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Information Exchange in Retail Markets with Uncertainty about Downstream Costs

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Abstract

An information exchange between two producers selling independent products to the same retailer can have ambiguous effects on market efficiency and surplus. When a retailer's costs are unobservable the producers may have an incentive to communicate about their negotiations with that retailer. If each producer is allowed to place one offer the producers will have no incentive to exchange information. However, the retailer may communicate that he refused the first offer to the other firm which subsequently might place a lower offer. When one firm is allowed to place a second offer, two equilibria involve communication between the producers. In a separating equilibrium an information exchange ensures that agreement will always be found. In a hybrid equilibrium, the likelihood that agreement is found is less likely.

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1 Introduction

The effects of an information exchange between competitors is ambiguous. In contrast to hard core cartels such as price-fixing agreements, exchanging sensitive information can promote efficiency gains as well as impede competition. The European Commission states in its guidelines on horizontal agreements:[1]

> *Information exchange is a common feature of many competitive markets and may generate various types of efficiency gains. It may solve problems of information asymmetries thereby making markets more efficient. [...]*
>
> *However, the exchange of market information may also lead to restrictions of competition in particular in situations where it is liable to enable undertakings to be aware of market strategies of their competitors. The competitive outcome of information exchange depends on the characteristics of the market in which it takes place.*

The purpose of this paper is to examine when the reduction in information asymmetries following an information exchange increases market efficiency and when it is detrimental to welfare. The paper focuses on retail markets where information exchange occurs between suppliers. Case evidence suggests that this is commonly observed. Examples of such infringements are the *drugstore articles* and the *TV Studio* cases in Germany.[2]

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[1] See paragraphs 57 and 58 of the European Commission's *Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements*, 2011/C 11/01.

[2] See the German Federal Cartel Office's cases B11-17/06 and B12-23/16, respectively.

While exchanging information about strategic variables such as future prices, rebates or contracts with customers constitutes an infringement by object, the effects of such agreements on competition are ambiguous (Bennett and Collins, 2010).[3] As the above mentioned statement of the European Commission makes clear, reductions in asymmetric information between competitors arising from an information exchange might be beneficial to consumers, however, it is *likely* that they are harmful. Moreover, even an information exchange between firms not being active in the same markets is deemed illegal. For example, in the *drugstore articles*-case not all suppliers involved in the information exchange were active in the same market: suppliers of personal care products exchanged information with suppliers of consumer detergents.[4]

In many industries, negotiations about the conditions of supply are a common feature (Smith and Thanassoulis, 2012; Caprice and Rey, 2015). Depending on the market a retailer may be able to exert substantial bargaining power to increase his surplus from trading with the suppliers (Dobson and Waterson, 1997). The high degree of buyer power may manifest in delisting the goods of a certain producer when negotiations fail. Such delisting decisions are also important drivers in this model as refusing in offer to decrease subsequent offers is a key feature in bargaining theory (Fudenberg and Tirole, 1983). Although they are no sign of buyer power in the model such delisting decisions can be important levers in the negotiations and

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[3]Infringements by object are defined as "those that by their very nature have the potential to restrict competition", see the Commission's *Guidance on restrictions of competition "by object" for the purpose of defining which agreements may benefit from the De Minimis Notice*, C(2014) 4136 final.

[4]See the German Federal Cartel Office's press release *Multi-million fines imposed on manufacturers of drugstore products on account of anti-competitive information exchange* of March 18, 2013 (URL: https://goo.gl/Ej7Lqo, last visited August 10, 2017). Note that some, but not all, producers who exchanged information were colluding.

may be far more harmful for a producer than for the retailer which is line with the literature (Dobson, 2005; Caprice and Rey, 2015).

In order to examine the impact of the information exchange in a vertically separated market the model comprises two producers who negotiate sequentially with one retailer about a fixed fee. Those fees can be interpreted as a fixed tariff paid by the retailer net off-invoice discounts. For instance, these may include advertising subsidies or slotting allowances as in, e.g., Shaffer (1991). One could also think of the producers offering an additional variable fee, the wholesale price. With such a two-part tariff in place one can assume that the firms try to avoid double-marginalization (See, e.g., Inderst and Wey (2007)). Thus, the wholesale price is normalized to zero throughout the analysis. After each negotiation with the retailer, a producer can communicate with the other producer and disclose information about its offer and whether or not it was accepted. This constitutes the information exchange.

Retail prices and a producer's demand on the goods market are exogenous and common knowledge as in Rey and Tirole (1986); Jullien and Rey (2007). The retailer has private information about his (marginal) cost for offering a producer's products to final consumers as in Jullien and Rey (2007, Ch. 5). For instance, these costs include advertising expenditures or the costs for 'slotting' a manufacturer's product. As prices and quantities are exogenous, these costs can be quite high because they include the sum of the variable costs to offer each producers' product line to final customers. For instance, the retailer has to hire staff to stock up the shelfs in various outlets to distribute the goods to the consumer. Moreover, he might bear the advertising expenditures for specific products.[5]

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[5]The results continue to hold if there is uncertainty about the retailer's fixed costs, see Section

Technically, the information exchange is embedded in a sequential bargaining framework established by, e.g., Fudenberg and Tirole (1983). In contrast to that model, two producers offering independent products are active who can communicate. As a consequence, the bargaining process does not end after an agreement is reached with one producer.

The model shows that when each producer is only allowed to place a single offer, the producers have no incentive to communicate. However, the retailer has an incentive to disclose information about the bargaining process in order to signal the second producer that he has high-cost. If one producer (firm 1) is allowed to place a second offer after the retailer negotiated with the producer (firm 2), two equilibria exist comprising an information exchange. The first one is a separating equilibrium where firm 1 plays a 'price discrimination' strategy. Firm 1 offers an intermediate tariff in the first period and a low tariff in the second period. This intermediate fee is set such that the retailer is just indifferent between immediate acceptance and accepting the low tariff in the second period. An information exchange occurs only if the retailer expects firm 2's offer to be high. Otherwise this intermediate fee decreases because firm 1 has to leave an information rent to the retailer. In that equilibrium, the producers' communications ensure that agreement will always be found. Secondly, there also exists a hybrid equilibrium. When the firms exchange information agreement will be found later on average. Moreover, the likelihood that agreement is found with firm 2 decreases.

The paper is structured as follows. In Section 2 the model setup will be described. The conditions for the existence of an equilibrium comprising an infor-

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4.3. Another alternative would be to view the problem as uncertainty about retailer's fixed costs incurred to receive an order (Kunreuther and Richard, 1971).

mation exchange in the single-offers case will be derived in Section 3. In Section 4 the model will be extended by allowing for a second offer for one firm. Section 5 concludes.

