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Abstract

In a model where two competing downstream firms establish an input joint venture (JV), we analyze how different royalty rules for covering fixed costs affect channel profits. Under running royalties (regardless of whether based on predicted or actual output), the downstream firms' perceived marginal costs are above the true marginal costs since fixed costs are incorporated. We find that tougher competition between the JV partners may actually increase channel profit under such a scheme. We also show that running royalties based on predicted output are outperformed by royalties based on actual output, but that lump-sum financing of the JV is preferable if the competitive pressure is weak.

JEL-Code: L100.

Keywords: input joint ventures, competition, royalty rules.

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1 Introduction

It is widely observed that competing firms establish upstream joint ventures (JVs). In high-tech industries, research and development joint ventures are common for e.g. software, electronic hardware and pharmaceutical products. Within telecommunications, the European Commission (2009) invites competing operators to create joint ventures and other forms of cooperative agreements to generate new infrastructure (such as fixed and mobile high-bandwidth networks) and to acquire spectrum rights. From the authorities' perspective the gains from allowing competing firms to set up JVs range from environmental improvements (e.g. co-siting of antennas for mobile networks), higher investment incentives and less duplication of fixed costs to more rapid rollout of new and better infrastructure. In grocery markets large retail chains have formed procurement alliances (buyer groups), such that the level of concentration is higher for procurement than for retailing (see e.g. Clarke et al., 2002, Dobson and Waterson, 1999 and Foros and Kind, 2008).[1]

We focus on the allocation of unavoidable fixed costs in the JV, i.e. costs which are not affected by output levels. Examples of such costs are joint investments in new digital infrastructure and development of digital information goods. Especially for fixed broadband investments, the largest part of the fixed cost is literally speaking sunk, spent on digging ducts (not on fiber-optic cables and other electronic equipment). Similarly, for digital information goods the large fixed costs are typically sunk when the first copy is developed. The same features hold for hardware. Think of a smartphone. When a new model is launched, the development costs cannot be regained even if the product becomes a flop. Royalty rules for covering fixed costs are by their very nature arbitrary[2], and our aim is to analyze how the three most common rules affect downstream competition.

[1] For an extensive list of examples of joint ownership in vertical market structures, see e.g. Park and Ahn (1999).

[2] As a consequence, we focus on fixed cost components ill-suited for cost allocation methods, such as Activity Based Costing (ABC). Noreen (1991) sets up the necessary requirements for using ABC. Bromwich and Hong (2000) provide an interesting example of the suitability of ABC when analyzing whether BT's accounting system satisfies the conditions for accounting separability.

As a benchmark we consider *lump-sum royalties.* Since lump-sum payments are not based on output, they do not affect the JV members' choice of downstream prices. We compare lump-sum royalties with running royalties, where payments depend on the downstream firms' output. We consider two forms of running royalties; one which depends on predicted output, and one which depends on actual output. Under a *running royalty scheme based on predicted output,* the per unit transfer price is calculated based on expectations of aggregate output. Since the transfer price is increasing in the size of the fixed costs, the perceived downstream marginal costs are higher than under lump-sum royalties. Sharing rules that incorporate fixed costs into the unit payments from the JV members thus soften downstream competition and lead to a higher price level than the lump-sum scheme.[3]

The alternative to predicted outcomes is *running royalties based on actual output,* where fixed costs are distributed based on realized volumes ex-post. This significantly changes the firms' pricing incentives. The reason is that when running royalties are based on actual output, a higher output reduces the perceived downstream marginal costs. Thus, the firms will have incentives to set relatively low end-user prices in order to reduce production costs on infra-marginal units.

If the firms are symmetric along all dimensions, we show that even though their incentives are quite different under the two running royalty schemes, the equilibrium outcomes will be identical. This is not so if the firms have different ownership shares in the JV. Then running royalties based on actual output generate higher profits than running royalties based on predicted output. The reason is that the firm with the larger ownership share will compete more aggressively than its rival under a predicted output scheme, and this distorts the market.

The question that begs to be asked is whether royalties based on actual output are widely used. At first glance it might not seem to be so, since joint venture agreements often include elements where fixed costs are allocated based on predicted volumes. However, such agreements typically also include a clause to adjust

[3] If each JV member estimates its own volume, it is obvious that sharing rules which are based on these estimates may generate opportunistic behavior. We intentionally abstract from such problems to focus on the interplay between fixed costs sharing rules and downstream competition.

for actual volumes if there are significant deviations between predicted and actual volumes. One example is provided by Groot and Merchant (2000) from the automobile industry, where the JV agreements involve a "solidarity principle": If actual volumes deviate significantly from expectations, then ex post adjustments are made where the party "over using" capacity relative to expectations, compensates the party which is "under using". In the grocery markets different forms of buy-back clauses may have the same effect (see e.g. Bloom et al., 2000).[4]

Since running royalties based on actual volumes weakly dominate schemes based on predicted volumes, we concentrate on actual volumes when comparing to lump-sum royalties. To highlight the vices and virtues of the rules, assume first that the downstream firms do not compete, such that they are *de facto* monopolies in their respective markets. Under a lump-sum royalty scheme the firms face the true marginal costs, and will therefore set the same prices as a perfect cartel would do. With running royalties, on the other hand, the perceived marginal costs are above the real ones. Therefore prices will be inefficiently high compared to what maximizes channel profits (analogous to Spengler, 1950).

