bönte 2003 and Mol 2005). As an alternative explanation for R&D contracts we demonstrate that even if the monopsonist does not utilize any of the suppliers' R&D for its own innovation activities, it has a per se incentive to finance part of its suppliers' R&D. In addition we show that the monopsonist's financial support to suppliers R&D can exceed that of a social planner who uses R&D subsidies in order to remedy market failures due to knowledge spillovers among suppliers.

What is the monopsonist's rationale behind financing suppliers' R&D? The monopsonist intends to exploit its market power upon reducing input purchases and lowering the input price respectively. This reduces margins in the upstream industry and, as a consequence, the ability and incentives to innovate. Farber (1981), Peters (2000) and Weiss and Wittkopp (2003) support this hypothesis empirically for 50 US industries, the German automotive industry and the German food sector respectively. The monopsonist accordingly suffers from rent shifting in terms of high upstream production costs (foregone process innovation) or few new product developments (foregone product innovation). In turn the monopsonist might have an incentive

[1] See EC (1999), Röller (2004) and cases Kesko/Tuko (1996), Blokker/Toys "R" Us (1997), Rewe/Meinl (1999), Carrefour/Promodes (2001) .

to increase the input price somewhat as to stimulate upstream innovations. However the monopsonist can resolve the tradeoff between pricing pressure and upstream R&D stimulation through a direct R&D subsidization while maintaining low input prices.

We exemplify this behavior by an admittedly stylized and simple model which nonetheless yields some interesting results. In particular we consider a competitive upstream industry and a monopsonistic downstream industry. In a first *no commitment* benchmark case firms decide simultaneously on the input price (the monopsonist) and R&D investments (upstream industry) before upstream firms determine their output quantities. This case reflects a monopsonist's pricing behavior without regard to effects on upstream innovation. In the second *price commitment* case we propose a sequential set up in which the monopsonist announces the input price prior to the upstream firms' R&D decisions. Again upstream output quantities are set in the last stage. This version of the model allows the monopsonist to trade off low input prices against potential distortions in upstream investment incentives. The third *finance commitment* case equals the benchmark (no commitment case) but introduces an initial stage in which the monopsonist determines its subsidization of upstream R&D investments.

Our results indicate that equilibrium upstream R&D investments increase in the price commitment case relative to the no commitment case and, even more, in the finance commitment case. This order holds for both the monopsonist's and upstream industry firms' profits respectively and, hence, we would expect that a monopsonist and competitive upstream firms indeed agree on R&D subsidization from the former to the latter. Our analyses thereby suggests that the concern of distorted upstream (R&D) investment incentives might be ill-founded in cases where direct investment subsidization is possible. From an empirical or case study perspective this arrangement might just as well be interpreted as a form of R&D outsourcing.

We extend our analysis by including *intra*-industry R&D spillovers between firms of the upstream industry. Knowledge spillovers are by itself a source of market failure: as long as firms are not compensated for the positive externalities their R&D provide for others, private incentives result in underinvestment from the social welfare perspective. A common policy instrument

is then to subsidize R&D in industries with high knowledge spillovers such that the socially optimal level of R&D is induced (e.g. Wright 1983, Beath et al. 1989, Romano 1989). Within our simple framework we find that a monopsonist has a stronger incentive to finance R&D investments of upstream firms in the presence of intra-industry R&D spillovers in the upstream industry. This finding raises the more general point that public R&D subsidization might be ill-founded in cases where concentrated vertically related industries are able to appropriate, at least partly, the benefits from intra-industry knowledge spillovers.

