Predatory accommodation in vertical contracting with externalities

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Predatory accommodation in vertical contracting with externalities*

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Abstract

The goal of this paper is to analyze vertical contracts between manufacturers and retailers in a channel including the upstream input market. Using a Nash bargaining framework, we study the contract negotiations between manufacturers and the common retailer, both in a simultaneous and sequential game. The oligopsonistic behavior of manufacturers on the upstream market provides a new explanation for predatory accommodation. With two-parts tariff, we show that joint profit of the industry is not maximised at simultaneous bilateral bargaining equilibria and that below marginal cost pricing in the intermediate goods market arises, when final products are substitutes, and may be welfare improving. When negotiations occurs sequentially, we show, in the two-manufacturers case, that the first manufacturer which enters into negotiations and the retailer may jointly prefer above marginal cost pricing or not, depending on the distribution of bargaining power in the channel. However, the second manufacturer equilibrium wholesale price is set below marginal cost.

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Key-words: bargaining, vertical relationships, contracts, oligopsony, market power, predatory pricing.

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1 Introduction

It is widely acknowledged that predatory pricing may cause injury to competition and this practice generally constitutes a violation of competition laws, especially when it drives out rivals or impedes entry of new firms. In particular, this is the case when predatory pricing occurs in intermediate goods markets (section 2(a) of the Robinson-Patman Act). Predatory pricing can be established when there is below-cost pricing still with possible recoupment of losses after the predator has driven its rivals out of the market. However, recent economic analysis offer a contrasted view on the impact of predatory pricing on the industry structure as well as on the welfare. Marx and Shaffer (1999) show that below cost pricing without exclusion of rivals may occur in intermediate goods market and may be welfare improving. They coined the term "predatory accommodation" for this kind of situation. They focus on pricing when a monopolist retailer negotiates two-parts tariffs sequentially with two suppliers of imperfect substitutes. It is shown that the retailer and the first manufacturer which negotiates jointly find profitable to establish the wholesale price under (constant) marginal cost in order to extract surplus from the second manufacturer.[1] Intuitively, when the retailer negotiates with the second manufacturer, the retailer's disagreement payoff is decreasing in the price at which it can buy additional units from the first manufacturer. So, by decreasing this price, the retailer and the first manufacturer jointly increase the size of concessions the second manufacturer must make. However, below-cost pricing does not drive the second manufacturer out of the market. On the contrary, both the retailer and the first manufacturer benefit from its presence by jointly extracting partly its surplus through below-cost pricing as a rent-shifting mechanism.

However, it is clear that their result relies heavily on the sequential nature of the timing and thus the observability of contracts, as acknowledged by the authors. Indeed, Shaffer (2001) shows that when bilateral bargaining are simultaneous then overall joint profit is

[1] The contracts depends only on the quantity purchased from a single supplier, so that exclusive dealing provisions such as in Aghion and Bolton's (1987) analysis are excluded.

maximized in any bargaining equilibrium and that marginal cost pricing prevails with two-parts tariffs. Thus, predatory accommodation is valid only for sequential timings.

In this paper, we provide a new explanation for predatory accommodation but in a framework with simultaneous bilateral bargaining. Our point relies on incorporating into the analysis the strategic interactions between manufacturers on the upstream market which provides the necessary inputs for production. More precisely, we consider a channel structure in which an upstream sector sells a homogenous raw product to a processing industry composed of $n \geq 2$ manufacturers. The manufacturers subsequently process and sell a final differentiated commodity to a downstream retailer acting as a monopoly. We assume a perfectly competitive upstream sector while market power is present at both the manufacturers and retail levels. Thus, manufacturers act both as an oligopsony when buying raw material and as an oligopoly when selling their products to the retailer. Similarly, the multi-products retailer acts both as a monopsony when negotiating with manufacturers and as a monopoly with respect to final consumers. The assumption of a monopolist retailer allows for a simple analysis while enabling to introduce market power at the retail level.

It is worth noting that empirically this framework is broadly consistent with available studies of market structure in the food industry sector both in the US and in Europe. Food processing industries often comprise few processors who purchase a raw farm product from many producers and process it into final products, possibly differentiated (Sexton and Lavoie (2002)). The literature posits an oligopsonistic relationship in markets where farm product producers meet with food processors and emphasizes that such an industry structure may result in imperfect competition on both the buying and selling sides of the market, which affects the surplus of both farmers and consumers (see e.g. Chen and Lent (1992), Wann and Sexton (1992), Alston, Sexton and Zhang (1997), Hamilton and Sunding (1998) and Hamilton (2002)). However, this literature has relatively neglected the existence and the importance of market power at the retail level. One key feature of our paper is to focus on market power both at the processing and retail levels.

We show that the presence of the oligopsonistic behavior on the upstream market induces a negative cost externality between manufacturers through quantities exchanged. We then characterize the optimal two-parts tariff for each bilateral bargaining between a manufacturer and the retailer. We show that wholesale price differs from the marginal processing cost depending on final demand characteristics and the intensity of oligopsonistic behavior on the upstream farm market. In particular, in the important case of imperfect substitution between final differentiated products, we find that wholesale price is always below marginal cost. We even prove that below average cost pricing may occur when the degree of products differentiation is sufficiently small. Intuitively, in presence of cost externalities and imperfect substitutes, each negotiated contract takes partially into account the negative effect of the quantities sold by the rival manufacturers' on the procurement cost. Indeed, for a given manufacturer, decreasing the wholesale price amounts to decrease the rivals' quantities sold by the retailer, which in turn lowers its own procurement cost by reducing cost externalities. Thus, the *perceived* marginal cost is lower than marginal cost. This strategic "reducing its own cost" effect is more compelling when final products are less differentiated, *ceteris paribus*. On the contrary, in the particular case where final demands for both products are independent, cost externalities are irrelevant for the wholesale pricing rule and marginal cost pricing occurs. Of course, the motivation for having below marginal cost pricing is very different from the "rent-shifting" motivation that occurs in Marx and Shaffer's analysis. Nevertheless, in our context, the properties of the equilibrium are similar: below cost pricing without exclusion of rivals.