Now, suppose that the firms are rivals in the downstream market. Then profits under the lump-sum scheme will clearly be lower the better substitutes the consumers perceive the goods to be. The same is not necessarily true with running royalties. On the contrary, it might well be that profits increase as downstream competition intensifies (products become closer substitutes). The reason for this is precisely that end-user prices are too high under running royalties if the goods are poor substitutes. Competition which presses down end-user prices and reduces the perceived marginal production costs might thus benefit the firms - although they will unambiguously be harmed if competition becomes too tough. Consequently, we have the seemingly counter-intuitive result that up to a point, more downstream

[4] Lund et al. (2004) find an analogous form of adjustment applied to transfer prices by trading subsidiaries to avoid allegations of tax evation. Transfer prices are in most cases based on projections, and projections are in many cases inaccurate. Thus the transfer price may fall short of covering unit costs and tax authorities may suspect attempts of tax evation. To mitigate this, many firms have started using so called "keep well" agreements which oblige the parties to make year-end adjustments.

competition increases profits. A corollary is that profit under running royalties may be higher when JV members are downstream rivals than when they operate in independent downstream markets. Managers arguing that they welcome more competition are usually met with skepticism. However, this may actually be true if they finance an input joint venture BY running royalties. Correspondingly, our model predicts that running royalties are more frequently used the more aggressively the firms compete in the downstream market.

The present paper is related to the literature on how unit royalties may be used to soften competition among members of an input JV (see e.g. Priest, 1977, Park and Ahn, 1999, Chen and Ross, 2003, and Motta, 2004). Park and Ahn (1999) analyze joint ownership upstream combined with a conjectural variations approach to downstream competition. The wholesale price between upstream and downstream firms is determined through bargaining where the bargaining power is based on the firms' ownership shares. Park and Ahn show that each firm either prefers a wholesale price equal to marginal cost or the monopoly price, depending on its ownership share. Chen and Ross (2003), in contrast, focus on the profitability of a JV compared to a full-scale merger. This is not an issue we focus on, nor on the related question of whether competing firms should buy from a common supplier. The latter is analyzed in Arya, Mittendorf, and Sappington (2008). They show how an integrated firm (with its own upstream input) may choose to buy from the same supplier as the downstream rival to make the external supplier less eager to offer the input on favorable terms to the downstream rival.

Recent studies have found the use of actual (instead of predicted) volume to have amiable properties also in regulated industries, specifically for regulation of access prices.[5] Fjell, Foros, and Pal (2010) show that basing average cost access prices on actual rather than predicted volumes, neutralizes the artificial cost advantage enjoyed by a vertically integrated incumbent and hence creates a truly, level playing field in the downstream market. See also Boffa and Panzar (2012).

The rest of the paper is organized as follows. In section 2 we present the model

[5]The majority of access price regulation rules within telecommunications used worldwide are based on an averaging of fixed costs (Vogelsang, 2003).

and compare pricing incentives under lump-sum royalties and running royalties. Then, in section 3, we put more structure to the model (consider a quadratic utility function) to compare profits and prices under the different schemes. Finally, in section 4 we provide some concluding remarks.

2 The model

We consider a market structure where two competing downstream firms form an input joint-venture (JV). Firm $i = 1, 2$ owns a share $s_i \in [0, 1]$ of the JV. We assume that ownership shares are exogenous, and that $s_1 + s_2 = 1$.

The cost structure of the JV is given by

$$C = F + cQ, \tag{1}$$

where F is the fixed capacity cost, $c \geq 0$ is marginal production costs, and Q is output. It takes one unit of the JV good to produce one unit of the downstream good, so with obvious notation we have $Q = q_1 + q_2$.

The JV's fixed costs are covered by the downstream firms, and we compare the outcomes from the following three payment schemes:

I **Lump-sum (LS)**: Fixed costs covered through lump-sum payments. Since lump-sum payments do not affect firm behavior per se, it is immaterial how much of the fixed costs are covered by each firm. However, to be specific, we assume that the lump-sum payment from Firm i equals $s_i \alpha F$, where $\alpha \geq 1$ is a markup on the JV's fixed costs.

II **Running royalties based on predicted output (PO)**: Firm i pays $\frac{q_i}{\widehat{Q}} \alpha F$, where $\widehat{Q}$ is predicted aggregate output.

III **Running royalties based on actual output (AO)**: Firm i pays $\frac{q_i}{Q} \alpha F$, where Q is actual output.

Since our focus is on whether the fixed costs should be financed through lump-sum payments or running royalties, we assume that there is no mark-up on the

JV's marginal production costs. The downstream firms thus pay c per unit of the upstream good in addition to the royalties. Thereby we also avoid the trivial solution that the JV partners achieve the same outcome as in a perfect cartel (or full merger) by a suitable choice of wholesale price from the JV to the downstream firms (see Priest, 1977, and Chen and Ross, 2003).