2 The Model

Two producers $i \in \{1, 2\}$ negotiate with a downstream retailer D about a fixed fee t_i which allows the retailer to receive the goods of producer i. Quantities and retail prices are denoted by q_i and p_i, respectively. Assume that q_i and p_i are exogenously given and common knowledge as in Jullien and Rey (2007). The retailer's costs of providing the good (or type) c can be low or high, $c \in \{\underline{c}, \overline{c}\}$ with $\overline{c} > \underline{c} \geq 0$. Note that, as q_i and p_i are fixed, c constitutes the costs for offering the full quantity q_i to final consumers. Section 4.3 provides a discussion on that assumption. Accordingly, define by $\overline{v}_i \equiv q_i(p_i - \underline{c})$ and $\underline{v}_i \equiv q_i(p_i - \overline{c})$ the retailer's valuation or market profits of producer i's products with $\overline{v}_i > \underline{v}_i$. The realization of c and, therefore, the valuation v_i is the retailer's private information. The retailer's profits are $\pi_D = \sum_i \pi_{Di}$ where $\pi_{Di} = q_i(p_i - c) - t_i$. Assume that production is costless as in Dobson and Waterson (1997). Producer i's profit is thus $\pi_i = q_i w_i + t_i$.

Define by $\alpha_i \in \{a_i, r_i\}$ the retailer's action set for the negotiation with each producer i. The retailer either accepts or rejects a proposed fee t_i of producer i, denoted by a_i or r_i, respectively. In case of rejection there will be no trade with producer i, i.e., $q_i = 0$. Producer i's prior belief that costs are low is denoted by $\phi_i \equiv \Pr(c = \underline{c})$. Accordingly, firm i beliefs that costs are high with probability $1 - \phi_i$. Define by $\mu(\underline{c}|r_1)$ firm 2's posterior belief that the retailer has low costs

given firm 1's offer was rejected. Assume that reporting is truthful. This is a strong assumption. However, it will be argued in Section 4.3 that there is no incentive to misreport if an information exchange occurs.

The timing of the game is as follows. On stage 1, the downstream firm learns its type $c \in \{\underline{c}, \overline{c}\}$ and firm 1 proposes a fee t_1. The downstream firm either accepts (a_1) or rejects (r_1) the offer. On stage two, firm 1 decides whether to report its offer t_1 and whether it was accepted or not to firm 2. On a third stage firm 2 proposes a fee t_2 based on the information acquired on stage 2. The retailer either accepts or rejects firm 2's offer.

3 One-Shot Bargaining

Consider a situation without an information exchange. Firm i's profit is $\pi_i = t_i$ if the retailer accepts t_i. A low offer $\underline{v}_i$ will always be accepted. As profits are monotonically increasing in t_i in case of acceptance, firm i proposes a maximum fee $\overline{v}_i$ if its beliefs to face a low cost type are sufficiently high:

$$\phi_i \overline{v}_i > \underline{v}_i. \tag{1}$$

Define the ratio of the different cost types' valuations of each producers' goods by $\rho_i \equiv \frac{\underline{v}_i}{\overline{v}_i}$. Given ρ_i, firm i's optimal offer without an information exchange is:

$$t_i(\phi) = \begin{cases} \underline{v}_i \ if \ \phi_i < \rho_i \\ \overline{v}_i \ if \ \phi_i > \rho_i \end{cases} \tag{2}$$

For $\phi_i = \rho_i$ producer i randomizes between $\underline{v}_i$ and $\overline{v}_i$. Given this schedule, the

retailer always accepts $\underline{v}_i$ and rejects $\overline{v}_i$ if its type is $c = \overline{c}$. Trade between producer i and the retailer does not occur if a high cost type is offered a high retail price.

Consider now the effects of an information exchange. Given producer 1's message, firm 2 proposes a fee $t_2(\mu)$ to be determined as follows:

$$t_2(\mu) = \begin{cases} \underline{v}_2 \ if \ \mu < \rho_2 \\ \overline{v}_2 \ if \ \mu > \rho_2 \end{cases} \tag{3}$$

The optimal offer (3) is similar to the case without the information exchange as described in (2). The only difference is that the offer depends on the posterior belief updated based on the information acquired from firm 1. In particular, if a high offer $\overline{v}_1$ was accepted, firm 2 knows with certainty that it faces a low-cost retailer. Consequently, it would make a high offer $\overline{v}_2$ and the retailer does not realize any surplus.

To prevent firm 1 from revealing his type through the information exchange, a low-cost retailer thus has an incentive to reject firm 1's offer. This is captured by the incentive constraint

$$\overline{v}_1 - t_1 \geq \overline{v}_2 - t_2(\mu). \tag{4}$$

In (4) the LHS captures expected utility from accepting $t_1 > \underline{v}_1$. The retailer reveals its type $c = \underline{c}$, firm 2 charges $\overline{v}_2$, and if $t_1 = \overline{v}_1$ the LHS will be zero by definition of $\overline{v}_i$. The RHS of (4) represents expected utility from rejecting $t_1 > \underline{v}_1$.

Suppose a low cost retailer rejects $t_1 > \underline{v}_1$. Given a high cost type always rejects $t_1 > \underline{v}_1$, firm 2's posterior belief

$$\mu(\underline{c}|r_1) = \frac{\Pr(r_1|\underline{c})\phi_2}{\Pr(r_1|\underline{c})\phi_2 + (1-\phi_2)} \tag{5}$$

is lower than the prior belief ϕ_2 if type $\underline{c}$ randomizes, i.e., if $\Pr(r_1|\underline{c}) < 1$. Define $y \equiv \Pr(r_1|\underline{c})$. Lemma 1 states that the retailer thus plays a mixed strategy.

Lemma 1. *Given $t_1 > \underline{v}_1$, $y \in (0,1)$ in equilibrium.*

Proof. If $y = 1$, $\mu(\underline{c}|r_1) = \phi_2$ from (5) with $\mathbb{E}(\pi_{D2}(\phi_2)|y = 1) = \Pr(\phi_2 < \rho_2)(\overline{v}_i - \underline{v}_i)$. Suppose that $y < 1$. From (5), $\mu(\underline{c}|r_1) < \phi_2$ and $\mathbb{E}(\pi_{D2}(\mu)|y < 1) = \Pr(\mu < \rho_2)(\overline{v}_i - \underline{v}_i)$. Hence, $\Pr(\mu < \rho_2) \geq \Pr(\phi_2 < \rho_2)$ and $\mathbb{E}(\pi_{D2}(\mu)|y < 1) \geq \mathbb{E}(\pi_{D2}(\phi_2)|y = 1)$ from (3).[6]

$\square$

If the retailer always rejects $t_1 > \underline{v}_1$ ($y = 1$) this information will not be informative for firm 2. Randomizing $y < 1$ generates (pessimistic) posterior beliefs $\mu(\underline{c}|r_1) < \phi_2$. Hence, firm 2's offer (weakly) decreases ($t_2(\mu) \leq t_2(\phi)$) due to (3) and expected surplus from bargaining with firm 2 (weakly) increases.