We also characterize the optimal fees or slotting allowances paid by manufacturers to the retailer and we show that the sign of these transfers is generally ambiguous and depends on the gap between wholesale price and average cost, on the bargaining power of the manufacturer under scrutiny and on a scale effect that we identify. Moreover, we show that the presence of cost externalities impedes the maximization of joint profit in the simultaneous bargaining process in the channel. Thus, our finding indicates that the form of contracts plays a role in the degree of inefficiency in the channel.

Welfare analysis surprisingly shows that below cost pricing may be welfare improving as it causes consumer surplus and upstream producers surplus to increase. This increase can outweigh the reduction in joint profit of the industry (manufacturers and the retailer) due to the downward distortion on wholesale prices.

We then turn to the sequential case, restricting the analysis to two manufacturers interacting with the retailer. We show how Marx and Shaffer's results should be altered. We state that the wholesale price for the first manufacturer which enters into negotiation may be or not under marginal cost, contrary to the case under simultaneous bilateral bargaining. Actually, the gap between wholesale price and marginal cost can be decomposed into three components. One corresponds to the strategic "rent-shifting" effect identified by Marx and Shaffer (1999). A second one corresponds to the "reducing its own cost" strategy identified when bilateral bargaining are simultaneous. Both work in the same direction, that is below marginal cost pricing as a rule in case of substitutes.

However, there is a third effect which works in the opposite direction. Indeed, in sequential bargaining, the joint profit of the retailer and the first manufacturer takes into account the surplus extracted from the relationship between the retailer and the second manufacturer. This provides the retailer with incentives to partially internalize the negative externality of the quantity exchanged with the first supplier on this surplus. This consideration tends to produce above marginal cost pricing as long as the retailer retains some surplus in its negotiation with the second manufacturer. For instance, if products are independent and if the second manufacturer has no bargaining power then above marginal cost pricing is the rule. On the contrary, if the retailer has no bargaining power within its relationship with the second manufacturer, then below marginal cost pricing is the rule.

The paper is organized as follows. Section 2 is devoted first to assumptions and notations and second to establish the profit sharing in bargaining equilibria. Section 3 is devoted to the analysis of optimal two-parts tariffs in simultaneous bargaining. Section 4 provides the welfare analysis. In section 5, we analyze the negotiations when they occur sequentially. Section 6 concludes.

2 The model

2.1 Assumptions and notations

Consider a channel structure in which an upstream producer sector sells a (homogenous) raw product to a processing industry composed of $n \geq 2$ manufacturers, denoted M_i, $\forall i = 1, ..., n$. The manufacturers subsequently process and sell a final differentiated commodity to a downstream retailer R acting as a monopoly. We assume a perfectly competitive upstream sector while market power is present at both the manufacturers' level and retail level. Thus, manufacturers act both as an oligopsony when buying raw material and as an oligopoly when selling their products to the retailer. Similarly, the retailer acts both as a monopsony when negotiating with manufacturers and as a monopoly with respect to final consumers.

Upstream producers sell a quantity x_i of the raw product to any manufacturer M_i, $\forall i = 1, ..., n$, at a price p_x given by the inverse supply function $p_x = P_x(\sum\limits_i x_i)$, where $P_x' > 0$. Each manufacturer M_i produces a single product q_i given the processing technology $q_i = f_i(x_i)$ with $f_i'(x_i) > 0$, $\forall i = 1, ..., n$. Equivalently, we define $C_i(\mathbf{q})$ as the cost function for M_i, where $\mathbf{q} = (q_1, ..q_i.., q_n)$ is the vector of quantities:

$$C_i(\mathbf{q}) = \left[P_x(\sum_i f_i^{-1}(q_i)) \right] f_i^{-1}(q_i).$$

Obviously, given our assumption on P_x, upstream competition for raw material entails negative externalities between manufacturers because each production cost is increasing in other manufacturers' purchases ($\partial C_i(\mathbf{q})/\partial q_j = x_i P_x' / f_j'(x_j) > 0$, $\forall i \neq j$). The quantity q_i is sold to the retail monopolist R in exchange of a monetary transfer T_i. Then manufacturer M_i's profit is $\pi^i = T_i - P_x(\sum\limits_i x_i)x_i$ or equivalently $\pi^i = T_i - C_i(\mathbf{q})$.

Let $R(\mathbf{q})$ denote the revenue function of the retail monopolist.[2] Then the retailer's profit

[2] Alternatively, the retailer may be the final consumer and $R(\mathbf{q})$ can be interpreted as the indirect utility from consuming the bundle $\mathbf{q}$.

is $\pi^R = R(\mathbf{q}) - \sum_i T_i$ if the retailer has an agreement with each manufacturer. For simplicity, we assume that the retailer does not face any distribution cost and if $P_i(\mathbf{q})$ denotes the retail price for commodity i, then we have:

$$R(\mathbf{q}) = \sum_i P_i(\mathbf{q}) q_i.$$

Throughout the analysis, we make the following assumptions:

$A1$: $R(\mathbf{q})$ is continuous, twice differentiable and concave,

$A2$: $C_i(\mathbf{q})$ is continuous, twice differentiable and convex, $\forall i = 1, ..., n$,

$A3$: There are gains from trading all goods, i.e. $\exists \mathbf{q} \in \Re^n_+$ such that $R(\mathbf{q}) - \sum_i C_i(\mathbf{q}) > 0$.

In particular, assumption $A3$ ensures that we can consider equilibria where all products are sold. In addition, we assume that manufacturers are precluded from entering the downstream market so that each manufacturer has to induce the retailer to carry its product in order to obtain positive profits. Thus, the monopoly advantage for the retailer implies that any manufacturer's profit is non positive if it does not reach an agreement with the retailer (it can be negative if the relationship with the retailer entails specific investment costs before entering into negotiations).