Regardless of which payment scheme is chosen, Firm i receives revenues from the JV according to its ownership share s_i. Firm i's profit under the three different schemes is consequently given by:

$$\pi_i^{LS} = (p_i - r_{LS})\, q_i - s_i F; \text{ where } r_{LS} = c \tag{2}$$

$$\pi_i^{PO} = (p_i - r_{PO})\, q_i + s_i F \left(\alpha \frac{Q}{\hat{Q}} - 1 \right); \text{ where } r_{PO} = \frac{\alpha F}{\widehat{Q}} + c \tag{3}$$

$$\pi_i^{AO} = (p_i - r_{AO})\, q_i + s_i F\,(\alpha - 1); \text{ where } r_{AO} = \frac{\alpha F}{Q} + c \tag{4}$$

Throughout we assume that the demand function $q_i(p_1, p_2)$ and the profit function π_i satisfy the following properties:

$$\frac{\partial q_i}{\partial p_i} < 0, \qquad \frac{\partial q_i}{\partial p_j} > 0, \qquad \frac{\partial q_j}{\partial p_i} < -\frac{\partial q_i}{\partial p_i} \text{ and } \frac{\partial^2 \pi_i}{\partial p_i \partial p_j} \geq 0 \qquad i, j = 1, 2,\ i \neq j, \tag{5}$$

Condition (5) implies that the products are imperfect substitutes and that prices are strategic complements, as defined in Bulow et al. (1985). Throughout, we presuppose that all stability and second-order conditions hold (see e.g. Vives 1999, ch. 6). Furthermore, we assume that the cross-price effects on demand are symmetric, such that $\partial q_j / \partial p_i = \partial q_i / \partial p_j$.

We assume the following structure and timing of the game: At stage 1 the firms cooperatively choose between the LS, PO, and AO schemes to maximize aggregate channel profits.[6] At stage 2 they non-cooperatively decide downstream prices simultaneously.

In the **lump-sum (LS)** scheme it follows from (2) that the FOCs at stage 2 are given by :

[6]This seems natural, since they do not have any conflict of interest in choice of royalty scheme.

$$\frac{\partial \pi_i^{LS}}{\partial p_i} = \left[q_i + (p_i - r_{LS}) \frac{\partial q_i}{\partial p_i} \right] = 0; \text{ where } r_{LS} = c \tag{6}$$

Increasing the end-user price has the standard effect of raising the profit margin and reducing sales. Profit for Firm i is thus maximized by setting p_i such that the sum of the terms in the square bracket of (6) is equal to zero.

Defining $\varepsilon_i = -(\partial q_i / \partial p_i)(p_i / q_i) > 1$ as the own-price elasticity on good i, we can rewrite (6) to arrive at the standard inverse elasticity rule:

$$p_i^{LS} = \frac{1}{1 - \frac{1}{\varepsilon_i}} c. \tag{7}$$

Under **Running royalties based on predicted output (PO)**, it follows from (3) that the FOCs at stage 2 can be written as:

$$\frac{\partial \pi_i^{PO}}{\partial p_i} = \underbrace{\left[q_i + (p_i - r_{PO}) \frac{\partial q_i}{\partial p_i} \right]}_{\text{downstream effect}} + \underbrace{s_i \frac{\alpha F}{\hat{Q}} \frac{\partial Q}{\partial p_i}}_{\substack{\text{ownership effect} \\ (-)}} = 0; \text{ where } r_{PO} = \frac{\alpha F}{\widehat{Q}} + c \tag{8}$$

The term in the square bracket corresponds to the FOC for profit-maximization under LS, c.f. equation (6). However, since the perceived downstream marginal costs are greater here than under lump-sum financing ($r_{PO} > r_{LS}$), the end-user price will also be higher. A qualitatively important difference from the LS case, though, is that the firm will set a lower price than the one which maximizes downstream profits if $s_i > 0$, and more so the higher are s_i and α. Formally, this follows from the fact that the term outside the square bracket in (8) is negative (since $\frac{\partial Q}{\partial p_i} < 0$), such that the marginal profitability of a price increase is reduced. The intuition for this is simply that the upstream profit that Firm i makes from the JV is increasing in actual output, and therefore decreasing in own price. Since Firm i cares more about upstream profits the greater its ownership share in the upstream firm, we can state:

Proposition 1: *Assume that running royalties are based on predicted output (PO). The greater a firm's ownership in the joint venture (s_i), the lower its price will be in the end-user market.*

Solving equation (8) with respect to p_i, we can write Firm $i's$ equilibrium price as

$$p_i^{PO} = \frac{1}{1-\frac{1}{\varepsilon_i}} \left\{ c + \frac{\alpha F}{\hat{Q}} \left[1 - s_i \left(1 + \frac{\partial q_j / \partial p_i}{\partial q_i / \partial p_i} \right) \right] \right\}. \qquad (9)$$

Since $\frac{\partial q_j/\partial p_i}{\partial q_i/\partial p_i} \in (0, -1)$, the term in the square bracket of (9) is positive. Comparing with equation (7), we thus see that the end-user price under PO is unambiguously higher than under LS, but less so the greater the firm's ownership share in the JV.