Anticipating a strategic rejection, producer 1 places an offer for which the retailer is indifferent between accepting and rejecting, i.e.,

$$y(\overline{v}_2 - t_2(\mu)) = (1 - y)(\overline{v}_1 - t_1). \tag{6}$$

In (6), with probability y the retailer rejects firm 1's offer and realizes surplus $\overline{v}_2 - t_2(\mu)$ from bargaining with firm 2. With probability $1 - y$, firm 1's offer t_1

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[6]Depending on the distribution of ϕ_2, $\Pr(\mu < \rho_2) < \Pr(\phi_2 < \rho_2)$ and $\mathbb{E}(\pi_{D2}(\mu)|y < 1) > \mathbb{E}(\pi_{D2}(\phi_2)|y = 1)$.

is accepted and firm 2 knows that $c = \underline{c}$. For an offer t_1^x which satisfies (6) the retailer is indifferent between accepting and rejecting firm 1's offer.

If firm 1 truthfully reveals information it will prefer to place an offer $t_1^x > \underline{v}_1$ if $\phi_1 > \rho_1$ (See (2)). However, without the information exchange, firm 1 could ignore the retailer's incentive constraint (4) and offer $\overline{v}_1$. Truthfully revealing information about the results of the bargaining process with the retailer is thus unprofitable for firm 1 unless $t_1^x = \overline{v}_1$. According to (6) this can only be the case when $t_2(\mu) = \overline{v}_2$, i.e., when the retailer expects firm 2 to place a high offer even after learning that firm 1's offer was rejected.

This cannot occur in equilibrium. The retailer can adjust y such that posterior belief (5) is below ρ_2. Firm 2 will then always place a low offer. Expecting the retailer's strategic rejection firm 1 has an incentive not to reveal information. If $\phi_i > \rho_i$ for all i firm 1 expects its offer $\overline{v}_1$ to be accepted with probability $1 - y$ when it (truthfully) exchanges information and with probability 1 when it does not reveal any information.

It is interesting to that see the retailer has an incentive to voluntarily disclose information about the bargaining process. Refusing firm 1's offer decreases firm 2's posterior belief to face a low cost retailer and, therefore, firm 2's offer. This mechanism constitutes a benefit of delisting a producer's products. The retailer could then publicly announce that he failed to meet agreement with firm 1 prior to the negotiations with firm 2.

Another way to compensate firm 1 for revealing information is that either firm 2 or the retailer makes a side-payment to firm 1. A fixed payment to firm 1 after the second firm was placing an offer could compensate firm 1 for making an offer lower than $\overline{v}_1$. This transfer would then have to be $\overline{v}_1 - t_1^x$ where $t_1^x \in$

$[\underline{v}_1, \overline{v}_1)$. However, there is an incentive not to pay the transfer because the game ends subsequently. Whether such a transfer is actually paid thus depends on whether contracts between either firm 1 and firm 2 or firm 1 and the retailer are enforceable. Transfers between firm 1 and firm 2 are most likely to be deemed as illegal horizontal agreements which are not enforceable. Direct payments from the retailers to producers are very common and it is more likely that such contracts are not per se illegal. Such transfers are not analyzed in this model as this goes beyond a pure information exchange.

4 Repeated Bargaining

A crucial point when each firm can only place a single offer is that firm 1 cannot benefit from the communications. This section extends the model by allowing firm 1 to make one additional offer. Firms may exchange information after their offer was accepted or rejected.

To analyze this extended problem further definitions have to be introduced. Firm 1's offer will be denoted by t_1^t where the superscript $t \in \{1, 2\}$ indicates the "period" of offers, i.e., whether it is the first ($t = 1$) or the second offer ($t = 2$). Using the same notation, the retailer's strategy facing firm 1 in round t is $\alpha_1^t = \{a_1^t, r_1^t\}$ where a_1^t (r_1^t) means that the t's offer of firm 1 was accepted (rejected). If firm 1's first offer was rejected (r_1^1), the retailer's and producer 1's second period payoffs are discounted by a common discount factor $\delta \in (0, 1)$. This standard assumption captures time constraints of bargaining or an exogenous chance of a breakdown of the bargaining process (Sobel and Takahashi, 1983). The timing of the extended problem is as follows:

1. The retailer learns his type $c \in \{\underline{c}, \overline{c}\}$. Each producer i draws ϕ_i.

2. Producer 1 offers t_1^1. The retailer accepts (a_1^1) or rejects (r_1^1) the offer.

3. Producer 1 exchanges information.

4. Producer 2 forms posterior beliefs μ_2 based and offers $t_2(\mu_2)$. The retailer accepts (a_2) or rejects (r_2) the offer.

5. Producer 2 exchanges information.

6. Producer 1 forms posterior beliefs μ_1 offers $t_1^2(\mu_1)$. The retailer accepts (a_1^2) or rejects (r_1^2) the offer.

4.1 Bargaining without an information exchange

Firm 2 only places a single offer according to (2). If there is no information exchange the bargaining problem between the retailer and firm 1 is similar to a standard sequential bargaining game with two periods. Fudenberg and Tirole (1983) show that there exists a unique Bayesian equilibrium with the following properties.[7] The retailer is indifferent between accepting and rejecting the offer $t_1 = \tilde{v}_1 \equiv \overline{v}_1 - \delta(\overline{v}_1 - \underline{v}_1)$ with firm 1's payoffs being

$$\pi_1(\tilde{v}_1) = \phi_1 \tilde{v} + (1 - \phi_1)\delta\underline{v}. \tag{7}$$

There are three equilibrium strategies relevant for the analysis of an information exchange. Firstly, firm 1 can make a low offer $t_1^1 = \underline{v}_1$ which yields profits $\pi_1 = \underline{v}_1$. Secondly, offering $t_1^1 = \tilde{v}_1$ resembles features of price discrimination – a low cost

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[7]See Fudenberg and Tirole (1983), Proposition 1, for a detailed derivation of the results.

retailer accepts $\tilde{v}_1$ and a high cost retailer rejects it. In the second round, firm 1 will then offer $t_1^2 = \underline{v}_1$ which a high cost retailer accepts. This yields expected profits of $\pi_1(\tilde{v}_1)$. Thirdly, there exists a combination of (mixed) equilibrium strategies which can only occur if $\phi_1 > \rho_1$. Consider the low cost retailer's strategy $y_1 \equiv \Pr(r_1|\underline{c})$. Using posterior beliefs $\mu(\underline{c}|r_1) = \frac{\phi_1 y_1}{\phi_1 y_1 + (1 - \phi_1)}$, firm 1 is indifferent between making a low and a high offer in the second round if $\mu(\underline{c}|r_1)\overline{v}_1 = \underline{v}_1$. This requires the retailer to choose

$$y_{nX} \equiv \frac{1 - \phi_1}{\phi_1} \frac{\underline{v}_1}{\overline{v}_1 - \underline{v}_1}. \tag{8}$$