2.2 Negotiating contracts

We consider the following two-stages game between n manufacturers and their common retailer. In the first stage, the retailer negotiates a contract $T_i(q_i)$ simultaneously with each manufacturer. In the second stage, the retailer chooses how much to buy of each product q_i and order these quantities from manufacturers. Then, manufacturers compete to buy the raw product from the upstream sector and process the goods. Finally, the retailer resells these quantities to final consumers, exerting its monopoly power. We are only interested in considering equilibria where all products are sold through the retailer.

As emphasized by Marx and Shaffer (1999) and Shaffer (2001), the main difficulty comes from the linkage across negotiations which raises arduous questions. In particular, what does each manufacturer know about their rivals' contract terms? Indeed, when negotiating, each manufacturer must conjecture the set of terms its rivals have or have been offered. In equilibrium, this conjecture must be correct but out-of-equilibrium beliefs may be important in determining the bargaining outcome. In the cooperative bargaining approach, this problem is resolved by assuming that any bargaining outcome must be bilaterally renegotiation proof, i.e. no processor-retailer can deviate from the bargaining outcome in a way that increases their joint profit, taking as given all other contracts. Following Marx and Shaffer (1999) and Shaffer (2001), we thus assume that bargaining between the retailer and any manufacturer M_i maximizes the two players' joint profit, taking as given all other negotiated contracts. Moreover, we assume that each player earns its disagreement payoff (i.e. what it would earn if an agreement is not reached) plus a share of the incremental gains from trade, defined as the difference between the joint profit of the retailer and M_i when they trade and their joint profit when they do not trade), with proportion $\lambda_i \in [0, 1]$ going to manufacturer M_i.

In fact, it can be proven that the asymmetric Nash product, which is maximized by the Nash bargaining solution, is maximized if and only if the above assumptions are satisfied (see Proposition 2 in Shaffer (2001)). However, it can easily be shown that the equilibrium contract is not unique. We thus focus in the following on the particular case of two-parts tariffs.

3 Simultaneous bargaining with two-parts tariffs

In order to provide a precise characterization of bargaining equilibria, we specialize the model by restricting the set of possible contracts to the set of two-parts tariffs. Denote $T_i(q_i)$ the agreement reached by the retailer with manufacturer M_i, $\forall i = 1, ..., n$. T_i is defined as the net payment from the retailer to manufacturer M_i:

$$T_i(q_i) = \begin{cases} w_i q_i - F_i, & q_i > 0 \\ 0, & q_i = 0 \end{cases}, \forall i = 1...n.$$

where F_i, is a fee or slotting allowance paid by M_i to the retailer, in order to access to the final demand. Of course, the sign of the fee F_i is not restricted *a priori* in the analysis.

If the retailer buys all the manufacturers' products, his profit is given by:

$$\pi^R = \sum_i [P_i(\mathbf{q})q_i - T_i] = \sum_i [(P_i(\mathbf{q}) - w_i)q_i + F_i].$$

where $P_i(\mathbf{q})$ is the (final) inverse demand function for product i. If manufacturer M_i sells a positive quantity, his profit is :

$$\pi^i = w_i q_i - C_i(\mathbf{q}) - F_i = T_i - C_i(\mathbf{q}), \forall i. \tag{1}$$

As emphasized in the preceding section, we assume that bargaining between the retailer and each manufacturer M_i results in the maximization of the two players' joint profit denoted Π^i, taking as given the retailer's contract with all others manufacturers M_j, $j \neq i$ with:

$$\Pi^i = \sum_i [P_i(\mathbf{q})q_i] - C_i(\mathbf{q}) - \sum_{j \neq i} T_j$$

Then, each manufacturer earns a share of the incremental gains from trade, that is the joint profit with the retailer and manufacturer M_i when they trade minus their joint profit when they do not trade, with an exogenous proportion $\lambda_i \in [0, 1]$ going to manufacturer M_i. The proportion λ_i measures the bargaining power of M_i. A value of λ_i close to one means a large bargaining power and a value close to zero means that the manufacturer has low bargaining power.

Denote $\mathcal{T}_{-i}$ as the set of all contracts except for manufacturer M_i, i.e. $\mathcal{T}_{-i} = \{T_1, ..., T_n\} \setminus \{T_i\}$. If the retailer does not buy manufacturer i's product, his profit is given by:

$$\pi^R_{-i}(\mathcal{T}_{-i}) = \sum_{j \neq i} [P_j(\mathbf{q}_{-i})q_j - T_j]$$

where $\mathbf{q}_{-i} = (q_1, ..q_{i-1}, 0, q_{i+1}, ...q_n)$ is the vector of production when M_i does not sell through the retailer.

In the second stage, the retailer takes the contracts T_i with each manufacturer as given and conditional on the bargaining outcome he chooses $\mathbf{q}$ that maximizes his profit given the wholesale prices vector $\mathbf{w}$. We denote the equilibrium quantities $q_i(\mathbf{w})$, $\forall i$ when the retailer contracts with all manufacturers. Then:

$$\mathbf{q}(\mathbf{w}) \in \arg\max_{q_1,..,q_n} \pi^R = \sum_i \left[(P_i(\mathbf{q}) - w_i) q_i + F_i \right]. \tag{2}$$

As the retailer is a monopolist, the retail equilibrium quantities defined by program (2) are given by the following first-order conditions:

$$P_i(\mathbf{q}(\mathbf{w})) - w_i + \sum_j \frac{\partial P_j(\mathbf{q}(\mathbf{w}))}{\partial q_i} q_j(\mathbf{w}) = 0, \forall i \tag{3}$$

If an agreement does not occur with manufacturer i because negotiation fails in the first stage, then the retailer chooses:

$$\hat{\mathbf{q}}_{-i}(\mathbf{w}) \in \arg\max_{(q_j)_{j\neq i}} \pi^R_{-i}(\mathcal{T}_{-i}) = \sum_{j\neq i} \left[(P_j(\mathbf{q}_{-i}) - w_j) q_j + F_j \right],.$$

and we denote $\hat{\pi}^R_{-i}(\mathcal{T}_{-i})$ the resulting profit. We also denote

$$\Pi_{-i} = \sum_{j\neq i} \left[(P_j(\hat{\mathbf{q}}_{-i}(\mathbf{w}))\hat{q}_j(\mathbf{w}) - C_j(\hat{\mathbf{q}}_{-i}(\mathbf{w})) \right]$$

as the joint profit of all players (for a given $\mathbf{w}$) when M_i does not participate.