Finally, under **Running royalties based on actual output (AO),** the stage 2 FOCs follow from (4):

$$\frac{\partial \pi_i^{AO}}{\partial p_i} = \underbrace{\left[q_i + (p_i - r_{AO}) \frac{\partial q_i}{\partial p_i} \right]}_{\text{downstream effect}} + \underbrace{\left(- \frac{\partial r_{AO}}{\partial p_i} \right) q_i}_{\text{cost effect}} = 0; \text{ where } r_{AO} = \frac{\alpha F}{Q} + c \qquad (10)$$

$$(-)$$

The FOCs under scheme AO (10) are qualitatively different from the FOCs under scheme PO (8). Under scheme AO there is no ownership effect on Firm i's pricing incentives. The reason for this is that if the running royalties are based on actual volume, then JV profits are simply determined by the mark-up on the fixed costs given by α. In particular, JV profits are independent of output and thus of downstream prices. In contrast to when royalties are based on predicted volume, a majority shareholder has the same pricing incentives as a minority owner. A second qualitative difference from PO is that downstream firms will now have incentives to set relatively low end-user prices in order to increase output and thus reduce the perceived downstream marginal costs, as shown by the term outside the square bracket in (10):

$$\frac{\partial r_{AO}}{\partial p_i} = -\frac{\alpha F}{Q^2} \frac{\partial Q}{\partial p_i} > 0. \qquad (11)$$

We can state:

Proposition 2: *Assume that running royalties are based on actual output. Independent of their ownership share in the joint venture, the firms have incentives to set relatively low end-user prices in order to reduce downstream marginal production costs* r_{AO}.

We can use equations (10) and (11) to write equilibrium prices as

$$p_i^{AO} = \frac{1}{1-\frac{1}{\varepsilon_i}} \left\{ c + \frac{\alpha F}{Q} \left[1 - \frac{q_i}{Q} \left(1 + \frac{\partial q_j / \partial p_i}{\partial q_i / \partial p_i} \right) \right] \right\} \tag{12}$$

Note that the term with the cross-price effect, $\left(1 + \frac{\partial q_j/\partial p_i}{\partial q_i/\partial p_i}\right)$, is multiplied by Firm i's output share (q_i/Q). This share is equal to 1/2 if the firms are symmetric. If royalties instead are based on predicted output, equation (9) shows that the term is multiplied by the ownership share in the JV (s_i). Interestingly, we can thus conclude:

Proposition 3: *Assume* $s_1 \neq s_2$. *Other things equal, aggregate channel profits are higher if the running royalties are based on actual rather than on predicted output.*

Proposition 3 is true because if the goods enter symmetrically in consumer utility, then convexity of consumer preferences implies that aggregate profits for any given output are maximized if the firms charge the same prices, other things equal. The prices of the two firms will always be the same if running royalties are based on actual sales, but not if the royalties are based on predicted sales and $s_1 \neq s_2$. In the latter case royalties based on predicted sales create a distortion in the market which hurts the industry.

We assume that joint venture partners are rational when they predict output, such that $q_i + q_j = \hat{Q}$. If $s_1 = s_2$ we find that the first-order conditions under both PO and AO are equal to

$$\frac{\partial \pi_i^{PO}}{\partial p_i} = \frac{\partial \pi_i^{AO}}{\partial p_i} = \left[q_i + \left(p_i - \frac{\alpha F}{2 q_i} - c \right) \frac{\partial q_i}{\partial p_i} \right] + \frac{1}{2} \frac{\alpha F}{q_i} \frac{\partial q_i}{\partial p_i} = 0. \tag{13}$$

This allows us to state:

Corollary 1: *Assume that the firms are symmetric and have the same ownership shares in the JV ($s_1 = s_2 = 1/2$). Then a running royalty scheme based on predicted output yields the same profit as one based on actual output.*

Even though the firms' pricing incentives are quite different under the two schemes (taking into account changes in upstream profits under scheme PO and changes in marginal production costs under scheme AO), the equilibrium outcomes will thus be the same under perfect symmetry.

To summarize, the actual output scheme (AO) yields higher channel profits than the predicted output scheme (PO), except for the special case $s_1 = s_2 = 1/2$.

So what can be said about the relative performance of the lump-sum scheme? We can draw quite general conclusions also with regard this question; whether LS yields higher profits than running royalties depends on the competitive pressure. This can actually be seen without making any calculations. Suppose first that the goods are close substitutes (high cross-price effect). The firms will then necessarily compete marginal profits down to zero as price approaches marginal cost. In this case, a payment scheme based on running royalties (AO as well as PO) performs significantly better than the lump-sum scheme (LS). This is because perceived downstream marginal costs are higher under running royalties than under lump-sum financing of the JV's fixed costs. Thus, running royalties soften competition and lead to a higher price level than the lump-sum scheme (LS).

On the other hand, if products are poor substitutes (small cross-price effects), the fact that a running royalty scheme artificially raises perceived marginal costs above real marginal costs causes end-user prices to be too high. In this case, the lump-sum scheme (LS) maximizes aggregate industry profits.

