Input price discrimination, two-part tariff contracts and bargaining

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Abstract

We consider an upstream supplier who bargains with two cost-asymmetric downstream firms over the terms of interim observable two-part tariff contracts: contracts are initially secret (acceptance decisions are based on beliefs) but downstream firms observe the accepted contract terms before competing in prices. We show that the more efficient downstream firm pays a higher input price than its less efficient rival, a finding that is in stark contrast to the previous findings in the literature on input price discrimination with two-part tariff contracts. We also show that a ban on input price discrimination will reduce both consumer and total welfare when the upstream supplier bargains the common two-part tariff contract with the less efficient firm. This result is interesting from a policy perspective since it implies that even though under discriminatory input prices the upstream supplier favors the “wrong” firm, non-discriminatory input pricing can make things even worse in terms of welfare.

Keywords: Vertical relations, input price discrimination, two-part tariffs, bargaining, welfare.

JEL Classification: D4, L1, L4

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1. Introduction

The welfare effects of third-degree price discrimination in intermediate-good (input) markets have long been discussed among economic theorists and competition law practitioners.\(^1\),\(^2\) A key insight from most of the earlier contributions in the theoretical literature on this issue is that an unconstrained upstream supplier optimally discriminates among downstream firms based on differences in their derived demands; the less efficient downstream firm has a more elastic derived demand and thus pays a lower input price than its more efficient rival (DeGraba, 1990; Yoshida, 2000).\(^3\) The fact that the “wrong” firm obtains a discount implies that banning input price discrimination improves allocative efficiency and typically welfare as well. A common feature of the aforementioned studies is that the upstream supplier is restricted to linear contracts.

Another string of important contributions has investigated the welfare effects of input price discrimination when (non-linear) two-part tariff contracts are used. These contributions can be decomposed into two strands. The first assumes that contracts are unobservable when input price discrimination is practiced: each downstream firm observes only its own contract terms when competing in the final-goods market (O’ Brien & Shaffer, 1994; Rey & Tirole, 2007). In such case, the upstream supplier suffers from a severe opportunism problem: once a downstream firm has signed a contract, it has an incentive to offer better terms to the other competing downstream firms.\(^4\) In particular, when offering a lower input price to downstream firm \(i\), the upstream supplier cares about neither the other downstream firms’ response to firm \(i\)’s change in marginal cost nor their profit reduction. In other words, in its dealings with any single downstream firm, the monopolistic supplier acts as if in a bilateral monopoly position, i.e., it chooses contract terms as to maximize joint profits of the specific bilateral relation. The result is that all downstream firms, regardless of their efficiency, receive the same input price which is equal to the upstream supplier’s marginal cost. A ban on input price

\(^1\)The theoretical literature on third-degree price discrimination was initiated by the pioneering work of Robinson (1933), Katz (1987) was the first to extend the analysis of third-degree price discrimination in input markets.


\(^3\)Therefore, the above finding is clearly analogous to the result in the literature on third-degree price discrimination in final-good markets, where a buyer whose demand is less price sensitive (elastic) is charged a higher price.

\(^4\)The assumption of unobservable contracts and the associated opportunism problem of the upstream supplier dates back to the seminal work of Hart & Tirole (1990).
discrimination mitigates the supplier’s opportunism problem by making contracts observable, thereby leading to a higher input price and thus lower consumer surplus and welfare.5

The second strand assumes that two-part tariff contracts are public observably which means that each downstream firm can observe the contract terms of its rivals before deciding whether to accept its own contract (Inderst & Shaffer, 2009; Arya & Mittendorf, 2010). In such case, public commitment leaves no room for opportunistic behaviour. Due to the presence of fixed fees, input prices are chosen to maximize overall industry profits, which results in a lower input price for the more efficient downstream firm.6 The fact that the “right” firm obtains a discount implies that banning input price discrimination decreases allocative efficiency and typically welfare as well.7

In this paper, we focus on two-part tariff contracts that are only interim observably (Rey & Verge, 2004) when input price discrimination is feasible: contracts are initially secret (each downstream firm cannot observe the contract terms of its rivals before deciding to accept its own), however, contract terms are observed by downstream firms before competing in the final-goods market. Such is the case when, for instance, government regulations require the disclosure of vertical contract terms, like the Danish government’s mandate for disclosure of wholesale price contracts in the market for the supply of ready-to-mix concrete (Albaek et al, 1997). More recently, pharmaceutical companies are under great pressure by the U.S. government to disclose information about their costs at the wholesale level (thus aiming to make them justify their prices).8

We consider a vertically related market where a single upstream supplier bargains with two cost-asymmetric downstream firms that produce differentiated final goods and compete in prices. We show that with interim observable two-part tariff contracts, the less efficient downstream firm pays a lower input price than its more efficient rival. This result joins the conclusions of DeGraba (1990) and Yoshida (2000) which assume linear contracting, but is in stark contrast with the findings of the existing two-part tariff literature. The key assumption producing this divergence is that of interim observability.