In the first stage (bargaining game), negotiations occur between the retailer and each manufacturer simultaneously. When negotiating with M_i, the retailer and M_i take T_j $\forall j \neq i$ as given. The equilibrium wholesale price is given by the maximization of the joint profit:

$$\max_{w_i} \Pi^i = P_i(\mathbf{q}(\mathbf{w}))q_i(\mathbf{w}) - C_i(\mathbf{q}(\mathbf{w})) + \sum_{j\neq i} \left[(P_j(\mathbf{q}(\mathbf{w})) - w_j) q_j(\mathbf{w}) + F_j \right]. \tag{4}$$

Solving this maximization program, we state the following proposition.

Proposition 1 *In a simultaneous bilateral bargaining equilibrium with two-parts tariffs, wholesale prices are given implicitly by*

$$w_i - \frac{\partial C_i}{\partial q_i} = \sum_{j\neq i} \gamma_{ji} \frac{\partial C_i}{\partial q_j}, \qquad \forall i = 1, ..., n. \tag{5}$$

where $\gamma_{ji} = \frac{\partial q_j}{\partial w_i} / \frac{\partial q_i}{\partial w_i}$ *with* $\left|\gamma_{ji}\right| \in [0, 1]$. *Moreover, if products are imperfect substitutes (complements), then wholesale price is below (above) marginal cost* ($w_i - \frac{\partial C_i}{\partial q_i} < (>) 0, \forall i$).

Proof: The first order condition associated to (4) is:

$$P_i\frac{\partial q_i}{\partial w_i}+\sum_{j=1}^{n}\left[\frac{\partial P_i}{\partial q_j}\frac{\partial q_j}{\partial w_i}q_i\right]+\sum_{j\neq i}q_j\sum_{k=1}^{n}\left[\frac{\partial P_j}{\partial q_k}\frac{\partial q_k}{\partial w_i}\right]+\sum_{j\neq i}(P_j-w_j)\frac{\partial q_j}{\partial w_i}$$
$$-\sum_{j=1}^{n}\frac{\partial C_i}{\partial q_j}\frac{\partial q_j}{\partial w_i}=0,\forall i.$$

Using equation (3) and rearranging terms, we get:

$$\left(w_i-\frac{\partial C_i}{\partial q_i}\right)\frac{\partial q_i}{\partial w_i}=\sum_j\left[\frac{\partial P_j}{\partial q_i}q_j\frac{\partial q_i}{\partial w_i}\right]-\sum_{j=1}^{n}\left[\frac{\partial P_i}{\partial q_j}\frac{\partial q_j}{\partial w_i}q_i\right]$$
$$-\sum_{j\neq i}q_j\sum_{k=1}^{n}\left[\frac{\partial P_j}{\partial q_k}\frac{\partial q_k}{\partial w_i}\right]+\sum_{j\neq i}\left[(\sum_{k=1}^{n}\frac{\partial P_k}{\partial q_j}q_k)\frac{\partial q_j}{\partial w_i}\right]+\sum_{j\neq i}\frac{\partial C_i}{\partial q_j}\frac{\partial q_j}{\partial w_i}$$

Simplifying this expression, we get the result. Furthermore, we have $\frac{\partial q_i}{\partial w_i}<0$. Moreover, if commodities are imperfect substitutes (complements), then $\frac{\partial q_j}{\partial w_i}>(<)0$ and $\gamma_{ji}<(>)0$. Finally, because of the Cournot competition setting in the upstream sector, $\frac{\partial C_i}{\partial q_j}>0$, we get a negative (positive) gap between wholesale price and marginal cost if products are substitutes (complements). ■

Proposition 1 indicates that the equilibrium wholesale pricing differs from the marginal cost of production because of the presence of externalities both at the upstream and downstream levels. In the important case of substitutes, below marginal cost pricing occurs at the equilibrium. Without cost externalities (i.e. when $\partial C_i/\partial q_j=0,\forall j\neq i$), proposition 1 also states that marginal cost pricing prevails as in Shaffer's (2001) model. In presence of cost externalities and imperfect substitutes, each negotiated contract takes partially into account the negative effect of the quantities sold by the rival manufacturers' on the procurement cost. Indeed, decreasing the wholesale price amounts to decrease the rivals' quantities sold by the retailer, which in turn lowers its own procurement cost by reducing cost externalities. Thus, the *perceived* marginal cost ($\frac{\partial C_i}{\partial q_i}+\sum_{j\neq i}\gamma_{ji}\frac{\partial C_i}{\partial q_j}$) is lower than marginal cost. This strategic effect is more compelling when final products are less differentiated, *ceteris paribus*. On the contrary, in the particular case where final demands for both products are independent (i.e. $\partial q_j/\partial w_i=0,\forall j\neq i$), cost externalities are irrelevant for the wholesale pricing rule and marginal cost pricing occurs.