We can summarize these findings as follows:

Proposition 4: *Financing the JV through running royalties (regardless of whether based on actual or predicted output) yields higher channel profits than the lump-sum scheme if downstream competition is sufficiently strong. Otherwise, aggregate channel profits are higher under the lump-sum scheme.*

Since the JV members cooperatively choose the royalty rule at stage 1, they choose the rule that maximizes aggregate channel profits. Thus, the prediction from above is that, all other things equal, firms choose running royalties (based on actual output) as long as their products are close substitutes. When the degree of downstream competition is sufficiently low, firms prefer lump-sum royalty to running royalties. In the next section we illustrate the results above and also gain some additional insight by using a specific utility function.

3 Lump-sum vs. running royalties: Comparison of profits and prices

Let us now add more structure to the model by assuming that the consumers have a quadratic utility function:

$$U(q_1, q_2) = v \sum_{i=1}^{2} q_i - \left[(1-\sigma) \sum_{i=1}^{2} q_i^2 + \frac{\sigma}{2} \left(\sum_{i=1}^{2} q_i \right)^2 \right]. \tag{14}$$

The parameter $v > 0$ in equation (14) is a measure of the market potential and q_i is consumption of good i. The parameter $\sigma \in [0, 1)$ is a measure of how differentiated the goods are; they are closer substitutes from the consumers' point of view the higher is σ.[7]

Solving $\partial U/\partial q_i - p_i = 0$ for $i = 1, 2$, we find

$$q_i = \frac{1}{2} \left(v - \frac{p_i}{1-\sigma} + \frac{\sigma}{2(1-\sigma)} (p_i + p_j) \right) \tag{15}$$

Further, from 15 we have that

[7] Utility function (14) is due to Shubik and Levitan (1980). The advantage of this formulation is that σ is a unique measure of product differentiation. In a standard quadratic utility function, on the other hand, an increase in σ both means that the products become less differentiated and that the size of the market is reduced. See Motta (2004) for a discussion. Shaffer (1991) uses a similar framework to provide a comparative welfare analysis of slotting allowances and RPM. Deneckere and Davidson (1985) use the Shubik-Levitan utility function when they analyze the merger incentives of price-setting firms.

$$Q = v - \frac{p_i + p_j}{2}. \tag{16}$$

Royalty scheme PO

Consider first the royalty scheme based on predicted output, and define $f \equiv F/\hat{Q}$. Inserting (15) into (3) and setting $\partial\pi_i/\partial p_i = \partial\pi_j/\partial p_j = 0$ we find[8]

$$p_i^{PO} = \frac{2(1-\sigma)(c+v) + c\sigma + f\alpha}{4-3\sigma} - 2f\alpha\frac{1-\sigma}{4-\sigma}\left(s_i - \frac{1}{2}\right) \tag{17}$$

$$q_i^{PO} = \frac{(2-\sigma)(v-c) - f\alpha}{2(4-3\sigma)} + \frac{f\alpha}{4-\sigma}\left(s_i - \frac{1}{2}\right) \tag{18}$$

Consistent with our general results above, equation (17) shows that the price charged by Firm i is decreasing in its ownership share s_i in the JV. It thus follows that if $s_i > s_j$, then $p_i < p_j$ and $q_i > q_j$. However, aggregate output is independent of the distribution of the ownership shares; combining (16) and (17) yields

$$Q^{PO} = \frac{(v-c)(2-\sigma) - f\alpha}{4-3\sigma}. \tag{19}$$

Assuming rationality, such that $q_i + q_j = \hat{Q}$, we can solve $f = \frac{F}{\hat{Q}}$ to find that

$$f = \frac{(2-\sigma)(v-c) - \sqrt{(2-\sigma)^2(v-c)^2 - 4F\alpha(4-3\sigma)}}{2\alpha}. \tag{20}$$

Letting Π^{PO} denote aggregate channel profits, we have

$$\Pi^{PO} = \frac{[(2-\sigma)(v-c) - f\alpha][2(1-\sigma)(v-c) + f\alpha]}{(4-3\sigma)^2} - \frac{f^2\alpha^2(1-\sigma)(1-2s_1)^2}{(4-\sigma)^2} - F. \tag{21}$$

Royalty scheme AO

From the general analysis above we know that the outcomes under PO and AO are identical if $s_i = 1/2$. Therefore the expression for f in equation (20) holds in

[8] It can be shown that $\frac{\partial^2\pi_i}{\partial p_i^2} = -\frac{1}{2}\left(\frac{2-\sigma}{1-\sigma}\right) < 0$, that $\frac{\partial^2\pi_i}{\partial p_i \partial p_j} = \frac{1}{4}\left(\frac{\sigma}{1-\sigma}\right)$, and hence that the second order conditions for a unique maximum are satisfied by: $\frac{\partial^2\pi_i}{\partial p_i^2}\frac{\partial^2\pi_j}{\partial p_j^2} - \left(\frac{\partial^2\pi_i}{\partial p_i \partial p_j}\right)^2 = \frac{1}{16}\left(\frac{16-16\sigma+3\sigma^2}{[\sigma-1]^2}\right) > 0$.