Define $x_1(t_1^1) \equiv \Pr(t_1^2 = \underline{v}_1)$. The retailer is indifferent between immediate acceptance and accepting $\underline{v}$ in the second period if $x_1 = \frac{\overline{v}_1 - t_1^1}{\delta(\overline{v}_1 - \underline{v}_1)}$. Hence, firm 1 may charge $\overline{v}_1$ in the first period with payoffs

$$\pi_{nX} \equiv \pi(\overline{v}_1) = \phi_1(1 - y_{nX})\overline{v}_1 + \delta(\phi_1 y_{nX} + (1 - \phi_1))\underline{v}_1. \tag{9}$$

In (9), $\mu(\underline{c}|r_1)\overline{v}_1 = \underline{v}_1$ due to firm 1's indifference between a low and a high offer. In this case there will be no trade with a high cost retailer because $x_1(\overline{v}_1) = 0$.

4.2   Bargaining with an information exchange

In the following, assume that firm 2 exchanges information only if it received information from firm 1 before. The incentives to exchange information can be analyzed by deriving the effects an exchange would have on each of the equilibrium strategies which would occur when the firms did not exchange information.

As outlined in Section 4.1, firm 1's payoffs in this 'silent' or 'no exchange' game are $\Pi_{nX} = \max\{\underline{v}_1, \pi_1(\tilde{v}), \pi_1(\overline{v})\}$. In this section the incentives to exchange

information are derived by analyzing the following three cases.

1. When $\Pi_{nX} = \underline{v}_1$, there are no potential gains from an information exchange because firm 1's offer will always be accepted.

2. When $\Pi_{nX} = \pi_1(\tilde{v}_1)$ there will only be an information exchange if the retailer expects firm 2's offer to be high. An information exchange enhances market efficiency.

3. When $\Pi_{nX} = \pi_1(\overline{v}_1)$ an information exchange can occur when firm 1 is sufficiently patient. Firm 2's incentive to communicate is stronger the more optimistic firm 1 and the higher (lower) $\overline{v}_1$ ($\underline{v}_2$).

Case 1. Given that $\Pi_{nX} = \underline{v}_1$, firm 1's offer will be low and the retailer immediately accepts it. Firm 2 cannot learn anything from firm 1's message as a low offer will always be accepted. Hence, the exchange neither has an impact on equilibrium strategies nor on payoffs.

Case 2. Consider $\Pi_{nX} = \pi_1(\tilde{v}_1)$. Firm 1 only has a (weak) incentive to exchange information if its first period offer $\tilde{v}_1$ is at least as high as without an information exchange. This can only be the case if the retailer expects firm 2's offer to be high. Otherwise, the retailer has an incentive to reject firm 1's offer in order to decrease firm 2's first and firm 1's second offer. Hence, firm 1 would have to leave a higher rent to the retailer in the first round. Anticipating this effect, firm 1 prefers not to exchange information. This is stated in Proposition 1.

Proposition 1. *If $\Pi_1 = \pi_1(\tilde{v})$ and the retailer expects that firm 2's offer is high an information exchange can occur.*

Proof. If the retailer expects a high offer of firm 1 in the second round, the retailer immediately accepts firm 1's first offer. Expecting a low offer from firm 1 in the second round, the retailer immediately accepts an offer t_1^1 if and only if

$$\overline{v}_1 - t_1^1 \geq \overline{v}_2 - t_2 + \delta(\overline{v}_1 - \underline{v}_1). \tag{10}$$

A type $\underline{c}$-retailer immediately accepts firm 1's offer $t_1^1 = \tilde{v}_X(t_2)$ with

$$\tilde{v}_X(t_2) \equiv \overline{v}_1 - (\overline{v}_2 - t_2) - \delta(\overline{v}_1 - \underline{v}_1). \tag{11}$$

From (11) it follows that the information exchange is detrimental to firm 1 unless the retailer expects $t_2 = \overline{v}_2$. Only then $\tilde{v}_X = \tilde{v}_1$ (See (7)). If the retailer expects $t_2 \leq \overline{v}_2$, $\tilde{v}_X < \tilde{v}_1$ and firm 1's payoffs decrease if there is an information exchange.

$\square$

This result shows how an information exchange may increase market efficiency. When firm 1's first offer $\tilde{v}_1$ is rejected, firm 2 knows with certainty that it faces a high cost type and it will place a low offer. This would not be the case without an information exchange where firm 2 would place a high offer. Hence, in this case an information exchange increases welfare by ensuring that agreement will always be found.

Case 3. Consider now that $\Pi_1 = \pi_1(\overline{v})$. In this case a hybrid equilibrium arises containing mixed strategies. Define $y_i \equiv \Pr(r_i | \underline{c})$. The retailer chooses y_1 such that

$$\mu_2(\underline{c} | r_1)\overline{v}_2 = \underline{v}_2. \tag{12}$$

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Expecting an information exchange, the retailer randomizes between accepting and rejecting firm 1's offer to make firm 2 indifferent between placing a high and a low offer. Moreover, y_2 must satisfy that firm 1 is indifferent between placing a high and a low offer in the second round, i.e.,

$$\mu_1(\underline{c}|r_1, r_2)\overline{v}_1 = \underline{v}_1. \tag{13}$$

The retailer's equilibrium strategies satisfying (12) and (13), henceforth referred to as $\overline{y}_i$, deserve some discussion. When $\overline{v}_i$ increases posterior beliefs μ_i *ceteris paribus* have to decrease accordingly such that conditions (12) and (12) are satisfied. A counterintuitive effect arises: The probability that firm 2's offer $t_2 > \underline{v}_2$ is accepted is lower the higher the retailer's valuation for firm 2's products.

To see why this is the case, note that when $\overline{v}_2$ increases, μ_2 has to decrease (See (12)). As $\frac{\partial \mu_2}{\partial y_1} > 0$, $\overline{y}_1$ decreases accordingly. However, to ensure firm 1's indifference between placing a low and a high offer (condition (13)), a lower value of $\overline{y}_1$ decreases firm 1's posterior beliefs as $\frac{\partial \mu_1}{\partial y_1} > 0$.[8] The probability $\overline{y}_2$ thus has to increase in equilibrium to offset the effect of a lower value of $\overline{y}_1$. Hence, an increase in $\overline{v}_2$ leads to a higher value of $\overline{y}_2$. A similar explanation applies when $\overline{v}_1$ increases. From (13), y_2 has to decrease because a change in y_1 would inconsistent with condition (12).