5Caprice (2006) shows that a ban on input price discrimination may be welfare improving if the upstream supplier is constrained by the presence of a competitive fringe.
6This is the so-called “waterbed effect”, i.e., as one downstream firm becomes relatively more efficient, it pays the upstream supplier to increase the other downstream firm’s input price and thus amplify differences in firms’ competitiveness. This effect is also identified by Inderst & Valletti (2011) in a setting with linear contracting and an alternative supply option for downstream firms.
7Herweg & Müller (2016) show that the welfare findings may be reversed if downstream fixed costs are taken into account.
Since contract terms are initially secret, the supplier’s commitment problem distorts input prices away from that which would maximize overall industry profits, however, this distortion is mitigated by the fact that contract terms become observable before downstream competition takes place. This implies that, when offering a lower input price to downstream firm $i$, the upstream supplier now cares about downstream firm $j$’s response to firm $i$’s change in marginal cost, but not about the reduction in firm $j$’s profits. As a result, despite the presence of fixed fees, the upstream supplier optimally discriminates among downstream firms based on differences in their derived demands, just as it would do if only linear contracts were available: the downstream firm with the more elastic derived demand, i.e., the less efficient firm, obtains a lower input price than its more efficient rival.

When input price discrimination is banned, it is natural to assume that the two downstream firms receive the same two-part tariff contract, but the role of each downstream firm in determining the common contract-terms cannot be naturally assessed without further case-specific information. Obviously, the upstream supplier prefers to negotiate the contract terms with the weaker buyer, but both downstream firms prefer to be represented by the stronger one in the negotiation. In this paper, we restrict attention to the case where the less efficient downstream firm is the upstream supplier’s partner in the negotiation of the common two-part tariff contract; this could be indeed the case when the upstream supplier has enough bargaining power vis-à-vis the downstream firms.\footnote{The assumption that the upstream supplier has enough bargaining power vis-à-vis the downstream firms so that it bargains the common two-part tariff contract with the less efficient downstream firm could be justified by the fact that, at least from an antitrust perspective, price discrimination is an issue when the firm that practices it is in a dominant position. For a similar argument see Inderst & Shaffer (2009) and Herweg & Müller (2016). Unlike the present paper, these studies assume that the upstream supplier has all the bargaining power in the sense that it makes take-it-or-leave-it offers to downstream firms.}

Banning input price discrimination makes contracts observable thus mitigating the upstream supplier’s opportunism problem and leading towards overall industry profit maximization. This is one reason why both input prices rise as a result of a ban on input price discrimination. However, industry profits are not maximized since the same fixed fee must be offered to both downstream firms. More specifically, the common input price is chosen as to maximize overall industry profits \emph{excluding} the more efficient firm’s rent, defined as the difference between the more and the less efficient firm’s profits, and thus it will be distorted away from that which would maximize industry profits. In particular, the common input price will be further increased in order for the upstream supplier to extract more surplus from the downstream firm with the higher derived demand, i.e., the more efficient firm.
As a result, a ban on input price discrimination will have two opposing effects on welfare. On the one hand, it increases the society’s deadweight loss due to higher final-good prices that are caused by higher input prices. In other words, total output decreases leading to a reduction in welfare. On the other hand, given that under discriminatory pricing it is the less efficient firm that pays a lower input price, the input price increase after the ban is larger for the less efficient firm thereby shifting sales to the more efficient downstream firm which increases welfare. As it turns out, at least for the linear demand case, the latter effect is outweighed by the former implying that a ban on input price discrimination is detrimental to welfare. This finding is interesting from a policy perspective since it implies that even though under discriminatory input pricing the upstream supplier favors the “wrong” firm, banning input price discrimination can make things even worse in terms of welfare.

The rest of the paper is organized as follows. Section 2 describes the key elements of the model. Sections 3 deals with the case of input price discrimination. Section 4 investigates the welfare effects of banning input price discrimination. The final section concludes the paper.

2. The model

An upstream supplier, denoted by $U$, produces an input which two downstream firms, denoted by $D1$ and $D2$, use in the production of their final goods. Each unit of the final good requires one unit of the input. The upstream supplier’s constant marginal production cost is, for simplicity and without loss of generality, normalized to zero. Downstream firms face constant marginal cost of producing and selling their goods, $c_{D_i} (i=1,2)$. We assume that $D1$ is more efficient than $D2$. Specifically, we set $c_{D2} = c > 0 = c_{D1}$ so that $c$ denotes the production cost advantage of $D1$.