The relationship between buyer power and a supplier's innovation incentives has been analyzed previously by Inderst and Wey (2005 a, b). In their model a single supplier serves a fixed number of downstream firms and the latter operate in independent markets. Buyer power is modeled as the ability of large buyers to substitute away from the supplier. Buyers can threaten the supplier through withholding demand which allows them to obtain discounts. Under certain circumstances the supplier can improve its bargaining position by investing in innovations. Inderst and Wey show that in the presence of larger buyers and concave downstream revenues (convex upstream production costs) increase the supplier's incentive to invest in product (process) innovations. In contrast, we make use of a simple monopsony setup where suppliers do not have any bargaining power even after investing in innovations. Buyer power has a negative impact on upstream firms' innovation efforts whereas, in our model, the suppliers' incentives to invest in innovation are restored through the financial support of a monopsonistic downstream firm.

The paper is arranged as follows. In section 2 we set up the model and analyze the no commitment, the price commitment and the finance commitment case respectively. A comparison of the three cases completes section 2. Section 3 introduces knowledge spillovers into the basic model and compares the monopsonist's subsidization rate with a social planner's one. Section 4 concludes and provides directions for future research.

2 The model

We consider two vertically related industries with a downstream monopsonist and a competitive upstream industry. The monopsonist purchases a homogenous intermediate input in the quantity V, produced by $i = 1, ...n$ upstream firms, i.e. $V = \sum_i^n v_i$. The monopsonist transforms the input to a final output, Q, employing a 1:1 technology, i.e. one unit of input is needed to produce one unit of final product. Furthermore we assume that the downstream monopsonist is a price taker in *final* product market and that upstream firms are price takers in *intermediate input* market. The intermediate input price w is the same for all upstream firms.

Each upstream firm can reduce its marginal production costs through process innovation. In particular production costs are convex and given by

$$C(v_i) = (A - x_i)v_i + \frac{c}{2}v_i^2, \quad i = 1, ..., n$$

where $A > 0$ and $c > 0$ are exogenous parameters and x_i is each downstream firm's reduction of marginal production costs due to its R&D efforts. Increasing marginal costs of production ensure that firms in the upstream industry can earn a producer surplus to recover fixed costs.[2] As standard in the literature, the costs of innovation are also convex, i.e.

$$F(x_i) = \frac{\gamma}{2}x_i^2, \quad i = 1, ..., n,$$

where $\gamma > 0$ is an exogenous cost parameter. Finally we assume that the downstream monopsonist has constant marginal production costs which we normalize to zero.

No commitment by the monopsonistic buyer Our basic reference case consists of two stages. In the first stage the downstream monopsonist and the upstream supplier act simultaneously. In particular the monopsonist sets the

[2]The assumption of increasing marginal costs may be justified by the fact that the amount of physical capital is fixed in the short run. Firms may perform R&D to induce process innovations which make the existing capital stock more efficient but cannot adjust the physical capital stock. Empirically, upward sloping supply curves have been confirmed by Shea (1993) for 16 out 26 sample industries in the U.S.

intermediate input price, w, and each upstream firm determines its amount of cost reducing R&D efforts, x_i. This setting reflects a situation in which (a) the monopsonist does not announce a certain (e.g. high) input price (which would imply that the input-price is chosen prior to R&D decisions) and (b) the upstream firms don't consider the effect of their R&D on the monopsonist's input-price (which would imply that R&D efforts are chosen prior to the input-price)[3]. In the second stage the upstream suppliers choose their profit maximizing output quantities.

Using the standard backwards induction procedure we start in the second stage and derive the upstream firms' output decisions. The ith upstream firm's profit-function can be written as

$$\pi_i = wv_i - (A - x_i)v_i - \frac{c}{2}v_i^2 - \frac{\gamma}{2}x_i^2, \quad i = 1, ..., n. \tag{1}$$

Given the level of R&D efforts, x_i, and the price of the intermediate good, w, differentiation of (1) with respect to v_i and then solving first-order-condition for the firms' equilibrium output quantities yields

$$v_i^* = \frac{w - A + x_i}{c}, \quad i = 1, ..., n, \tag{2}$$

and the total output of the upstream industry is given by

$$V^*(x_i) = \sum_{i=1}^{n} v_i^* = n\frac{w - A}{c} + \sum_{i=1}^{n} \frac{x_i}{c}, \tag{3}$$

which simplifies to

$$V^* = n\frac{w - A + x}{c} \tag{4}$$

in the case of a symmetric upstream industry. As one will expect the level of upstream firms' output depends positively on the intermediate input price and on firms' R&D efforts.