These effects are important drivers of the result that the lower the retailer's valuation for firm 2's good is relative to firm 1, the more likely the information exchange pays off for firm 2. This will be shown further below after firm 1's incentive to exchange information are outlined.

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[8]From (15), $\frac{\partial \mu_1}{\partial y_i} > 0 \Leftrightarrow (1 - \phi_1)\phi_1 y_i > 0$.

Firm 1's incentive to participate in an information exchange is determined by an inter-temporal trade-off. The probability that firm 1's first offer is rejected increases when the producers exchange information due to the retailer's incentive to utilize the information exchange between the producers in order to drive down firm 2's offer. This will be stated in Lemma 2. However, when placing its second offer firm 1 receives additional information from firm 2 which potentially increases firm 1's second period payoffs.

Lemma 2. *The probability of rejecting firm 1's offer increases when the producers exchange information.*

Proof. The probability $\overline{y}_1$ can be computed as follows.

$$\frac{\phi_2 y_1}{\phi_2 y_1 + (1 - \phi_2)} \overline{v}_2 = \underline{v}_2 \Leftrightarrow \overline{y}_1 \equiv \frac{1 - \phi_2}{\phi_2} \frac{\underline{v}_2}{\overline{v}_2 - \underline{v}_2} \tag{14}$$

Given posterior beliefs $\mu_1(\underline{c}|r_1, r_2) = \frac{\phi_1 \Pr(r_1|\underline{c}) \Pr(r_2|\underline{c})}{\phi_1 \Pr(r_1|\underline{c}) \Pr(r_2|\underline{c}) + (1 - \phi_1)}$ and substituting $\overline{y}_1$,

$$\frac{\phi_1 \overline{y}_1 y_2}{\phi_1 \overline{y}_1 y_2 + (1 - \phi_1)} \overline{v}_1 = \underline{v}_1 \Leftrightarrow \overline{y}_2 \equiv \frac{1}{\overline{y}_1} \frac{1 - \phi_1}{\phi_1} \frac{\underline{v}_1}{\overline{v}_1 - \underline{v}_1} = \frac{\phi_2}{1 - \phi_2} \frac{\overline{v}_2 - \underline{v}_2}{\underline{v}_2} \frac{1 - \phi_1}{\phi_1} \frac{\underline{v}_1}{\overline{v}_1 - \underline{v}_1} \tag{15}$$

Using (8), $\overline{y}_2 < 1$ requires $y_{nX} < \overline{y}_1$.

$\square$

The potential benefits from the exchange can be shown using firm 1's *ex ante* profits, henceforth referred to as π_X.

$$\pi_X = \phi_1(1 - \overline{y}_1)\overline{v}_1 + \delta \left[(\phi_1 \overline{y}_1 \overline{y}_2 + (1 - \phi_1))\underline{v}_1 + \overline{y}_1(1 - \overline{y}_2)\overline{v}_1 \right] \tag{16}$$

The first term in (16) depicts expected surplus from the first round of bargaining. This surplus is lower than without an information exchange because the chance of rejection is higher. The first term in brackets in (16) is exactly equal to the second term in (9) due to $\overline{y}_2 = \frac{y_n X}{\overline{y}_1}$ (See Lemma 2). However, firm 1 has the chance to realize high payoffs in the second round which is captured by the last term in (16). When firm 2's offer $t_2 > \underline{v}_2$ was accepted firm 1 knows with certainty that the retailer's type is $\underline{c}$ and offers the maximum fee $\overline{v}_1$.

Before turning to firm 1's incentive to exchange information, consider the producers' equilibrium strategies. The retailer is indifferent between accepting and rejecting firm 2's offer t_2 if

$$\overline{v}_2 - t_2 = \delta x_1(t_2)(\overline{v}_1 - \underline{v}_1) \tag{17}$$

where $x_1(t_2)$ is the probability that firm 1's second offer is low. The retailer is indifferent between accepting firm 1's offer $t_1^1 > \underline{v}_1$ if

$$\overline{v}_1 - t_1^1 = x_2(\overline{v}_2 - \underline{v}_2) + \delta x_1(t_2)(\overline{v}_1 - \underline{v}_1). \tag{18}$$

In (18), x_2 is the probability that firm 2's offer is low. Condition (17) uniquely determines the equilibrium value x_1 for which the retailer is indifferent between accepting and rejecting firm 1's second offer. From (17) and (18) it becomes obvious that for $t_1^1 = \overline{v}_1$ both retailer never place a low offer and there will never be trade with a high cost retailer. This feature is very similar to the case without an information exchange. However, if the firms did not exchange information, firm 2 would place a low offer if $\underline{v}_2 > \phi_2 \overline{v}_2$ in which case agreement would be found.

One can now show that firm 1 has an incentive to exchange information. When $\bar{y}_2 \in (0, 1)$, firm 1 benefits from the information exchange when it is sufficiently patient.[9]

Proposition 2. *An information exchange strictly increases firm 1's payoffs if $\delta > \phi_1$.*

Proof. Given $\bar{y}_2 = \frac{y_{nX}}{\bar{y}_1}$ in equilibrium, $\pi_X > \pi_{nX}$ if

$$\phi_1(1 - \bar{y}_1)\bar{v}_1 + \delta\bar{y}_1(1 - \bar{y}_2)\bar{v}_1 > \phi_1(1 - y_{nX})\bar{v}_1$$

$$\Leftrightarrow \delta\bar{y}_1\left(1 - \frac{y_{nX}}{\bar{y}_1}\right) > \phi_1(\bar{y}_1 - y_{nX}) \tag{19}$$

$$\Leftrightarrow \delta > \phi_1.$$

Hence, if firm 1 is sufficiently patient an information exchange pays off.

$\square$

The higher the prior ϕ_1 the more likely it is that firm 1 charges a high fee in the first round. Hence, for higher values of ϕ_1 firm 1 is better off not exchanging information due to the increased chance of firm 1's first offer being rejected when the retailer anticipates the producers' communication. However, when firm 1's first offer is rejected, firm 2's offer will be accepted with probability $1 - \bar{y}_2$ in equilibrium. Firm 1 then learns from the communications that it faces a low cost retailer when placing its second offer. If it is sufficiently patient ($\delta > \phi_1$) firm 1 thus benefits from the exchange.

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[9]When firm 2's offer $t_2 > \underline{v}_2$ is always rejected, firm 1's payoff with an information exchange π_X is the same as without an information exchange π_{nX} (See (9) and (16) with $\bar{y}_2 = 1$). When firm 2's offer is never rejected, firm 1's first offer will always be accepted because the retailer anticipates a high offer in the second round.