Proposition 1 does not allow to state that operating profits (i.e. excluding the fee or slotting allowance F_i) for manufacturers are positive in the case of imperfect substitutes (i.e. when $\gamma_{ji} < 0$). In theory, it may be the case that the distortions due to cost externalities are so strong that wholesale prices are below average cost for some manufacturers. Indeed, assuming symmetry in cost and demand functions, it is possible to prove that a necessary and sufficient condition to have below average cost pricing at the equilibrium is that $1+\sum_{j\neq i}\gamma_{ji} < 0$, which means that final commodities are few differentiated *ceteris paribus* (see Appendix A).

We now show that the presence of externalities does not allow to maximize overall joint profit.

Proposition 2 *In a simultaneous bilateral bargaining equilibrium with two-parts tariffs, joint profit of all manufacturers and the retailer is not maximized.*

Proof: Maximizing the profit $\Pi^{IVS} = \sum_i [P_i(\mathbf{q})q_i - C_i(\mathbf{q})]$ of the corresponding integrated vertical structure would lead to the following first order condition for the quantity q_i:

$$\sum_j \frac{\partial P_j(\mathbf{q}^m)}{\partial q_i} q_j^m + P_i(\mathbf{q}^m) - \sum_j \frac{\partial C_j(\mathbf{q}^m)}{\partial q_i} = 0, \forall i. \tag{6}$$

In the non integrated vertical structure, the retailer maximization program implies the following first-order condition (see (3)):

$$P_i(\mathbf{q}) - w_i + \sum_j \frac{\partial P_j(\mathbf{q})}{\partial q_i} q_j = 0, \forall i. \tag{7}$$

Replacing w_i by its value given by (5), equation (7) becomes

$$\sum_j \frac{\partial P_j(\mathbf{q})}{\partial q_i} q_j + P_i(\mathbf{q}) - \sum_j \frac{\frac{\partial q_j}{\partial w_i}}{\frac{\partial q_i}{\partial w_i}} \frac{\partial C_i(\mathbf{q})}{\partial q_j} = 0, \forall i \tag{8}$$

Comparing expressions (6) and (8), we obtain that the non integrated vertical structure outcome does not maximize the joint profit of the integrated vertical structure. Indeed, in general, we have

$$\sum_j \frac{\frac{\partial q_j}{\partial w_i}}{\frac{\partial q_i}{\partial w_i}} \frac{\partial C_i}{\partial q_j} \neq \sum_j \frac{\partial C_j}{\partial q_i}, \forall i.$$

Even assuming symmetry of the cost functions (i.e. $\frac{\partial C_i}{\partial q_j} = \frac{\partial C_j}{\partial q_i}$), we still have $\frac{\partial q_j}{\partial w_i} / \frac{\partial q_i}{\partial w_i} \neq 1$ because products are imperfect substitutes. ■

Thus, the externality induced by the upstream competition induces an efficiency loss in the vertical structure that depends on the final demand assumptions and on the intensity of upstream competition. Indeed, a way to implement the optimum for an integrated (both horizontally and vertically) structure is to set the (internal) wholesale price at $w_i = \sum_j \frac{\partial C_j}{\partial q_i}$, as indicated by (6). This result indicates that the *perceived* marginal cost is then the sum of all marginal effects of quantity q_i on all manufacturers' costs and thereby all upstream externalities are internalized at the equilibrium. By contrast, in the non integrated vertical structure, only the negative externalities of others' quantities on its own cost are partially taken into account in each bilateral bargaining.

Finally, the fee F_i is chosen to divide the incremental gains from trade so that each party earns as profit as it would earn if negotiations have failed. Let Π_{-i} denote the equilibrium joint profit of all players when M_i does not participate and let Π denote the equilibrium joint profit when all parties are active. We have:

$$\Pi_{-i} = \sum_{k \neq i} \left[(P_k(\hat{\mathbf{q}}_{-i}))\hat{q}_k - C_k(\hat{\mathbf{q}}_{-i}) \right], \quad \text{and} \quad \Pi = \sum_i \left[P_i(\mathbf{q}) q_i - C_i(\mathbf{q}) \right]$$

where $\mathbf{q} = \mathbf{q}(\mathbf{w})$ and $\hat{\mathbf{q}}_{-i} = \hat{\mathbf{q}}_{-i}(\mathbf{w})$. Then, the following proposition states the equilibrium fees and payoffs to the retailer and to the manufacturers.

Proposition 3 *In a simultaneous bilateral bargaining equilibrium with two-parts tariffs, the equilibrium payoff to manufacturer M_i, for any i, is:*

$$\pi^i = \lambda_i \left[\Pi - \Pi_{-i} - \Delta_{-i} \right]$$

while the equilibrium payoff to the retailer is:

$$\pi^R = \left(1 - \sum_i \lambda_i \right) \Pi + \sum_i \lambda_i \Pi_{-i} + \sum_i \lambda_i \Delta_{-i}$$

where $\Delta_{-i} = \sum_{j \neq i} \left[w_j q_j - C_j(\mathbf{q}) \right] - \sum_{j \neq i} \left[w_j \hat{q}_j - C_j(\hat{\mathbf{q}}_{-i}) \right]$.

Proof: Given that the disagreement payoff of any manufacturer is zero because there is only one retailer (actually what is really important is that these payoffs must be constant), we can express the equilibrium payoff for manufacturer M_i as follows:

$$\pi^i = \lambda_i \left[\Pi^i - \hat{\pi}^R_{-i}(\mathcal{T}_{-i})\right] \tag{9}$$

or equivalently,

$$\begin{aligned}
\pi^i &= \lambda_i \left[P_i(\mathbf{q})q_i - C_i(\mathbf{q}) + \sum_{j\neq i} [(P_j(\mathbf{q}) - w_j)q_j + F_j] - \sum_{j\neq i} [(P_j(\hat{\mathbf{q}}_{-i}) - w_j)\hat{q}_j + F_j] \right] \\
&= \lambda_i \left[P_i(\mathbf{q})q_i - C_i(\mathbf{q}) + \sum_{j\neq i} [(P_j(\mathbf{q}) - w_j)q_j - C_j(\mathbf{q}) + C_j(\mathbf{q})] - \sum_{j\neq i} [(P_j(\hat{\mathbf{q}}_{-i}) - w_j)\hat{q}_j] \right] \\
&= \lambda_i \left[\Pi + \sum_{j\neq i} [C_j(\mathbf{q}) - w_j q_j] - \sum_{j\neq i} [(P_j(\hat{\mathbf{q}}_{-i}) - w_j)\hat{q}_j + C_j(\hat{\mathbf{q}}_{-i}) - C_j(\hat{\mathbf{q}}_{-i})] \right].
\end{aligned}$$