Consumers’ direct demand for $D_i$’s final good is given by:

$$q_i = \frac{(1-\theta) - p_i + \theta p_j}{1-\theta^2}, \quad i, j = 1, 2, \quad i \neq j,$$

where the parameter $\theta \in (0,1)$ is a measure of the degree of product substitutability. In the limit, as $\theta \to 0$, the final goods of downstream rivals become independent, while in the limit, as $\theta \to 1$, final goods become perfect substitutes. Demand functions are symmetric and thus

\[\text{(10)}\]

The qualitative nature of our results remains unchanged if we assume that $c_{D2} > c_{D1} > 0$, but we would lose in simplicity and not gain any further insights by doing so.

\[\text{(11)}\]

See Singh & Vives (1984) for more details regarding the derivation of this demand function from the representative consumer’s utility maximization problem.
differences in the downstream firms’ derived demands for the input stem solely from differences in their marginal costs.

When input price discrimination is feasible, the timing of the two-stage game is as follows. At the first stage, the upstream supplier bargains with each downstream firm over the terms of a two-part tariff contract, i.e., over an input price, \( w_i \) and a fixed fee, \( F_i \). The first stage negotiations over contract terms are conducted simultaneously and separately in the sense that during negotiations between the upstream supplier and one downstream firm each of them takes as given the outcome of the simultaneously-run negotiations of the supplier and the other downstream firm.\(^{12}\) The outcome is a set of input prices and fixed fees which represent a non-cooperative Nash equilibrium of the separate Nash bargaining problems. At the second stage, the downstream firms compete in prices after observing each other’s contract terms. Therefore, two-part tariff contracts are \textit{interim observable}: contract offers are initially secret (acceptance decisions are based on beliefs), but downstream firms observe the contractual terms before downstream market competition.

When input price discrimination is banned, it is natural to assume that the two downstream firms receive the same two-part tariff contract, but the role of each downstream firm in determining the common contract-terms cannot be naturally assessed without further case-specific information. Obviously, the upstream supplier prefers to negotiate the contract terms with the weaker buyer, but both downstream firms prefer to be represented by the stronger one in the negotiation. We restrict attention to the case where the less efficient downstream firm is the upstream supplier’s partner in the negotiation of the common two-part tariff contract; this could be indeed the case when the upstream supplier has enough bargaining power \textit{vis-à-vis} the downstream firms.\(^{13}\)

We make the following assumption throughout the paper:

\textbf{Assumption 1.} \( c < c_{ex}(\theta) = \frac{2(2 + \theta)(1 - \theta)}{6 + 3\theta^2} \).

Assumption 1 requires that the production cost advantage of \( D1 \) over \( D2 \) is not too high and guarantees that both downstream firms will produce a positive quantity of the final-good in all cases under consideration. For notational reasons, we use the superscript \( D \) to denote

\(^{12}\)This is a standard assumption in models with multilateral contracting (see, e.g., Horn & Wolinsky (1988), Hart & Tirole (1990), O’ Brien & Shaffer (1992), McAfee & Schwartz (1994, 1995), Rey & Verge (2004), and Alipranti et al. (2014)). One possible justification is that the upstream supplier employs two representatives, each negotiating independently with each downstream firm (see Inderst & Wey (2003), Milliou & Petrakis (2007), Iozzi & Valletti (2014)).

\(^{13}\)For a justification of this assumption see the Introduction section.
equilibrium values under discriminatory input pricing and the superscript \( N \) to denote equilibrium values under non-discriminatory input pricing.

3. Input price discrimination

We begin our analysis with the case where input price discrimination is feasible. Working backwards, we solve first the last stage of the game. Downstream firms choose their prices simultaneously and independently in order to maximize their gross profits:

\[
\max_{p_1} \pi_{D1} = \frac{(1-\theta) - p_1 + \theta p_2}{1-\theta^2} (p_1 - w_1), \quad \max_{p_2} \pi_{D2} = \frac{(1-\theta) - p_2 + \theta p_1}{1-\theta^2} (p_2 - w_2 - c). \tag{1}
\]

The first order conditions give rise to the following best-response functions:

\[
p_1(p_2, w_1) = \frac{(1-\theta) + w_1 - \theta p_2}{2}, \quad p_2(p_1, w_2) = \frac{(1-\theta) + (w_2 + c) - \theta p_1}{2}. \tag{2}
\]

Solving the system of best-response functions in (2), we obtain the second-stage subgame equilibrium prices and outputs as functions of input prices:

\[
\hat{p}_1 = \frac{(2+\theta)(1-\theta) + 2w_1 + \theta (w_2 + c)}{4-\theta^2}, \quad \hat{p}_2 = \frac{(2+\theta)(1-\theta) + 2(w_2 + c) + \theta w_1}{4-\theta^2}, \tag{3}
\]

\[
\hat{q}_1 = \frac{(2+\theta)(1-\theta) - (2-\theta^2)w_1 + \theta (w_2 + c)}{(1-\theta^2) (4-\theta^2)}, \quad \hat{q}_2 = \frac{(2+\theta)(1-\theta) - (2-\theta^2)(w_2 + c) + \theta w_1}{(1-\theta^2) (4-\theta^2)}.
\]