both cases, and $Q^{AO} = Q^{PO}$. By setting $s_i = 1/2$ into equations (17) - (21) we can further immediately see that we have:[9]

$$p_i^{AO} = \frac{2(1-\sigma)(c+v) + c\sigma + f\alpha}{4-3\sigma}, \tag{22}$$

$$q_i^{AO} = \frac{(2-\sigma)(v-c) - f\alpha}{2(4-3\sigma)}. \tag{23}$$

and

$$\Pi^{AO} = \frac{((2-\sigma)(v-c) - f\alpha)(2(1-\sigma)(v-c) + f\alpha)}{(4-3\sigma)^2} - F. \tag{24}$$

Royalty scheme LS

The equilibrium with lump-sum financing of the JV's fixed costs is most easily found by setting $\alpha = 0$ into equations (17) - (21). This yields

$$p_i^{LS} = \frac{2(1-\sigma)(c+v) + c\sigma}{4-3\sigma} \tag{25}$$

$$q_i^{LS} = \frac{(2-\sigma)(v-c)}{2(4-3\sigma)} \tag{26}$$

and

$$\Pi^{LS} = 2(\sigma-1)(c-v)^2 \frac{\sigma-2}{(4-3\sigma)^2} - F. \tag{27}$$

Comparison of royalty schemes AO and LS

We now concentrate on *AO* for running royalties since this scheme weakly dominates *PO*. To highlight the differences between financing the JV through lump-sum payments and running royalties, let $\alpha = 1$ (such that there is no upstream profit). We then find

$$\Pi^{AO} - \Pi^{LS} = f\frac{(v-c)\sigma - f}{(4-3\sigma)^2} \gtrless 0.$$

[9]This is of course straight-forwardly verified by inserting for (15) into (4) and solving $\partial\pi_i/\partial p_i = 0$.

The left-hand side panel of Figure 1 shows Π^{AO} and Π^{LS} as functions of the differentiation between the goods. Not surprisingly, the curve Π^{LS} is strictly downward-sloping. This reflects a well-known result; the better substitutes two firms produce, the more fiercly they will compete. At $\sigma = 1$ the goods are perfect substitutes, and we will then have the Bertrand paradox where price equals marginal costs ($p = c$). If both firms are operative, they will not be able to cover the fixed costs (F). With the chosen parameter values (see Appendix), we have $\Pi^{LS} > 0$ only if $\sigma < \sigma_{c2} \approx 0.75$.

The curve Π^{AO} is more striking; but illustrates Proposition 4. The curve is at first upward-sloping. Along this segment the firms will consequently make higher profits the better substitutes they produce. The reason for this surprising result is that competition presses down end-user prices, and thus increases output. This means that Q is an increasing function of σ, and f is therefore decreasing in σ. Put differently, because competition induces the firms to expand output, they will also face lower (perceived) marginal production costs. This in turn leads to a further increase in output. Competition thus creates positive externalities between the rivals which imply that profits increase along the upward-sloping curve. The profit margin falls, but due to the lower marginal production costs output increases sufficiently to increase joint profits. However, as we approach $\sigma = 1$, the firms will necessarily compete *total profits* down to zero. This is nonetheless significantly better than if the firms had planned to finance a possible JV through lump-sum payments; *downstream profits* would then be pressed down to zero, making the joint venture project infeasible.[10]

[10] If $\alpha > 1$ the firms would make super profit ($\pi_1 > 0$) even at $s = 1$, while they would be unable to cover the fixed at least in the neighborhood of $\sigma = 1$ if $\alpha < 1$.

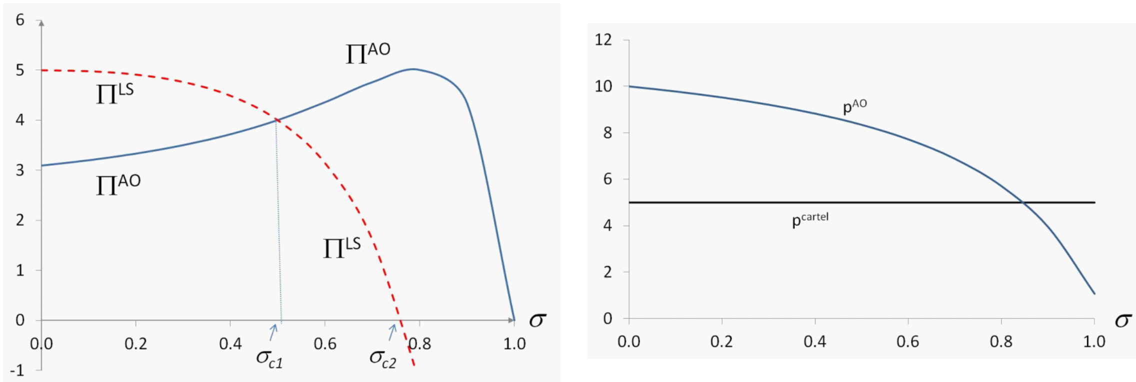

Figure 1: *Profits, prices and substitutability*

The artificially high marginal costs thus explain why $\Pi^{AO} > \Pi^{LS}$ if σ is sufficiently high ($\sigma > \sigma_{c1}$). Interestingly, they also explain why $\Pi^{AO} < \Pi^{LS}$ for lower values of σ. This is most easily understood if we consider the limit $\sigma = 0$. Here each firm has monopoly power in its own market segment, and profits must then necessarily be highest if the firms set prices based on the true marginal costs (c). However, at $\sigma = 0$ output will be particularly low, and the perceived marginal production costs (r) thus correspondingly high. We consequently see that whether output-based or lump-sum financing of the JV is most profitable depends critically on how fiercly the firms compete in the end-user market (and on the value of α).