Finally, we obtain

$$\pi^i = \lambda_i \left[\Pi - \Pi_{-i} + \sum_{j\neq i} [C_j(\mathbf{q}) - w_j q_j] - \sum_{j\neq i} [C_j(\hat{\mathbf{q}}_{-i}) - w_j \hat{q}_j] \right].$$

Consequently, the equilibrium profit for the retailer is:

$$\pi^R = \Pi - \sum_i \pi^i.$$

Substituting, we obtain that:

$$\pi^R = \left(1 - \sum_i \lambda_i\right)\Pi + \sum_i \lambda_i \Pi_{-i} - \sum_i \lambda_i \left[\sum_{j\neq i} [C_j(\mathbf{q}) - w_j q_j] - \sum_{j\neq i} [C_j(\hat{\mathbf{q}}_{-i}) - w_j \hat{q}_j] \right].$$

This concludes the proof. ■

Proposition 3 indicates that the equilibrium payoff of any manufacturer is proportional to the incremental gain of its product $(\Pi - \Pi_{-i})$ diminished by a scale effect Δ_{-i}. When products are substitutes, we have $q_j < \hat{q}_j$. Rewriting the scale effect, we get:

$$\begin{aligned}
\Delta_{-i} &= \sum_{j\neq i} [w_j q_j - C_j(\mathbf{q})] - \sum_{j\neq i} [w_j \hat{q}_j - C_j(\hat{\mathbf{q}}_{-i})] \\
&= \sum_{j\neq i} \left[\left(\frac{C_j(\mathbf{q}) - C_j(\hat{\mathbf{q}}_{-i})}{q_j - \hat{q}_j} - w_j \right)(q_j - \hat{q}_j) \right]
\end{aligned}$$

Similarly, we can decompose the equilibrium payoff of the retailer π^R into three components. The first one is proportional to joint profit and can be negative if the manufacturers possess a sufficiently high bargaining power ($\sum_i \lambda_i > 1$). The second one is a weighted sum of joint profit when one manufacturer does not participate ($\sum\limits_i \lambda_i \Pi_{-i}$). Finally, the third one is a weighted sum of scale effects ($\sum\limits_i \lambda_i \Delta_{-i}$).

Finally, using the definition of M_i's profit and result from Proposition 3 gives the equilibrium fee paid by the manufacturer M_i to the retailer:

$$F_i = \left[w_i - \frac{C_i(\mathbf{q})}{q_i} \right] q_i - \lambda_i \left[\Pi - \Pi_{-i} - \Delta_{-i} \right].$$

We have $\lambda_i \left[\Pi - \Pi_{-i} - \Delta_{-i} \right] \geq 0$ by definition (equilibrium payoff for M_i). Moreover, the sign of the first term between brackets is positive as long as the wholesale price is higher than average cost at the equilibrium output level. Overall, the sign of F_i is undetermined and depends on the magnitude of the margin. When the retailer has all the bargaining power ($\lambda_i = 0$), then $F_i > 0$ if wholesale price is between marginal cost and average cost.

4 Welfare

In the previous section, we have shown that the equilibrium contracts imply below marginal cost pricing (hereafter BMCP) but that this does not mean that some manufacturers are driven out of the market. Because this practice is often considered as injury to competition, we analyze in this section whether below marginal cost pricing is welfare reducing compared to pricing at marginal cost (hereafter MCP). We define welfare as the non weighted sum of the surplus of the raw product producers (PS), of the industry channel (IS) (that is the manufacturers and the retailer) and of consumers (CS).

The equilibrium surplus of the raw product producers can be written as follows:

$$\begin{aligned} PS &= P_x(\sum_i x_i) \sum_i x_i - \int_0^{\sum_i x_i} P_x(u) du \\ &= \sum_i C_i(q) - \int_0^{\sum_i f_i^{-1}(q_i)} P_x(u) du. \end{aligned}$$

Denote $V(q) = \sum_i \int_0^{q_i} P_i(u, q_{-i})du$ the utility of a representative consumer buying quantities q_i of each commodity. Then, the equilibrium consumer surplus is:

$$CS = V(q) - \sum_i P_i(q)q_i.$$

Finally, the total equilibrium welfare reduces to:

$$W = V(q) - \int_0^{\sum_i f_i^{-1}(q_i)} P_x(u)du.$$

Intuitively, we conjecture that BMCP may often induce a rise in quantities sold at the equilibrium, and is thereby beneficial for consumers but also for the raw product producers. On the other hand, this increase in quantities may be detrimental for the industry surplus. Overall, the total effect is unclear. We thus specialize the model and we state the following proposition.

Proposition 4 *Assume that* $n = 2$. *Consider (symmetric) linear demand functions,* $P_i(q_i, q_j) = \alpha - q_i - \nu q_j$ *where* $0 \leq \nu \leq 1$ *as well as a linear supply function* $P_x = \delta + \phi(x_i + x_j)$. *In addition, consider a Leontieff (constant return to scale) technology where* $q_i = kx_i$. *Then, below marginal cost pricing is always welfare improving compared to marginal cost pricing.*

Proof: see Appendix B. ∎

Intuitively, the pro-competitive effect of below marginal cost pricing overcomes the loss in industry surplus. In Table 1, we simulate the impact on welfare for given values of the demand and supply parameters ($\alpha = 1$, $\nu = 0.5$, $\delta = 1$, $\phi = 2$ and $k = 3$).