We turn now to the first stage of the model in which the monopsonist and the upstream firms choose the input price and the R&D efforts respectively.

[3]For this case it can be shown that upstream R&D efforts are lower than those in the in the simultaneous move case. However, this scenario is not realistic because the profits of the monopsonist and the upstream suppliers are lower compared with the profits in the fixed-price case.

Consider first the monopsonist's decision. Its profit-function is given by

$$\Pi = pQ - wV. \tag{5}$$

Due to our assumption of a 1:1 technology we can substitute $V^*(x_i)$ as given by (3) for Q and V to re-write (5) as

$$\Pi = pV^*(x_i) - wV^*(x_i), \tag{6}$$

which is maximized with respect to w, leading to

$$w^*(x_i) = \frac{1}{2}(p + A - \frac{1}{n}\sum_{i=1}^{n} x_i) \tag{7}$$

and

$$w^* = \frac{1}{2}(p + A - x) \tag{8}$$

in the symmetric case respectively. According to equation (8) the input price the monopsonist is willing to pay increases with the product price in the final product market and the cost parameter A. In contrast, higher symmetric R&D efforts in the upstream industry lead to lower intermediate input prices.[4] Thus, the monopsonist is able to squeeze profits from upstream firms' process innovations.

Next we analyze an upstream firm's R&D decision. The upstream firms take the input price w as given when deciding about their R&D efforts. Substitution of v_i^* as given by (2) for v in equation (1) yields the first-stage profit-function of the i'th upstream firm:

$$\pi_i = wv_i^* - (A - x_i)v_i^* - \frac{c}{2}v_i^{*2} - \frac{\gamma}{2}x_i^2, \quad i = 1, ..., n. \tag{9}$$

Solving the first-order-condition, $\partial\pi_i/\partial x_i = 0$, for x_i yields the ith upstream firm's optimal R&D efforts,

$$x_i^* = \frac{w - A}{c\gamma - 1}. \tag{10}$$

[4]Since we assume symmetric R&D efforts, an increase in x by one unit means an increase of R&D efforts of all upstream firms by one unit.

The second-order-conditions, $\partial^2\pi_i/\partial x_i^2 < 0, \quad i = 1, ..., n$, require $c\gamma > 1$ which will be assumed throughout. We substitute w^* for w in (10), omit subscript i to reflect the symmetric case and solve for

$$x^* = \frac{p - A}{2c\gamma - 1}. \tag{11}$$

The optimal R&D efforts of upstream firms are positively affected by a higher price of the final product and negatively by the production cost parameters A and c and R&D cost parameter γ.

Input-price commitment by the monopsonistic buyer In the previous setting we have assumed that the monopsonist does not take into account the impact of the intermediate input price on upstream firms' R&D decisions. However even a powerful buyer may be willing to set a higher input price, anticipating that this leads to an increase in upstream R&D efforts. To incorporate this rationale we now propose that the monopsonist announces a (higher) price prior to upstream firms' R&D decisions[5] which transforms the two stage no commitment setting into a three stage setting. In the first stage the monopsonist sets its input price w in anticipation of the upstream firms' optimal second stage R&D decisions x_i^* as given by (10). In the final stage upstream suppliers set their output quantities v_i^* as given by (2).

Let superscript P denote the price commitment case. Then we obtain

$$V^P = n\frac{\gamma(w - A)}{c\gamma - 1}, \tag{12}$$

upon substitution of x_i^* as given by (10) into (3) and can re-write the monopsonist's profit function as

$$\Pi = pV^P - wV^P. \tag{13}$$

[5] Of course the monopsonist would have an incentive to behave opportunistically and set a lower input price *ex post*, i.e. after R&D decisions of upstream firms are irreversible. However, if perfect contracts exist the price of the intermediate input cannot be changed by the buyer after upstream firms have conducted their cost-reducing R&D. Then, each of the upstream firms and the monopsonistic supplier may agree on a contract that prevents opportunistic behavior of the monopsonist.