It is straightforward to derive the respective equilibrium downstream and upstream profits:

\[
\pi_{D1}(w_1, w_2) = (\hat{p}_1 - w_1)\hat{q}_1 - F_1, \quad \pi_{D2}(w_1, w_2) - F_2 = (\hat{p}_2 - w_2 - c)\hat{q}_2 - F_2, \tag{4}
\]

\[
\pi_U(w_1, w_2) + F_1 + F_2 = w_1\hat{q}_1 + w_2\hat{q}_2 + F_1 + F_2.
\]

Next, we determine the equilibrium contract terms – we solve the first stage of the game. When the \((U, D1)\) pair negotiates over the input price \(w_1\) and the fixed fee \(F_1\), it takes as given the outcome of the simultaneously-run negotiations of the other pair, i.e., it takes \(w_2^{dp}\) and \(F_2^{dp}\) as given. The upstream supplier and downstream firm \(D1\) choose \(w_1\) and \(F_1\) to maximize the following generalized Nash product,

\[
\max_{w_1, F_1} \left[ \pi_U(w_1, w_2^{dp}) + F_1 + F_2^{dp} - d_2 \left[ \pi_{D1}(w_1, w_2^{dp}) - F_1 \right]^{\gamma} \right]^{1/\beta} \tag{5}
\]
where the bargaining power of $U$ and $D1$ in bilateral negotiations is given respectively by $\beta$ and $1-\beta$ with $\beta \in (0,1)$.

The disagreement payoff of $D1$ is zero since it has no alternative trading partner. However, the upstream supplier’s disagreement payoff, $d_2$, is not zero since in the case of an unsuccessful negotiation with $D1$, it can still sell to the other downstream firm $D2$. More specifically, if an agreement between $U$ and $D1$ is not reached, then $U$’s disagreement payoff is given by $d_2 = w^{DS}_2 q^{mon}(w^{DS}_2) + F^{DS}_2$, where $q^{mon}(w^{DS}_2) = (1 - w^{DS}_2 - c)/2$ is the quantity expected to be produced by a downstream monopolist $D2$ which faces an input price $w^{DS}_2$.

As it is well-known in the literature, a two-part tariff contract is bilaterally efficient due to the existence of a fixed fee; that is, it maximizes the joint profits of a bargaining pair given the rival pairs’ bargaining outcomes. Maximizing (5) with respect to $F_1$ we obtain:

$$F_1 = \beta[\pi_{D1}(w_1, w^{DS}_2)] - (1-\beta)[\pi_U(w_1, w^{DS}_2) - w^{DS}_2 q^{mon}(w^{DS}_2)].$$

Substituting (6) into (5), it follows that the generalized Nash product reduces to an expression proportional to the joint profits of $U$ and $D1$. Hence, $w_1$ is chosen to maximize these joint profits,

$$\max_{w_1} \pi_{D1}(w_1, w^{DS}_2) + \pi_U(w_1, w^{DS}_2) - w^{DS}_2 q^{mon}(w^{DS}_2),$$

Similarly, the upstream supplier and downstream firm $D2$ choose $w_2$ and $F_2$ to maximize the following generalized Nash product,

$$\max_{w_2, F_2} [\pi_U(w^{DS}_1, w_2) + F^{DS}_1 + F_2 - d_1]^{\beta} [\pi_{D2}(w^{DS}_1, w_2) - F_2]^{1-\beta}.$$

The disagreement payoff of the integrated supplier when negotiations with $D2$ break down is given by $d_1 = w^{DS}_1 q^{mon}(w^{DS}_1) + F^{DS}_1$, where $q^{mon}(w^{DS}_1) = (1 - w^{DS}_1 - c)/2$ is the quantity expected to be produced by a downstream monopolist $D1$ which faces an input price $w^{DS}_1$. Following the same steps as above, $w_2$ is chosen to maximize the joint profits of $U$ and $D2$:

\[\text{Therefore, we assume that the two-part tariff contract of a bargaining pair is not contingent on the disagreement of the rival pair. In other words, a breakdown in one bargaining pair’s negotiations does not trigger new negotiations in the rival pair. For a justification of the non-contingency assumption regarding disagreement see Milliou & Petrakis (2007). Nevertheless, later in this section, we discuss robustness of our results if we allow for contingency in disagreement.}\]
max \pi_{D_2}(w_1^D, w_2) + \pi_U(w_1^D, w_2) - w_1^D q_1^{\text{mon}}(w_1^D). \hskip 1cm (8)

From the first order conditions of (7) and (8), we obtain the equilibrium input prices:\(^{15}\)

\[ w_1^D = \frac{\theta^2}{4}, \quad w_2^D = \frac{(1-c)\theta^2}{4}. \hskip 1cm (9) \]

From the equilibrium input prices in (9), it is straightforward that the less efficient downstream firm pays a lower input price than its more efficient rival.