Some further insight into the relationship between end-user prices under running royalties and downstream substitutability is provided in the right-hand side panel of Figure 1. The cartel price in our numerical example is $p^{cartel} = 5$ (the intrinsical willingness to pay for the goods, and thus the cartel price, is independent of how close substitutes the goods are). If the goods are poor substitutes, the artificiality high perceived marginal costs imply that end-user prices will be much too high - they are equal to $p^{AO} = 10$ for $\sigma = 0$. As σ increases and competition intensifies, the perceived marginal costs and end-user prices fall. At $\sigma \approx 0.84$ we arrive at the remarkable result that the equilibrium price with competition is equal to the cartel price. Only if the goods are closer substitutes than this will the firms compete prices below the level that maximizes aggregate channel profit.

Finally, let us look at the relationship between profits and ownership shares in the JV when the royalties are based on predicted output. As noted above, asymmetric ownership creates a distortion in the end-user market that reduces joint profits, and it is not clear whether the majority or minority share owner will make the higher profit. For the specific model used in this section we prove the following in the Appendix:

Proposition 5: *Assume that royalties are based on predicted output and that* $s_1 > 0.5$*. Firm 1 has lower total profits than Firm 2 if* $\sigma < \sigma^* \equiv \frac{4F}{(v-c)^2}$ *and higher profits if* $\sigma > \sigma^*$ *(*$\pi_1 < \pi_2$ *if* $\sigma < \sigma^*$ *and* $\pi_1 > \pi_2$ *if* $\sigma > \sigma^*$*).*

To see the intuition for Proposition 5, assume first that $\sigma \approx 1$. The goods are then almost perfect substitutes such that the cross-price elasticity is very high. Firm 1 will thus capture most of the market and make a higher profit than its rival. It thus benefits from the fact that its high ownership share makes it credible that it will set a low end-user price.

Suppose next that $\sigma = 0$. Now there is no competition between the firms, and the low price charged by Firm 1 is clearly an advantage for Firm 2, because it increases its output and thus reduces the perceived marginal production costs (r). In a sense Firm 2 is a free-rider in the downstream market for Firm 1's pursuit of higher upstream profits.

The result in Proposition 5 is shown by the hump-shaped curves in Figure 2 (see Appendix for parameter values). The maximal differences in profits for the two firms are more pronounced the higher the fixed costs. This is because the larger is F, the stronger incentives Firm 1 will have to set a relatively low end-user price to expand output. This explains why the solid curve (where $F = 5$) in Figure 2 is flatter than the dotted curve (where $F = 10$).

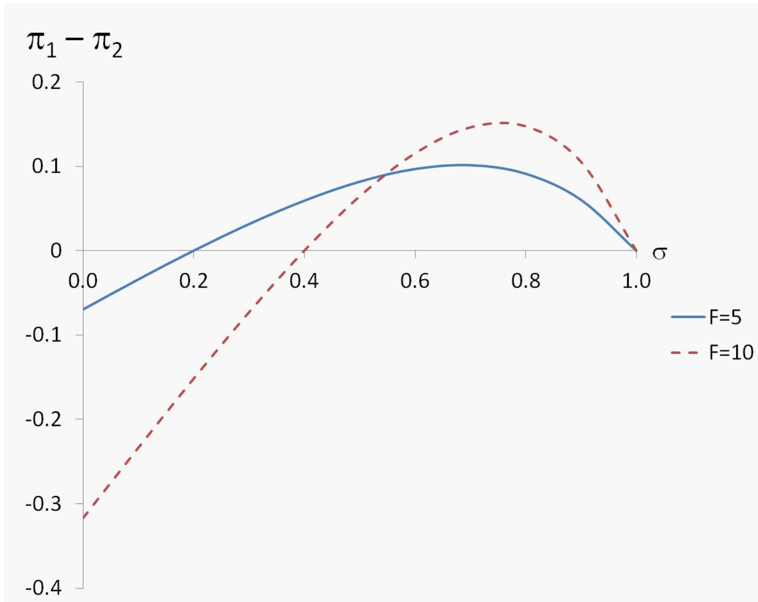

Figure 2: *Asymmetric ownership shares and profits.*

4 Concluding remarks

In this paper we analyze a market structure where two downstream competitors establish an input joint venture, and we show how the choice of royalty rule to cover fixed costs may affect competition downstreams. If the firms compete aggressively, their aggregate profits are higher under running royalties than under lump-sum royalties. If running royalties are used, we show that there is a hump-shaped relationship between the firms' profitability and how fiercly they compete.

We do not analyze interactions with firms outside the joint venture. If there is a third firm in the market (with access to an alternative input source), our conjecture is that the use of running royalties may lead to a Stackelberg game where the two JV members commit to using higher (perceived) marginal costs when deciding on downstream prices. In such a context, the outcome could crucially depend on whether the JV members can credibly commit to a royalty rule observed by the third firm.