TABLE 1: Comparisons between below-cost pricing, marginal cost pricing and integrated vertical structure

	MCP	BMCP*	IVSP*
PS	0.0147	+6.35%	-11.10%
IS	0.1139	-0.51%	+0.36%
CS	0.0330	+8.16%	-11.10%
W	0.1616	+1.5%	-3.02%
$(w_i - \frac{\partial C_i}{\partial q_i})/\frac{\partial C_i}{\partial q_i}$	0.00%*	-4.54%**	+8.51%**
Average cost	0.4141	+0.61%	-1.11%
w_i	0.4545	-3.74%	+6.86%
P_i	0.7273	-1.18%	+2.13%

*: These values are in percentage of MCP. **: These percentages indicate the value of ratios.

Below marginal cost pricing amounts to higher quantities sold on the final market. Final prices decrease by 1.18%. This benefits to consumers. On the other hand, these additional quantities induce a larger use of raw product that raises its price. Consequently, the surplus of raw product producers increases. However, the manufacturers and the retailer would jointly benefit from committing to marginal cost pricing. Indeed, strategic interactions at work leads each manufacturer to overproduce in order to reduce rival's quantity, which in turn lowers the procurement cost. This strategic effect induces losses in industry surplus (IS).

Now, in the benchmark case of integrated vertical structure pricing (IVSP), Table 1 indicates that above marginal cost pricing occurs as it is clear from Proposition 2 and leads to improvement in industry surplus. Actually, quantities decreases as a consequence of high wholesale prices. This in turns reduces both producer and consumer surplus. Overall, welfare decreases because the gain in industry surplus does not compensate the loss for upstream producers and consumers.

It is also interesting to analyze the impact of commodity substitutability on our results. We present the case where the degree of differentiation between the two products is increased. The demand functions are now: $P_i(q_i, q_j) = 1 - 0.75q_i - 0.25q_j$.[3]

TABLE 2: Impact of commodity substitutability on welfare.

	MCP	BMCP*	IVSP*
PS	0.0278	+5.80%	-14.8%
IS	0.1528	-0.65%	+0.65%
CS	0.0469	+5.76%	-14.9%
W	0.2274	+1.49%	-4.35%
$(w_i - \frac{\partial C_i}{\partial q_i})/\frac{\partial C_i}{\partial q_i}$	0.00%*	-3.92%**	+10.53%**
Average cost	0.4444	+0.72%	-1.69%
w_i	0.5	-2.86%	+7.7%
P_i	0.75	-0.95%	+2.56%

*: These values are in percentage of MCP. **: These percentages indicate the value of ratios.

[3] It is worth noting that a change only in ν induces also a change in total demand and can yield to unwanted results, as emphasized by Irmen (1997). This is why we choose to decrease the coefficient of both q_i and q_j as indicated in the text. Actually, this is equivalent to divide by 2 the cross-price sensitivity (i.e. coefficient b in: $q_i = a - dp_i + b(p_j - p_i)$). For more on this, see Irmen (1997).

A decrease in the substitutability of the product tends to increase welfare (40% in the considered example). However, the gain in welfare due to BMCP is slightly reduced when products are less substitute. Intuitively, when products are more differentiated, the impact of externalities on the wholesale pricing rule is reduced *ceteris paribus* (see equation (5)). The pro-competitive effect of below marginal cost pricing is thus attenuated.

5 Sequential bargaining

This section is devoted to the analysis of sequential negotiations between manufacturers and the retailer. Following Marx and Shaffer (1999), we restrict for simplicity the study to the case of two manufacturers of imperfect substitutes. We let manufacturer M_1 be the first supplier to negotiate with the retailer. The game has now three stages. In stage one, the retailer negotiates a contract T_1 with M_1 for the purchase of q_1. In stage two, the retailer negotiates a contract T_2 with M_2 for the purchase of q_2. In stage three, the retailer chooses quantities q_1 and q_2 to purchase and resells them in the final goods market. We thus solve for the equilibrium strategies of the retailer and manufacturers using backward induction. Our solution concept is subgame perfection.

In stage three, the retailer takes as given the contracts with the two manufacturers as in the case of simultaneous bargaining (section 3), and chooses q_1 and q_2 as stated in (2), whenever an agreement is reached with both suppliers:

$$\max_{q_1,q_2} \pi^R = R(q_1, q_2) - \sum_{i=1}^{2}(w_i q_i - F_i). \tag{10}$$

Denote q_1^* and q_2^* the maximizers in (10), which are assumed to be uniquely defined.

In stage two, the manufacturer M_2 and the retailer negotiates a contract T_2, taking as given the contract T_1. The optimal two-parts tariff maximizes the joint profit Π^2 which is given by:

$$\Pi^2 = R(q_1^*, q_2^*) - T_1(q_1^*) - C_2(q_1^*, q_2^*).$$

Proposition 1 obviously applies here and yields to:

$$w_2^* = \frac{\partial C_2}{\partial q_2} + \gamma_{12}\frac{\partial C_2}{\partial q_1}.$$

Now, given T_1, if there is no agreement between the retailer and M_2, then the retailer chooses q_1 to solve:

$$\max_{q_1} \pi_{-2}^R = R(0, q_1) - w_1 q_1 + F_1.$$

which maximizer is denoted $\hat{q}_1$.

Overall, both players divide the gains from trade so that each receives its disagreement payoff plus a share of the incremental gains, with proportion λ_2 accruing to M_2. Consequently, the optimal fee F_2^* is given by:

$$F_2^* = \left(w_2^* - \frac{C_2}{q_2^*}\right) q_2^* - \lambda_2 \left(\Pi^2 - \pi_{-2}^R\right) \tag{11}$$

where $\pi_{-2}^R = R(\hat{q}_1, 0) - T_1(\hat{q}_1)$.