**Proposition 1.** When price discrimination is feasible and the upstream supplier bargains over interim observable two-part tariff contracts with downstream firms, the less efficient downstream firm pays a lower input price than its more efficient rival.

The finding in Proposition 1 is in line with DeGraba (1990) and Yoshida (2000) which assume linear contracting, but is in stark contrast with the findings of the existing two-part tariff literature which assumes that contracts are either unobservable or publicly observable. The key assumption producing this divergence is that of interim observability.

When contracts are unobservable, as in O’Brien & Shaffer (1994) and Rey & Tirole (2007), the upstream supplier suffers from a severe opportunism problem: once a downstream firm has signed a contract, it has an incentive to offer better terms to the other downstream firm. In particular, when offering a lower input price to downstream firm \(D_i\), the upstream supplier cares about neither downstream firm \(D_j\)’s response to firm \(D_i\)’s change in marginal cost nor the reduction in firm \(D_j\)’s profits. In other words, in its dealings with any single downstream firm, the monopolistic supplier acts as if in a bilateral monopoly position, i.e., it chooses contract terms as to maximize joint profits of the specific bilateral relation. The result is that both downstream firms, regardless of their efficiency, receive the same input price which is equal to the upstream supplier’s marginal cost. When contracts are publicly observable, as in Inderst & Shaffer (2009) and Arya & Mittendorf (2010), there is no room for opportunistic behaviour due to the public commitment. In such case, input prices are

\(^{15}\)As it can be seen from (9), the equilibrium input prices increase with the degree of product substitutability. As products become closer substitutes downstream competition is fiercer and thus it is more urgent for the upstream supplier to decrease the aggressiveness of its downstream customers in the downstream market. On the other hand, in the extreme case where firms operate in separate markets, i.e., \(\theta = 0\), input prices for both downstream firms are equal to upstream supplier’s marginal cost, which in our model is normalized to zero. Furthermore, equilibrium input prices are independent of the bargaining power distribution since the use of two-part tariffs leads to joint profit maximization by each bargaining pair.
chosen to maximize overall industry profits, which results in a lower input price for the more efficient downstream firm.

In our model, since contract terms are initially secret, the supplier’s opportunism problem distorts input prices away from that which would maximize overall industry profits, however, this distortion is mitigated by the fact that contract terms become observable before downstream competition takes place. This implies that, when offering a lower input price to downstream firm \( D_i \), the upstream supplier now cares about downstream firm \( D_j \)’s response to firm \( D_i \)’s change in marginal cost, but not about the reduction in firm \( D_j \)’s profits. As a result, despite the presence of fixed fees, the upstream supplier optimally discriminates among downstream firms based on differences in their derived demands, just as it would do if only linear contracts were available: the downstream firm with the more elastic derived demand, i.e., the less efficient firm, obtains a lower input price than its more efficient rival.

Regarding the supplier’s disagreement profits, our main assumption is that the two-part tariff contract of a bargaining pair is *not* contingent on the disagreement of the rival pair. In other words, a breakdown in one bargaining pair’s negotiations does not trigger new negotiations in the rival pair. Another possible assumption, adopted by, for example, Inderst & Wey (2003) and de Fontenay & Gans (2005), is that the contract terms of a bargaining unit are *contingent* on the disagreement of the rival bargaining unit, i.e., a breakdown in one bargaining pair’s negotiations triggers new negotiations in the rival pair. Technically, this implies that the upstream supplier’s disagreement payoff, when negotiations with firm \( D_i \) break down, arises from negotiations with \( D_j \) given that the latter is a monopolist in the downstream market. In such case, the upstream supplier’s disagreement profits are given by \((1-c)/4\) (when there is disagreement with \( D_1 \)) and \(1/4\) (when there is disagreement with \( D_2 \)). However, the equilibrium input prices in (9) are the same since it is straightforward that the first order conditions are the same as those stemming from (7) and (8).

It rather evident from the previous discussion that Proposition 1 and its implications still hold under the contingency case. Moreover, the welfare effects of banning price discrimination, obtained in the next section, also remain unaffected since the assumption of contingency affects only the equilibrium fixed fees which do not have any effect on consumer surplus or welfare as they are simply used to transfer surplus from downstream firms to the upstream supplier without affecting marginal costs or quantities produced at equilibrium.