Firm 2 prefers to communicate with firm 1 if the benefits from receiving information outweigh the losses due to an increased chance that its offer is rejected. Payoffs are $\pi_2 = \max\{\underline{v}_2, \phi_2\overline{v}_2\}$ without an information exchange. When the firms exchange information, $\pi_2 = \max\{\underline{v}_2, (1 - \overline{y}_2)(\overline{y}_1\underline{v}_2 + (1 - \overline{y}_1)\overline{v}_2)\}$. If firm 1's offer was accepted (probability $1 - \overline{y}_1$) firm 2 will know with certainty that the retailer's type is $\underline{c}$. In case of a rejection of firm 1's offer (probability $\overline{y}_1$), firm 2's beliefs to face a low cost retailer will be lower than without an information exchange. Using (12), $\mu_2(\underline{c}|r_1)\overline{v}_2 = \underline{v}_2$. In both cases an offer $t_2 > \underline{v}_2$ will be accepted with probability $1 - \overline{y}_2$. Producer 2 thus prefers to exchange information if

$$(1 - \overline{y}_2)(\overline{y}_1\underline{v}_2 + (1 - \overline{y}_1)\overline{v}_2) > \phi_2\overline{v}_2. \tag{20}$$

In the following part of this section it will be shown under which condition an information exchange is preferred by firm 2. One can show that if firm 2 prefers to charge a low offer it will not exchange information. Hence, an information exchange requires that $\phi_2\overline{v}_2 > \underline{v}_2$.

Lemma 3. *If $\underline{v}_2 > \phi_2\overline{v}_2$, no information exchange occurs.*

Proof. The claim that when $\underline{v}_2 > \phi_2\overline{v}_2$ also $\underline{v}_2 > (1 - \overline{y}_2)(\overline{y}_1\underline{v}_2 + (1 - \overline{y}_1)\overline{v}_2)$ will be proven by contradiction. Suppose that $\phi_2\overline{v}_2 < \underline{v}_2 < (1 - \overline{y}_2)(\overline{y}_1\underline{v}_2 + (1 - \overline{y}_1)\overline{v}_2)$. Rearranging this condition and substituting $\overline{y}_2 = \frac{y_{nX}}{\overline{y}_1}$ yields

$$\phi_2\overline{v}_2 - \underline{v}_2 < 0 < (\overline{y}_1 - y_{nX} - 1)\underline{v}_2 + (\overline{y}_1 - y_{nX})(1 - \overline{y}_1)\overline{v}_2. \tag{21}$$

Condition (21) requires $(\overline{y}_1 - y_{nX})(1 - \overline{y}_1)\overline{v}_2 > 0$ because $(\overline{y}_1 - y_{nX} - 1) < 0$. However, $1 - \overline{y}_1 = \frac{\phi_2\overline{v}_2 - \underline{v}_2}{\phi_2(\overline{v}_2 - \underline{v}_2)} < 0$ by assumption. Hence, as $\overline{y}_1 - y_{nX} > 0$ from

20

Lemma 2, $(\overline{y}_1 - y_{nX} - 1)\underline{v}_2 + (\overline{y}_1 - y_{nX})(1 - \overline{y}_1)\overline{v}_2 < 0$ if $\phi_2 \overline{v}_2 < \underline{v}_2$.

$\square$

To see the impact of the retailer's valuations for producer i's products one has to consider that the retailer plays mixed strategies. The probability that firm 2's offer is rejected increases (decreases) in the upper bound of the retailer's valuation for firm 2's (firm 1's) products. This follows from the derivatives $\frac{\partial \overline{y}_2}{\partial \overline{v}_2} = \frac{v_1(1-\phi_1)\phi_2}{\underline{v}_2 \phi_1(1-\phi_2)(\overline{v}_1 - \underline{v}_1)} > 0$ and $\frac{\partial \overline{y}_2}{\partial \overline{v}_1} = -\frac{v_1(1-\phi_1)\phi_2(\overline{v}_2 - \underline{v}_2)}{\underline{v}_2 \phi_1(1-\phi_2)(\underline{v}_1 - \overline{v}_1)^2} < 0$. As explained above, this result occurs because conditions (12) and (13) have to be satisfied in equilibrium.

For the same reason an increase in the lower bound of the retailer's valuation for firm 1's products, $\underline{v}_1$, decreases firm 2's profits from an information exchange. From (13), an increase in $\underline{v}_1$ must be offset by a higher posterior belief $\mu_1(\underline{c}|r_1, r_2)$ in equilibrium. As $\frac{\partial \mu_1}{\partial y_2} > 0$ (see (15)), the probability that firm 2's offer $t_2 > \underline{v}_2$ is rejected increases.[10]

From $\frac{\partial \overline{y}_2}{\partial \underline{v}_2} = -\frac{v_1 \overline{v}_2(1-\phi_1)\phi_2}{\underline{v}_2^2 \phi_1(1-\phi_2)(\overline{v}_1 - \underline{v}_1)} < 0$ a decrease in the lower bound of the retailer's valuation for firm 2's products *ceteris paribus* increases the probability that firm 2's offer is accepted. If $\underline{v}_2$ increases, posterior beliefs $\mu_2(\underline{c}|r_1)$ have to decrease, hence $\overline{y}_1$ increases. Since also (13), must hold in equilibrium $\overline{y}_2$ decreases accordingly. However, note that profits without an information exchange are also increasing in $\overline{v}_2$. Hence, increasing the upper bound of the retailer's valuation for producer 2's goods has an ambiguous effect on the emergence of an information exchange.

Consider now the impact of the producer's prior beliefs on firm 2's profits from an information exchange. Differentiating the left-hand term in (20) with respect to ϕ_1 yields

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[10]One can also see that $\overline{y}_2$ increases in equilibrium from $\frac{\partial \overline{y}_2}{\partial \underline{v}_1} = \frac{(1-\phi_1)\phi_2 \overline{v}_1(\overline{v}_2 - \underline{v}_2)}{\phi_1(1-\phi_2)(\overline{v}_1 - \underline{v}_1)^2 \underline{v}_2}$.

21

$$-\frac{\partial \overline{y}_2}{\partial \phi_1}(\overline{y}_1(\phi_2)\underline{v}_2 + (1 - \overline{y}_1\phi_2)\overline{v}_2) \tag{22}$$

From (15), $\frac{\partial \overline{y}_2}{\partial \phi_1} = \frac{\phi_2 \underline{v}_1(\overline{v}_2 - \underline{v}_2)}{\underline{v}_2 \phi_1^2(\phi_2 - 1)(\overline{v}_1 - \underline{v}_1)} < 0$. Hence, firm 2 is more likely to exchange information when ϕ_1 is high because the probability that firm 2's offer is rejected is lower. As $\phi_1 < \delta$ has to hold for an information exchange to be beneficial for firm 1, however, higher values of firm 1's prior beliefs make it less likely that also firm 1 prefers to communicate.