Differentiation of (13) with respect to w yields the monopsonist's first-order condition which can be solved for the optimal intermediate input price

$$w^P = \frac{1}{2}(p + A). \tag{14}$$

By (14) and (8) it is apparent that a monopsonist's commitment to an input price before upstream suppliers decide about their R&D efforts results in a higher input price for positive R&D efforts, i.e. $x > 0 \Longrightarrow w^P > w^*$. Substituting w^P in equation (10), we get the equilibrium R&D efforts in the upstream industry for the price commitment case:

$$x^P = \frac{1}{2}\frac{p - A}{c\gamma - 1}. \tag{15}$$

Finance commitment by the monopsonistic buyer The input price commitment affects R&D efforts only indirectly via higher supplier profits and, moreover, an upstream firm ignores the positive effects its R&D has on the monopsonist's profit. Therefore the effects of such a commitment may mainly show up in an increase in supplier profits rather than in a an increase in R&D efforts. Consequently, the monopsonist might prefer a more direct way to increase upstream R&D which we will now discuss: financial support to suppliers R&D. For instance, she may place out R&D contracts to each of her suppliers. In these contracts the monopsonist guarantees to finance a certain share, s_i, of its i'th supplier's R&D costs whereby R&D is still solely performed by the supplier. Then the i'th firm's overall R&D costs are split in the following way:

$$F(x_i) = \underbrace{(1 - s_i)F(x_i)}_{\text{supplier } i} + \underbrace{s_i F(x_i)}_{\text{monopsonist}} = (1 - s_i)\frac{\gamma}{2}x_i^2 + s_i\frac{\gamma}{2}x_i^2, \quad i = 1, ...n.$$

We analyse the case of the monopsonist's finance commitment within the no commitment framework adding an initial stage in which the monopsonist decides on the amount of financial support for the i'th firm. That is in the first stage the monopsonist sets s_i, in the second stage the monopsonist sets $w^*(x_i)$ as given by (7) and upstream firms decide on their R&D investments and in the third stage upstream firms determine their output quantities v_i^* as given by (2).

In order to analyze the suppliers' second-stage R&D levels for a given s_i we modify (9) to introduce the term $(1 - s_i)$ which yields

$$\pi_i = wv_i^* - (A - x_i)v_i^* - \frac{c}{2}v_i^{*2} - (1 - s_i)\frac{\gamma}{2}x_i^2, \quad i = 1, ..., n. \tag{16}$$

Differentiation of (16) with respect to x_i gives the i'th firm's first-order-condition, which can be solved for

$$x_i^{\overline{S}} = \frac{w - A}{(1 - s_i)\gamma c - 1}. \tag{17}$$

Substitution of w^* as given by (8) for w in (17) and omitting subscript i to reflect the symmetric case results in

$$x^{\overline{S}} = \frac{p - A}{2(1 - s)\gamma c - 1} \tag{18}$$

where superscript $\overline{S}$ denotes the subsidization case. The second-order conditions, $\partial^2\pi_i/\partial x_i^2 < 0 \quad i = 1, ..., n$, require $\gamma c > 1/(1 - s_i)$ which we assume throughout in order to obtain meaningful results, e.g. (17) is strictly positive.