Substituting (9) into (3), we obtain:
\[
\begin{align*}
\hat{p}_1^* &= \frac{(2-\theta) + \theta c}{4}, \quad \hat{p}_2^* = \frac{(2-\theta) + 2c}{4}, \\
\hat{q}_1^* &= \frac{(2 + \theta)(1-\theta) - \theta c}{4(1-\theta^2)}, \quad \hat{q}_2^* = \frac{(2 + \theta)(1-\theta) - (2-\theta^2)c}{4(1-\theta^2)}.
\end{align*}
\]

Using (10), we can calculate consumer surplus and total welfare as:

\[
\begin{align*}
CS^{D^*} &= \frac{1}{2} \left[ (1 - p_1^*)q_1^* + \frac{1}{2} (1 - p_2^*)q_2^* \right] = \frac{[1 + (1-c)^2][4 - 3\theta^2] - 2\theta^3(1-c)}{32(1-\theta^2)}, \\
TW^{D^*} &= CS^{D^*} + \pi_{U}^{D^*} + \pi_{D1}^{D^*} + \pi_{D2}^{D^*} = \frac{[1 + (1-c)^2][12 - 5\theta^2] - 2\theta(8-\theta^2)(1-c)}{32(1-\theta^2)}.
\end{align*}
\]

3. A ban on input price discrimination

We now consider the effects of a ban on input price discrimination on welfare by assuming that the upstream supplier must offer the same two-part tariff contract \((w,F)\) to both downstream firms. Substituting \(w_1 = w_2 = w\) into (3), it is straightforward that the second-stage subgame equilibrium prices and outputs as functions of the input price are now given by:

\[
\begin{align*}
\tilde{p}_1 &= \frac{(2+\theta)(1-\theta) + (2+\theta)w + \theta c}{4 - \theta^2}, \quad \tilde{p}_2 = \frac{(2+\theta)(1-\theta) + (2+\theta)w + 2c}{4 - \theta^2}, \\
\tilde{q}_1 &= \frac{(2+\theta)(1-\theta)(1-w) + \theta c}{(1-\theta^2)(4-\theta^2)}, \quad \tilde{q}_2 = \frac{(2+\theta)(1-\theta)(1-w) - (2-\theta^2)c}{(1-\theta^2)(4-\theta^2)}.
\end{align*}
\]

The respective equilibrium downstream and upstream profits are given by:

\[
\begin{align*}
\pi_{D1}(w) - F &= (\tilde{p}_1 - w)\tilde{q}_1 - F, \quad \pi_{D2}(w) - F = (\tilde{p}_2 - w-c)\tilde{q}_2 - F, \\
\pi_U(w) + 2F &= w_1\tilde{q}_1 + w_2\tilde{q}_2 + 2F
\end{align*}
\]

The upstream supplier and \(D2\) choose \(w\) and \(F\) to maximize the following generalized Nash product:

\[
\max_{w,F}\left[\pi_U(w) + 2F\right]^{\beta}\left[\pi_{D2}(w) - F\right]^{1-\beta}
\]

Maximizing (14) with respect to \(F\) we obtain:

\[
F = \beta \pi_{D2}(w) - \frac{(1-\beta)}{2} \pi_U(w).
\]
Substituting (15) into (14), the generalized Nash product reduces to the following expression which is maximized with respect to $w$,

$$\max_w 2\pi_{D_2}(w) + \pi_{U_i}(w).$$  \hspace{1cm} (16)

The input price $w$ is chosen as to maximize the upstream profits and twice the profits of the less efficient downstream firm because, although the supplier does not bargain with the more efficient downstream firm, the same contract terms, i.e., $w$ and $F$, that will result from negotiations with the less efficient firm, must also be offered to the more efficient firm. Note that after some straightforward manipulation, (16) can also be rewritten as:

$$\max_w \left[ w\tilde{q}_1 + w\tilde{q}_2 + \pi_{D_1}(w) + \pi_{D_2}(w) \right] - \left[ \pi_{D_1}(w) - \pi_{D_2}(w) \right].$$  \hspace{1cm} (17)

From the first order condition of (17), we obtain the equilibrium input price,

$$w^{N^*} = \frac{2\theta(2 + \theta) + c(4 - 3\theta^2)}{4(2 + \theta)},$$  \hspace{1cm} (18)

**Proposition 2.** After a ban on input price discrimination, the upstream supplier bargains with the less efficient downstream firm. The equilibrium common input price will be higher than the otherwise prevailing input prices under discrimination, i.e., $w^{N^*} > w_1^{D^*} > w_2^{D^*}$.