Another interesting topic is the potential effects of allowing the JV to offer access to the input joint venture to a third party. Even if the third party operates in an independent downstream market, providing such access will typically affect the coverage of fixed costs. Under running royalties, this would affect downstream pricing incentives. Interactions with (i) a third party with access to an alternative input source and/ or (ii) a third party that buys access from the JV are interesting topics for further research.

5 Appendix

Parameter values

In Figure 1 we have set $\alpha = 1$, $s_i = 1/2$, $v = 10$, $c = 0$, and $F = 20$. In Figure 2 $\alpha = 1$, $s_1 = 3/4$, $v = 10$ and $c = 0$.

Proof of Lemma 1

Inserting for (20) into the firms' profit functions we have

$$\pi_1 - \pi_2 = -2\left(s_1 - \frac{1}{2}\right)\frac{f\alpha(1-\sigma)N}{(4-3\sigma)(4-\sigma)},$$

where $N \equiv 2(1-\sigma)(v-c) - \sqrt{(2-\sigma)^2(v-c)^2 - 4F\alpha(4-3\sigma)}$. It is now straight forward to show that $signN = sign\left[4F\alpha - \sigma(v-c)^2\right]$. Q.E.D.

6 References

Arya, A., B. Mittendorf and D.E.M Sappington. 2008. The make-or-buy decision in the presence of a rival: Strategic outsourcing to a common supplier, Management Science, 54(10), 1747-1758.

Bloom, P. N., G.T. Gundlach, and J.P. Cannon. 2000. Slotting allowances and fees: Schools of thought and views of practicing managers, Journal of Marketing, 64, 92-108.

Boffa, F. and J. Panzar. 2012. Bottleneck co-ownership as a regulatory alternative, Journal of Regulatory Economics 41, 201-215.

Bromwich, M. and C. Hong. 2000. Costs and regulation in the UK telecommunications industry, Management Accounting Research, 11(1), 137-165.

Bulow, J. I., J.D: Geanakoplos, and P.D. Klemperer. 1985. Multimarket oligopoly: Strategic substitutes and complements, Journal of Political Economy 93, 488–511.

Clarke, R., S. Davies, P. Dobson, and M. Waterson. 2002. Buyer power and competition in European food retailing, Edward Elgar Publishing Limited; Massachusetts, USA.

Chen, Z. and Ross, T.W. 2003. Cooperating upstream while competing downstream: A theory of input joint ventures, International Journal of Industrial Organization 21, 381–397.

Deneckere, R.J. and C. Davidson. 1985. Incentives to form coalitions with Bertrand competition, Rand Journal of Economics, 16(4), 473–86.

Dobson, P.W. and M. Waterson. 1997. Countervailing power and consumer prices, Economic Journal, 107, 418-430.

Dobson, P.W. and M. Waterson. 1999. Retailer power: recent developments and policy implications, Economic Policy, 135-164.

European Commission. 2009. Directive 2009/140/EC of the European Parliament and of the Council of 25 November 2009 amending Directives 2002/21/EC on a common regulatory framework for electronic communications networks and services.

Fjell, K., Ø. Foros and D. Pal. 2010. Endogenous Average Cost Based Access Pricing. *Review of Industrial Organization*, 36(2), 149-162.

Foros, Ø. and H.J. Kind. 2008. Does slotting allowances harm retail competition?, Scandinavian Journal of Economics, 110(2), 367-384.

Groot, T. L. and K.A. Merchant. 2000. Control of international joint ventures,Accounting, Organizations and Society, 25(6), 579-607.

Horngren, C. T., S.M. Datar, G. Foster, M.V. Rajan, and C. Ittner. 2009. Cost Accounting: a managerial emphasis, 13th edn, Pearson Prentice Hall, Upper Saddle River, N.J.

Lund, H., C. Scholz, and T. Tsiopoulos. 2004. Fiscal, management and regulatory challenges, International Tax Review, 16-22.

Motta, M. 2004. Competition policy: Theory and practice, Cambridge University Press.

Noreen, E. 1991. Conditions under which Activity-Based Cost systems provide relevant costs, Journal of Management Accounting Research, 3, 159-168.

Park, Y-S. and B-H. Ahn. 1999. Joint ownership and interconnection pricing in network industries, International Review of Economics and Finance 8, 183-198.

Priest, G. 1977. Cartels, and patent license arrangements, Journal of Law and Economics, 20(2), 302-377.

Shaffer, G. 1991. Slotting allowances and resale price maintenance: A comparison of facilitating practices. Rand Journal of Economics, 22(1), 120-135.

Shubik, M. and R. Levitan. 1980. Market structure and behavior, Cambridge, MA: Harvard University Press.

Spengler, J.J. 1950. Vertical integration and antitrust policy, Journal of Political Economy, 58(4), 347-352.

Vives, X. 1999. Oligopoly Pricing: Old ideas and new tools, MIT Press.

Vogelsang, I. 2003. Price regulation of access to telecommunications networks, Journal of Economic Literature, XLI, 830-862.