In the first stage the monopsonist decides about the extent of financial support, s_i. Anticipating upstream firms' R&D decisions as given by (18), the monopsonistic buyer chooses the (symmetric) share of financial support to maximize its profit-function

$$\Pi = pV^{\overline{S}} - w^*V^{\overline{S}} - n\ s\ \frac{\gamma}{2}(x^{\overline{S}})^2, \tag{19}$$

where we obtain $V^{\overline{S}}$ upon substitution of $x^{\overline{S}}$ for x in (4). Differentiating (19) with respect to s and solving the first-order-condition for s yields the optimal share of financial support,

$$s^* = \frac{2c\gamma + 1}{6c\gamma} \tag{20}$$

It is easy to see that the optimal share of financial support to suppliers' R&D decreases with higher values of parameters c and γ with a minimum (maximum) share of 1/3 if $c\gamma \to \infty$ (of 3/7 if $\gamma c \to 1/(1 - s)$). If R&D costs raise (high values of γ) monopsonist's financial support becomes more expensive and therefore the buyer reduces the share of financial support. If the supply curve of firms in the upstream industry is very steep (high values

of c) the monopsonist does not benefit that much from a shift in the supply curve due to cost reducing R&D and does therefore reduce the share of financial support. Finally we substitute s^* for s in (18) to obtain symmetric equilibrium R&D efforts in the upstream industry,

$$x^S = \frac{3}{4}\frac{p-A}{\gamma c - 1}. \tag{21}$$

Comparison of settings We can now compare the results of the three settings we discussed so far with respect to the implied levels of R&D efforts in the upstream industry and the levels of profits in up- and downstream industry respectively. First we compare the optimal levels of upstream firms' R&D efforts for the monopsony case without any commitment, x^*, input price commitment, x^P, and with finance commitment, x^S.

Proposition 1 *Equilibrium upstream R&D investments satisfy*

$$x^S > x^P > x^*.$$

Proof. By (15) and (11), $x^P > x^*$ and by (21) and (15), $x^S > x^P$ since $p - A > 0$ and $c\gamma > 1/(1-s)$. ■

For the discussion to follow it is useful to define a benchmark case, namely that of buyer competition (price taking behavior). In this case the intermediate input price equals the final output price, i.e. $w = p$. Accordingly optimal R&D efforts in the upstream industry can be obtained by substitution of p for w in (10),

$$x^C = \frac{p-A}{\gamma c - 1}, \tag{22}$$

where the superscript C denotes buyer competition. A comparison of upstream firms' optimal R&D efforts in the case of monopsony, as given by (11), with the R&D efforts in the case of buyer competition, as given by (22), reveals that the existence of a monopsony in the downstream industry leads to a strong reduction of R&D efforts in the upstream industry: the level of R&D is reduced by more than 50 percent. This is because an upstream firm benefits the more from its cost-reducing R&D the higher is its output whereby the existence of a downstream monopsony, of course, reduces upstream output. An input price commitment increases R&D levels

but equilibrium upstream R&D efforts are by (15) and (22) still 50 percent lower than in the case of buyer competition. A monopsonist's commitment to financial support of suppliers' R&D has a stronger impact on upstream R&D efforts and yields by (21) and (22) 75 percent of the amount of R&D in the case of buyer competition.

Of course, the upstream monopsonist will only commit to a higher input price or financial support of suppliers' R&D if this leads to an increase in its profits. Therefore we analyze the profitability of such commitments by comparing equilibrium profit levels in the setting without commitment, Π^*, with input price commitment, Π^P, and with finance commitment, Π^S, for symmetric R&D efforts in the upstream industry.

Proposition 2 *Equilibrium profits of the monopsonistic buyer satisfy*

$$\Pi^S > \Pi^P > \Pi^*.$$

Proof: see appendix.

Next we investigate whether upstream firms also benefit from input price and finance commitments by the monopsonistic buyer. The answer is given by the following Proposition:

Proposition 3 *Equilibrium upstream profits satisfy*

$$\pi^S > \pi^P > \pi^*.$$

Proof: see appendix.

The (high) price commitment makes the monopsonist as well as the upstream firms better off. The intuition for this result is rather straightforward. The downstream monopsonist takes two counteracting effects into account when setting the input price. On the one hand a decrease in the input price down to the level w^* will, ceteris paribus, lead to an increase in the monopsonist's profit. On the other hand such a decrease lowers suppliers' profits and discourages cost reducing R&D efforts which in turn negatively affects the monopsonist's profits. If the monopsonist forces upstream firms to accept input prices below the level w^P the latter effect dominates the former.