A ban on input price discrimination makes contracts observable thus eliminating the upstream supplier’s opportunism problem and leading towards overall industry profit maximization. This is one reason why both input prices rise. However, industry profits are not maximized since the same fixed fee must be offered to both downstream firms. More specifically, the common input price is chosen as to maximize overall industry profits minus the more efficient downstream firm’s rent (see (17)), and thus it will be distorted away from that which would maximize industry profits. In particular, the common input price will be further increased since the more efficient downstream firm’s profits are reduced by more than the less efficient downstream firm’s profits for any given increase in the common input price, i.e., $\partial[\pi_{D_1}(w) - \pi_{D_2}(w)]/\partial w < 0$.\textsuperscript{16}

\textsuperscript{16}Note that the more efficient downstream firm, although it pays a higher input price than its less efficient rival under discrimination, it still sells a larger quantity (see (10)) and thus is affected on a larger volume base for any
To gain a better intuition of why the latter effect is in play, consider the extreme case where final-goods are independent in demand and thus the upstream supplier does not suffer from the opportunism problem. In such case, under discriminatory pricing, input prices will be equal to upstream marginal cost, i.e., it holds that \( w_i^{\text{op}} \big|_{\theta=0} = w_2^{\text{op}} \big|_{\theta=0} = 0 \). Under non-discriminatory pricing, however, it holds that \( w^{\text{NN}} \big|_{\theta=0} = c/2 > 0 \). The upstream supplier finds it optimal to set the input price above its marginal cost in order to extract larger rents from the downstream firm with the higher derived demand, i.e., the more efficient firm.

Substituting (18) into (12), we obtain:

\[
\begin{align*}
 p_1^{N*} &= \frac{2(2+\theta) + c(2+3\theta)}{4(2+\theta)}, \\
 p_2^{N*} &= \frac{2+3c}{4}, \\
 q_1^{N*} &= \frac{2(2+\theta)(1-\theta) - c(2-3\theta-3\theta^2)}{4(2+\theta)(1-\theta^2)}, \\
 q_2^{N*} &= \frac{2(2+\theta)(1-\theta) - c(6+\theta-3\theta^2)}{4(2+\theta)(1-\theta^2)}. \\
\end{align*}
\] (19)

Using (19), we calculate consumer surplus and total welfare as:

\[
\begin{align*}
 CS^{N*} &= \frac{2(4+8\theta-\theta^2-3\theta^3)(1-c) + (4+4\theta+\theta^2-\theta^3) - (5+3\theta)(4-3\theta^2)(1-c)^2}{16(1-\theta^2)(2+\theta)^2}, \\
 TW^{N*} &= \frac{2(4-16\theta-21\theta^2-7\theta^3)(1-c) + (12+12\theta+11\theta^2+5\theta^3) - (28+20\theta-5\theta^2-3\theta^3)(1-c)^2}{16(1-\theta^2)(2+\theta)^2}. \\
\end{align*}
\] (20)

A ban on input price discrimination will have two opposing effects on welfare. On the one hand, it increases the society’s deadweight loss due to higher final-good prices that are caused by higher input prices. In other words, total output decreases leading to a reduction in welfare. On the other hand, given that under discriminatory pricing it is the less efficient firm that pays a lower input price, the input price increase after the ban is larger for the less efficient firm thereby shifting sales to the more efficient downstream firm which increases welfare. As it turns out, at least for the linear demand case, the latter effect is outweighed by the former implying that a ban on input price discrimination is detrimental to welfare.

given change in the common input price. Alternatively, it is easy to verify from (9) that \( w_i < w_2 + c \) which implies that, under discrimination, the upstream supplier favours the less efficient firm, however by less than its initial efficiency disadvantage.

\( ^{17} \)It is straightforward that when downstream firms operate in separate markets, the equilibrium contract terms will be the same regardless of the contract observability.\[ ^{18} \]The requirement that \( q_2^{N*} > 0 \) reduces to \( c < c_\text{ex}(\theta) \) with \( c_\text{ex}(\theta) \) given in Assumption 1.
**Proposition 3.** After a ban on input price discrimination, the upstream supplier bargains with the less efficient downstream firm. Then, banning input price discrimination reduces both consumer surplus and total welfare.

The finding in Proposition 3 is interesting from a policy perspective since it implies that even though under discriminatory input prices the upstream supplier favors the “wrong” firm, non-discriminatory input pricing can make things even worse in terms of welfare.

4. Conclusions

In this paper, we have considered an upstream input supplier who bargains with two cost asymmetric downstream firms over the terms of interim observable two-part tariff contracts: contracts are initially secret (acceptance decisions are based on beliefs) but downstream firms observe the accepted contracts before competing in prices. Under discriminatory two-part tariff contracts and downstream price competition, we have shown that the upstream supplier finds it optimal to charge the more efficient downstream firm a higher input price, a finding that is in stark contrast to the previous findings in the literature on input price discrimination with two-part tariff contracts.