The derivative of the left-hand term in (20) with respect ϕ_2 to reads

$$\frac{\partial \overline{y}_1}{\partial \phi_2}(\overline{v}_2 - \underline{v}_2)(\overline{y}_2 - 1) + \frac{\partial \overline{y}_2}{\partial \phi_2}(\overline{v}_2(\overline{y}_1 - 1) - \overline{y}_1\underline{v}_2). \tag{23}$$

From (14), $\frac{\partial \overline{y}_1}{\partial \phi_2} = -\frac{\underline{v}_2}{\phi_2^2(\overline{v}_2 - \underline{v}_2)} < 0$ and from (15), $\frac{\partial \overline{y}_2}{\partial \phi_2} = \frac{\underline{v}_1(1 - \phi_1)(\overline{v}_2 - \underline{v}_2)}{\underline{v}_2 \phi_1(\phi_2 - 1)^2(\overline{v}_1 - \underline{v}_1)} > 0$. The higher ϕ_2, the more likely it is that firm 1's offer is accepted in which case firm 2 knows with certainty the retailer's type $\underline{c}$. However, the probability that firm 2's offer is accepted decreases which makes the information exchange less attractive. Hence, higher values of ϕ_2 may or may not facilitate an information exchange.

To illustrate firm 2's incentive to participate in the information exchange, suppose that $c \in \{0, 5\}$, $q_2 = 4$ and $\overline{v}_2 = 60$. When both firms have prior beliefs of 0.5 an information exchange will only occur if $\overline{v}_1$ is much higher than $\overline{v}_2$. This can be seen in figure 1. The orange (blue) plane displays firm 2's payoffs from (not) exchanging information. When the orange plane lies above the blue plane firm 2 has an incentive to exchange information. For instance, when $(\underline{v}_1, \overline{v}_1) = (20, 200)$ firm 2's profits from exchanging information exceed those from not communicating.
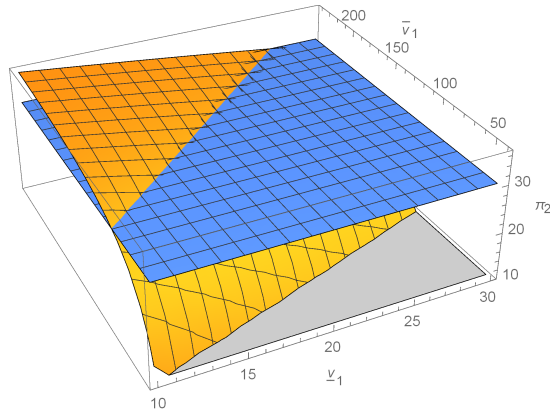
Figure 1: Firm 2's profits for $\phi_i = 0.5$.

If firm 1 becomes more 'optimistic' it is more likely that the information exchange pays off for firm 2. Figure 2 shows that if firm 1 has prior beliefs $\phi_1 = 0.7$, an information exchange is more likely to pay off for firm 2. As argued above, this is due to the fact that the probability that firm 2's offer is rejected decreases in ϕ_1.
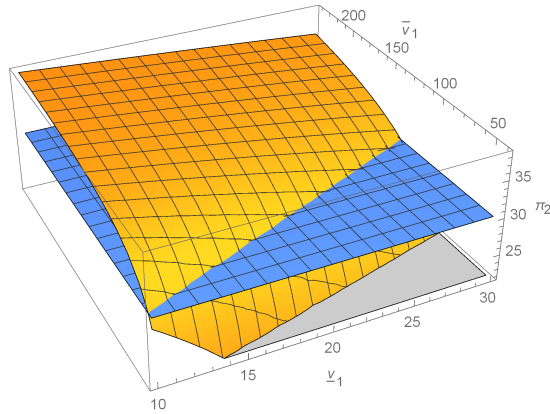

Figure 2: Firm 2's profits for $\phi_1 = 0.7$ and $\phi_2 = 0.5$

The following figures 3, 4 and 5 illustrate the effect of an increase in $\underline{v}_2$ and $\overline{v}_2$ on firm 2's incentives to exchange information. Figure 3 shows that in the same setup as above with $\phi_1 = 0.7$ the incentives to exchange information decrease when

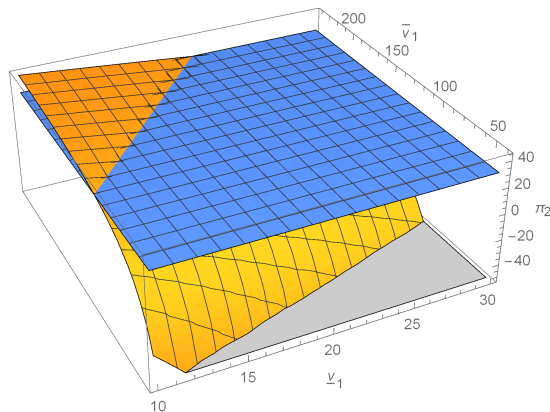the lower bound is $\underline{v}_2 = 5$. The area shrinks where the orange plane lies above the blue one.

Figure 3: Firm 2's profits for $\phi_1 = 0.7$, $\phi_2 = 0.5$ and $\underline{v}_2 = 5$.

The following two figures depict the comparison of firm 2's profits for $\overline{v}_2 = 50$ and $\overline{v}_2 = 100$, respectively, with the remaining parameters $\phi_1 = 0.7$, $\phi_2 = 0.5$ and $\underline{v}_2 = 20$. One can see that the area where the orange plane is above the blue one is slightly larger in figure 2 where $\overline{v}_2 = 60$ than in figures 4 ($\overline{v}_2 = 50$) and 5 ($\overline{v}_2 = 100$). This illustrates that an information exchange is not per se more beneficial to firm 2 if its goods are more valuable to the retailer.
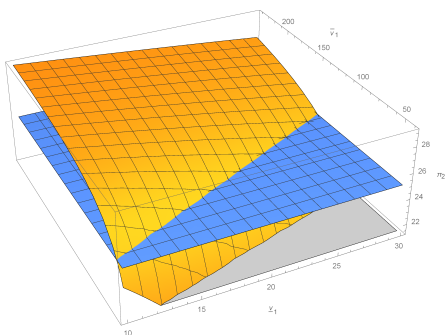

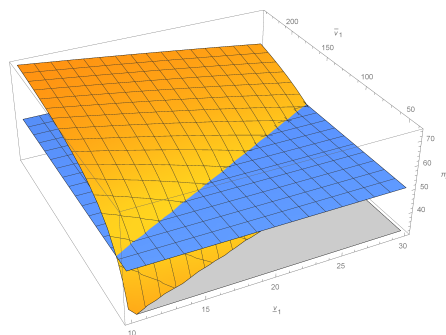Figure 4: Firm 2's profits for $\overline{v}_2 = 50$.

Figure 5: Firm 2's profits for $\overline{v}_2 = 100$.