However, the monopsonist and the upstream firms benefit even more from the monopsonist's commitment to financial support of upstream R&D.

In particular the monopsonist overcomes the dilemma of loosing margins through the (high) input price commitment on the one hand and discouraging R&D investments through pricing pressure on the other. As it does not come at the disadvantage of loosing margins through high input prices, by means of direct financial support, the monopsonist is willing to to induce a stronger increase in upstream R&D and, respectively, a larger reduction in upstream production costs and a stronger increase in the supply of the intermediate inputs. Apparently this implies that the monopsonist's marginal cost/disadvantage of inducing more upstream R&D is always higher through input-price commitment than through direct financial support; which is true, interestingly, for any level of marginal R&D costs, γ. As a consequence the monopsonist earns higher profits through direct financial support. At the same time upstream firms also benefit from this because financial support (higher R&D efforts) outweighs the low intermediate input price which suppliers have to accept.

3 Finance of suppliers' R&D in the presence of knowledge spillovers

In this section we will briefly analyze how knowledge spillovers in the upstream industry affect the downstream monopsonist's incentive to finance upstream R&D. It will turn out, as one might expect, that knowledge spillovers increase the buyer's financial support. More interestingly the buyer's financial support even exceeds that of social planner, ceteris paribus.

In order to model the impact of knowledge spillovers we introduce the *effective* knowledge of the i'th upstream firm which is each firm's reduction of marginal cost due to own R&D and due to the R&D received from other firms in the upstream industry. Following the literature we employ a simple linear effective knowledge function

$$X_i = x_i + \beta \sum_{j \neq i} x_j, \quad i = 1, ...n,$$

where β, $0 \leq \beta \leq 1$, represents the share of firm j's knowledge, $j \neq i$, that spills over to firm i. The i'th firm then produces with marginal production

costs $(A - X_i)$ instead of $(A - x_i)$. To analyze the upstream firms' second stage R&D decisions we modify (16) to introduce the effective knowledge, X_i, which becomes

$$\pi_i = wv_i^K - (A - X_i)v_i^K - \frac{c}{2}(v_i^K)^2 - (1 - s_i)\frac{\gamma}{2}x_i^2, \quad i = 1, ..., n. \tag{23}$$

where the superscript K indicates the knowledge spillover case and the i'th firm's optimal output is now given by

$$v_i^K = \frac{w - A + X_i}{c}, \tag{24}$$

and total upstream output respectively,

$$V^K = \frac{1}{c}(n(w - A) + \sum_{i=1}^{n} X_i), \tag{25}$$

Differentiation of (23) with respect to x_i gives the ith firm's first-order-condition, which can be solved for ith firm's optimal R&D effort

$$x_i^{\overline{K}} = \frac{w - A}{(1 - s_i)\gamma c + \beta(n - 1) - 1}. \tag{26}$$

Analog to (8), the optimal intermediate input price without price commitment in the symmetric case is given by

$$w^K = \frac{1}{2}(p + A - X) \tag{27}$$

Substitution of (27) for w in (26) and omitting subscript i to reflect the symmetric case yields

$$x^{\overline{K}} = \frac{p - A}{2(1 - s)\gamma c + \beta(n - 1) - 1}. \tag{28}$$