We have also shown that a ban on price discrimination will reduce both consumer and total welfare when the upstream supplier bargains with the less efficient downstream firm the terms of the common two-part tariff contract. This result is interesting from a policy perspective since it implies that even though under discriminatory input pricing the upstream supplier favors the “wrong” firm, non-discriminatory input pricing can make things even worse in terms of welfare.

Appendix

**Proof of Proposition 2.** Since we know from Proposition 1 that $w_1^{p^*} > w_2^{p^*}$, it suffices to show that $w_1^{N^*} > w_1^{p^*}$. Using (11) and (24), and after some straightforward calculations, we obtain

\[ w_1^{N^*} - w_1^{p^*} = \frac{\theta(4 - \theta^2) + (4 - 3\theta^2)c}{4(2 + \theta)} > 0. \]

**Proof of Proposition 3.** First, we show that $p_1^{N^*} > p_1^{p^*}$ and $p_2^{N^*} > p_2^{p^*}$. Using (12) and (25), we obtain

\[ p_1^{N^*} - p_1^{p^*} = \frac{(\theta(2 + \theta) + c(2 + \theta - \theta^2))/(2 + \theta)}{4(2 + \theta)} > 0 \quad \text{and} \quad p_2^{N^*} - p_2^{p^*} = \frac{(c + \theta)}{4} > 0. \]

Since
both final-good prices increase due to a ban on price discrimination then consumer surplus unambiguously falls.

Regarding total welfare, we define $\Delta TW^\ast = TW^D\ast - TW^N\ast$. Note that a ban on price discrimination decreases total welfare when $\Delta TW^\ast > 0$. Using (15) and (28), we obtain after some straightforward manipulation,

$$
\Delta TW^\ast = \frac{A + 2Bc + \Gamma c^2}{32(2 + \theta)^2(1 - \theta^2)},
$$

(A1)

with $A = 2\theta(4 + \theta)(1 - \theta)(2 + \theta)^2$, $B = (1 - \theta)(2 + \theta)(8 - 2\theta^2 + \theta^3)$, $\Gamma = (8 + 4\theta + 5\theta^2)(2 - 2\theta - \theta^2)$.

Clearly, $\Delta TW^\ast$ in (A1) has the sign of its numerator. It is straightforward that $A > 0$ and $B > 0$. It can be easily checked that $\Gamma > 0$ ($\Gamma < 0$) when $0 < \theta < (\sqrt{3} - 1)$ ($(\sqrt{3} - 1) < \theta < 1$) with $(\sqrt{3} - 1) \approx 0.732$. Therefore, we consider two cases regarding the parameter $\theta$:

(i) $0 < \theta < (\sqrt{3} - 1)$: In such case, since $A$, $B$ and $\Gamma$ are all positive then it is straightforward that $\Delta TW^\ast > 0$.

(ii) $(\sqrt{3} - 1) < \theta < 1$: In such case, since $\Gamma < 0$ then the sign of $\Delta TW^\ast$ is not a priori obvious. Solving the numerator of $\Delta TW^\ast$ given in (A1) for $c$ we obtain two roots, i.e.,

$$
c_1 = \frac{(-B - \sqrt{B^2 - 4\Gamma})}{A} \quad \text{and} \quad c_2 = \frac{(-B + \sqrt{B^2 - 4\Gamma})}{A}.
$$

We first show that $B^2 - 4\Gamma$ is always positive in the relevant range $(\sqrt{3} - 1) < \theta < 1$. We have that:

$$
B^2 - 4\Gamma = [(1 - \theta)(2 + \theta)(8 - 2\theta^2 + \theta^3)]^2 - [2\theta(4 + \theta)(1 - \theta)(2 + \theta)^2][8 + 4\theta + 5\theta^2](2 - 2\theta - \theta^2)] =
$$

$$
= (2 + \theta)^2(1 - \theta)[8 - 136\theta^2 + 30\theta^3 + 67\theta^3 + 123\theta^4 + 68\theta^5 + 10\theta^6]
$$

The sign of $B^2 - 4\Gamma$ depends on the sign of $A$, which is positive in the relevant range $(\sqrt{3} - 1) < \theta < 1$. Given that $A > 0$, $B > 0$ and $B^2 - 4\Gamma > 0$, the smaller root is negative, i.e., $c_1 < 0$, whereas the larger root is higher than $c_\alpha(\theta)$, i.e., $c_2 > c_\alpha(\theta)$. Given that $c_1 < 0$ and $c_2 > c_\alpha(\theta)$, $\Delta TW^\ast$ has the same sign in the interval $(0, c_\alpha)$. It then suffices to show that

$$
\lim_{c \to 0} \Delta TW^\ast = (4 - \theta)^2/16(1 + \theta) > 0.
$$

Therefore, from (i) and (ii), we have that $\Delta TW^\ast > 0$ for all $\theta \in (0, 1)$.

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References