24

4.3 Discussion

Now that the producer's incentive to exchange information are outlined, the effects of the communications on the retailer and market efficiency can be evaluated when $\Pi_{nX} = \pi_1(\overline{v}_1)$. Firstly, one can see that when an exchange occurs, the probability that a low cost retailer accepts firm 2's offer $t_2 > \underline{v}_2$ is smaller than 1. Without an exchange, a low cost retailer always accepts firm 2's offer. Thus, when the producers communicate there is the chance that a low cost retailer does not offer producer 2's goods which most likely harms final consumers. Secondly, it was shown that the retailer rejects firm 1's first offer with a higher frequency when the producers communicate. Agreement will thus be delayed. However, communications will not prevent that agreement is found between firm 2 and a high cost retailer. From Lemma 3 it follows that an information occurs only if firm 2 would charge a high fee, anyway.

It remains to address two further topics: Credibility and an interpretation of the valuations. If an information exchange between the producers is not credible it is highly unlikely that it occurs. In the model, the producers may have an incentive to misreport on two stages. Firm 1 might lie to firm 2 after its first offer and firm 2 might lie to firm 1 before firm 1's second offer.

Firm 2 does not have an incentive to misreport on the outcome of the negotiations. As firm 2's profits are realized after its offer was accepted or rejected it does not benefit from lying. Hence, only firm 1 might have an incentive to misreport. Firm 1 does not benefit from inducing a low offer of firm 2 because this offer will always be accepted. It is therefore crucial that firm 1 has no incentive to falsely report that its (high) offer was accepted. From Lemma 3, firm 2 must

prefer to place a high offer for an information exchange to occur. If the producers communicate, firm 1 thus has no benefit from lying.

The numerical results suggest that the larger the upper bound of the retailer's valuation for firm 1's products the higher the likelihood that firm 2 has an incentive to exchange information. This implies that the retailer realizes a higher overall revenue with firm 1's products and with a larger quantity of firm 1's good being sold. To see this, consider the example presented in figure 1 where $\phi_i = 0.5$. It was assumed that $\underline{c} = 0$ and $\overline{c} = 5$ with $\underline{v}_2 = 20$ and $\overline{v}_2 = 60$ which implies that $q_2 = 8$ and $p_1 = 7.5$. Firm 2 prefers to exchange information if, e.g., $\underline{v}_1 = 20$ and $\overline{v}_1 = 200$ which implies $q_1 = 18$ and $p_1 \approx 5.5$. If only $\overline{v}_1 = 100$ then $q_1 = 16$ and $p_1 = 6.25$ and no information exchange occurs. Firm 2 has an even stronger incentive to communicate if the lower bound of the retailer's valuation of firm 1's goods is low and the upper bound is high, e.g., when $\underline{v}_1 = 10$ and $\overline{v}_1 = 200$ for which $q_1 = 38$ and $p_1 \approx 5.263$. These result suggest that the likelihood that an information exchange occurs is higher between a smaller firm and a larger firm in terms of quantities sold.

One could also think about different assumptions regarding the retailer's cost structure. For instance, one could assume that the retailer incurs fixed costs. This would be a reasonable assumption in grocery retailing where a retailer possibly maintains a country-wide structure of outlets. In that case, total costs can assumed to be private information such that $\pi_{Di} = q_i p_i - q_i ac - t_i$ where ac are average total costs. When assuming that marginal costs are zero and that fixed costs are unknown, assumptions would have to be made on how much of the retailer's total fixed costs are covered from selling each firm's goods. From a practical perspective it seems unlikely that a retailer covers all fixed costs with the goods of a single

producer. This could be a done in future extensions of the model. However, note that the crucial part of the analysis above is the retailer's valuation v_i. All results qualitatively continue to hold irrespective of how v_i depends on the retailer's costs.

5 Conclusion

This paper analyzes information exchange between two manufacturers about the outcome of a bargaining process with a single retailer whose (variable) costs of offering the goods to final consumers is private information. The producers each propose a fixed fee or tariff which the retailer has to pay in order to receive a given quantity of goods. Although not being active in the same goods markets, the producers may benefit from an information exchange by learning the retailer's costs and, therefore, his valuation for each producer's products.

In models of sequential bargaining rejecting an offer constitutes a signal (Fudenberg and Tirole, 1983). Those signals are important drivers of the results of this paper: the retailer has an incentive to reject one producer's offer to decrease the offer of the other. When each producer is only allowed to place a single offer an information exchange does not occur because of this mechanism.

When negotiations fail with one producer this applies that that producer's goods are delisted. By signaling to be a high cost type, delisting can thus improve the retailer's bargaining position (Sloot and Verhoef, 2008). This finding is supported by Davies (1994) who reports that delisting decisions in practice rarely occur because an offer is unprofitable. The model suggests that in situations where negotiations are short, i.e., the producers cannot place many offers, it is rather the retailer who has an incentive to voluntarily disclose information when the parties

failed to find agreement. In practice this could apply to negotiations between a relatively large retailer and small producers whose products are rather unimportant to the retailer.

The retailer's incentive to improve his bargaining position in future negotiations by refusing an offer is still present when one producer is allowed to place an additional offer. However, in this case an information exchange may occur because the communications may also yield valuable information for the producers. An information exchange then has two potential effects. Firstly, it can make it more likely that agreement is found, especially with a high cost retailer. Communications between producers then improve market efficiency. This result is in line with Kühn and Vives (1994) who propose that producers sharing information concerning single customers should be legal because problems of adverse selection can be solved. However, they state that such exemptions should exist primarily in insurance and banking industries. As detrimental effects of asymmetric information can be present in any industry where a downstream firm's valuation is unknown (e.g., due to uncertainty about costs), an information exchange may be beneficial not only in those particular industries.

In the model, an information exchange may also harm the retailer as well as impede market efficiency. Although this result seems unsurprising, the reasons for these detrimental effects are not straightforward. The European Commission expects producers' communications to be harmful because they facilitate (tacit) collusion.[11] This cannot explain any welfare losses in the setup analyzed in this paper because the producers are not active in the same market. However, they

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[11]See Chapter 2 of the European Commission's Horizontal Guidelines (Reference in Footnote 1).

negotiate with the same retailer. Being informed about that retailer's valuation by knowing his costs allows the producers to extract higher rents. Although an information exchange thus merely shifts profits from downstream to upstream firms, the likelihood that agreement is found decreases thereby reducing welfare.

The model can be extended in multiple ways. Firstly, one could allow for more rounds of bargaining. Although negotiations in, e.g., grocery retailing, occur over a limited time period, it is reasonable that producers are allowed to place at least two offers. Secondly, the producers may compete directly on the goods market. Then prices and quantities would be determined endogenously. Thirdly, the number of manufacturers or retailers may be increased. This may allow for a more realistic determination of the firms' outside options.

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