As can be seen from (28) optimal R&D investments in the upstream industry decrease with the spillover level and increase with the share of the monopsonist's financial support. In the first stage we can solve for the monopsonist's optimal share of financial support by maximizing

$$\Pi = pV^{\overline{K}} - w^{\overline{K}}V^{\overline{K}} - ns\frac{\gamma}{2}(x^{\overline{K}})^2, \tag{29}$$

where we obtain $V^{\overline{K}}$ and $w^{\overline{K}}$ upon substitution of $X^{\overline{K}}$, $X^{\overline{K}} = x^{\overline{K}} + (n-1)x^{\overline{K}}$, for X in (25) and (27). Differentiating (27) with respect to s and solving the first order condition for s gives the monopsonist's optimal share of financial support

$$s^K = \frac{2c\gamma + 1}{6c\gamma} + \frac{\beta(n-1)(1+8\gamma c)}{6\gamma c(3+2\beta(n-1))}, \tag{30}$$

where the optimal share of financial support, s^K, does now also depend on the spillover parameter, β, and the number of firms in the upstream industry, n. The first term of (30) equals (20). Obviously this optimal share of financial support, s^K, is equal to the one we derived in the previous section, s^*, if the value of β is zero, i.e. the second term is zero. For $1 \geq \beta > 0$ the second term is positive, increasing in β and increasing in the number of firms, n. Thus the existence of knowledge spillovers in the upstream industry leads to an increase in the downstream monopsonist's optimal share of financial support.

In order to compute symmetric equilibrium R&D efforts in upstream industry, x^K, we substitute s in equation (28) by s^K which yields

$$x^K = \frac{p - A}{2(1-s^K)\gamma c + \beta(n-1) - 1}. \tag{31}$$

As in the previous section, we will now compare the upstream firms' optimal R&D efforts in the case of finance commitment with those R&D efforts that would arise in the case of buyer competition. In the latter case input price equals output price ($w = p$) and by substitution of w in equation (26) for p and setting $s = 0$ we obtain upstream firms' optimal R&D efforts for the buyer competition case

$$x^C = \frac{p - A}{\gamma c + \beta(n-1) - 1}. \tag{32}$$

Comparison of (31) and (32) shows that the optimal R&D investments in the upstream industry will be higher in the case of finance commitment than in the case of buyer competition if the monopsonist commits herself to finance more than 50 percent of suppliers' R&D efforts ($s^K > 0.5$). This result differs from the result of the previous section (no spillovers) where the level of R&D investment in the finance commitment case was only about 75 percent of

level of R&D efforts in the buyer competition case. Now it can exceed R&D efforts in buyer competition if, for instance, the spillover level is high.

4 Conclusion

This paper aims to make two main points. The first one addresses concerns regarding inefficient upstream investment behavior due to rent appropriation of powerful, monopsonistic buyers. We show that the latter does not only have options but also incentives to circumvent distortions in upstream investment behavior. In particular powerful buyers may commit either to higher input prices or to financing a certain share of upstream investments directly. The latter option, direct investment financing, is the most profitable one for both the monopsonist and the upstream industry. This result may offer an alternative explanation for the increasing pattern of R&D contracting within buyer-supplier relationships.

The second point addresses public policy towards market failures in R&D. In the presence of upstream *intra*-industry knowledge spillovers, a monopsonist has a stronger incentive to finance upstream R&D. If monopsonists commits herself to finance more than fifty percent of suppliers R&D efforts, R&D investments in upstream industry will be higher than in the case of buyer competition. This result suggests more conservative public R&D promotion in cases where concentrated vertically related industries are able to internalize, at least partly, the positive externalities from R&D through lower input prices. In these cases private subsidization incentives might simply be crowded out by public subsidizations. It is worth emphasizing that we obtain this result without any *inter*-industry spillovers.

However we derive our results for a rather restrictive setting. It might therefore be fruitful to extend our basic monopsony - competitive industry model to more general versions with oligopsony and oligopoly industries respectively. In particular the existence of a downstream competitor might result in adverse subsidization incentives due to free-riding effects. We intend to explore this issue in future research.

5 Appendix

Proof of Proposition 2. For the symmetric case substitution of (8), (11) and (3) in (6) gives the profit of the monopsonist without commitment,

$$\Pi^* = nc\gamma^2 \frac{(p-A)^2}{(2c\gamma-1)^2}, \tag{33}$$

and substitution of (14), (15) and (3) in (6) gives the profit of the downstream monopsonist with input price commitment,

$$\Pi^P = \frac{n\gamma}{4}\frac{(p-A)^2}{c\gamma-1} \tag{34}$$

and substitution of (8), (20), (21) and (3) in (19) gives the profit of the downstream monopsonist with finance commitment,

$$\Pi^S = \frac{n}{32}\frac{p^2(8c\gamma+1)+A^2(8c\gamma+1)-pA(16c\gamma+2)}{(c\gamma-1)\,c}. \tag{35}$$

First, $\Pi^P > \Pi^*$, as

$$\begin{aligned}
\frac{n\gamma}{4}\frac{(p-A)^2}{c\gamma-1} &> nc\gamma^2\frac{(p-A)^2}{(2c\gamma-1)^2} \\
\frac{1}{4c\gamma(c\gamma-1)} &> \frac{1}{(2c\gamma-1)^2} \\
4c\gamma c\gamma - 4c\gamma + 1 &> 4c\gamma c\gamma - 4c\gamma,
\end{aligned}$$

where the latter inequality holds for $c\gamma > 1/(1-s)$.
Secondly, $\Pi^S > \Pi^P$ follows by

$$\begin{aligned}
\frac{n}{32}\frac{p^2(8c\gamma+1)+A^2(8c\gamma+1)-pA(16c\gamma+2)}{(c\gamma-1)\,c} &> \frac{n\gamma}{4}\frac{(p-A)^2}{c\gamma-1} \\
(p-A)^2\frac{1+8c\gamma}{8c} &> \gamma\,(p-A)^2 \\
1+8c\gamma &> 8c\gamma,
\end{aligned}$$

which again holds by $c\gamma > 1/(1-s)$.■

Proof of Proposition 3. Substitution of (8), (11) and (2) in (1) gives the profit of the ith upstream firm in the case of no commitment by the monopsonist,

$$\pi_i^* = \frac{1}{2}\gamma\frac{(p-A)^2(\gamma c-1)}{(2\gamma c-1)^2}, \tag{36}$$

substitution of (14), (15) and (2) in (1) gives the profit the ith of upstream firm in the case of input price commitment by the monopsonist,

$$\pi_i^P = \frac{1}{8}\gamma\frac{(p-A)^2}{\gamma c-1}, \tag{37}$$

and substitution of (8), (21) and (2) in (1) gives the profit the ith of upstream firm in the case of finance commitment by the monopsonist,

$$\pi_i^S = \frac{1}{64}\frac{5(p-A)^2-4\gamma c(p-A)^2+8\gamma^2c^2(p-A)^2}{c\,(\gamma c-1)^2}. \tag{38}$$

First we have $\pi_i^P > \pi_i^0$ as

$$\begin{aligned}
\frac{1}{8}\gamma\frac{(p-A)^2}{\gamma c-1} &> \frac{1}{2}\gamma\frac{(p-A)^2(\gamma c-1)}{(2\gamma c-1)^2}\\
\frac{1}{4(\gamma c-1)^2} &> \frac{1}{(2\gamma c-1)^2}\\
4\gamma^2c^2-4\gamma c+1 &> 4\gamma^2c^2-8\gamma c+4\\
4\gamma c+1 &> 4,
\end{aligned}$$

which is true for $c\gamma > 1/(1-s)$.

Secondly $\pi_i^S > \pi_i^P$ follows by

$$\begin{aligned}
\frac{1}{64}\frac{5(p-A)^2-4\gamma c(p-A)^2+8\gamma^2c^2(p-A)^2}{c\,(\gamma c-1)^2} &> \frac{1}{8}\gamma\frac{(p-A)^2}{(\gamma c-1)}\\
5-4\gamma c+8\gamma^2c^2 &> 8c^2\gamma^2-8c\gamma\\
5+4\gamma c &> 0,
\end{aligned}$$

which is true for $c\gamma > 1/(1-s)$.■

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