In stage one, the manufacturer M_1 and the retailer negotiates a contract T_1, taking as given the equilibrium strategies in stage two and three. The optimal two-parts tariff maximizes the joint profit Π^1 which is given by:

$$\begin{aligned}
\Pi^1 &= R(q_1^*, q_2^*) - T_2(q_2^*) - C_1(q_1^*, q_2^*) \\
&= R(q_1^*, q_2^*) - w_2^* q_2^* + F_2^*(w_1) - C_1(q_1^*, q_2^*).
\end{aligned}$$

Replacing F_2^* by its value in (11), we rewrite Π^1 as follows:

$$\begin{aligned}
\Pi^1 &= R(q_1^*, q_2^*) - w_2^* q_2^* - C_1(q_1^*, q_2^*) + w_2^* q_2^* - C_2(q_1^*, q_2^*) - \lambda_2 \left(\Pi^2 - \pi_{-2}^R\right) \\
&= R(q_1^*, q_2^*) - C_1(q_1^*, q_2^*) - C_2(q_1^*, q_2^*) \\
&\quad -\lambda_2 \left[R(q_1^*, q_2^*) - C_2(q_1^*, q_2^*) - w_1 q_1^* + F_1 - R(\hat{q}_1, 0) + w_1 \hat{q}_1 - F_1\right].
\end{aligned}$$

Rearranging terms, we obtain the following expression for joint profit:

$$\Pi^1 = (1 - \lambda_2)\left(R(q_1^*, q_2^*) - C_2(q_1^*, q_2^*)\right) - C_1(q_1^*, q_2^*) + \lambda_2 w_1 (q_1^* - \hat{q}_1) + \lambda_2 R(\hat{q}_1, 0). \tag{12}$$

This allows us to state the following proposition, assuming that the production of both products is efficient (from the viewpoint of the integrated vertical structure).

Proposition 5 *At the equilibrium with sequential bilateral negotiations, the wholesale price for M_1 is given by:*

$$w_1^* - \frac{\partial C_1}{\partial q_1} = (1-\lambda_2)(1-\eta)\frac{\partial C_2}{\partial q_1} + \gamma_{21}\frac{\partial C_1}{\partial q_2} - \frac{\lambda_2}{\frac{\partial q_1}{\partial w_1}}(q_1^* - \hat{q}_1) \tag{13}$$

where $\gamma_{ji} = \frac{\partial q_j}{\partial w_i} / \frac{\partial q_i}{\partial w_i}$ and $\eta = \gamma_{21}\gamma_{12}$.

Proof: Differentiating (12) with respect to w_1, we get:

$$\begin{aligned}\frac{\partial \Pi^1}{\partial w_1} &= (1-\lambda_2)\left(\frac{\partial R}{\partial q_1}\frac{\partial q_1^*}{\partial w_1} + \frac{\partial R}{\partial q_2}\frac{\partial q_2^*}{\partial w_1} - \frac{\partial C_2}{\partial q_1}\frac{\partial q_1^*}{\partial w_1} - \frac{\partial C_2}{\partial q_2}\frac{\partial q_2^*}{\partial w_1}\right) - \frac{\partial C_1}{\partial q_1}\frac{\partial q_1^*}{\partial w_1} - \frac{\partial C_1}{\partial q_2}\frac{\partial q_2^*}{\partial w_1} \\ &\quad + \lambda_2(q_1^* - \hat{q}_1) + \lambda_2 w_1 \frac{\partial q_1^*}{\partial w_1}\end{aligned}$$

recalling that $\frac{\partial R(\hat{q}_1,0)}{\partial q_1} = w_1$. Furthermore, recall that at the optimum, we also have: $\frac{\partial R(q_1^*,q_2^*)}{\partial q_1} = w_1$ and $\frac{\partial R(q_1^*,q_2^*)}{\partial q_2} = w_2$. Replacing and rearranging terms, we then obtain:

$$\frac{\partial q_1^*}{\partial w_1}\left[w_1 - \frac{\partial C_1}{\partial q_1} - (1-\lambda_2)\frac{\partial C_2}{\partial q_1}\right] + \frac{\partial q_2^*}{\partial w_1}\left[(1-\lambda_2)\left(\frac{\frac{\partial q_1^*}{\partial w_2}}{\frac{\partial q_2^*}{\partial w_2}}\frac{\partial C_2}{\partial q_1}\right) - \frac{\partial C_1}{\partial q_2}\right] + \lambda_2(q_1^* - \hat{q}_1) = 0.$$

using the result concerning the optimal wholesale price w_2. Further manipulations yields to the result. ■

As indicated by Proposition 5, the gap between wholesale price and marginal cost can be decomposed into three terms. The last one $(-\lambda_2/\frac{\partial q_1}{\partial w_1})(q_1^* - \hat{q}_1))$ corresponds to the strategic effect identified by Marx and Shaffer (1999). This term is non positive when products are imperfect substitutes because $q_1^* < \hat{q}_1$. Intuitively, given the common procurement cost w_1, the quantity q_1^* sold when the substitute is also on the market is lower than the quantity $\hat{q}_1$ sold when the other product is not on the shelf. As suggested by Marx and Shaffer, a lower wholesale price has two sub-effects. On one hand, it allows to increase the retailer's disagreement payoff in proportion to $\hat{q}_1$ at the margin. This provides the retailer with an incentive for below marginal cost pricing with M_1. On the other hand, a lower wholesale price also increases the retailer's joint profit with manufacturer M_2 (in proportion to q_1^* at the margin), giving the retailer a weaker bargaining position in its negotiations with M_2. This provides the retailer with an incentive for above marginal cost pricing with M_1. As long as there are surplus to extract from M_2 i.e. $\lambda_2 > 0$ then the first consideration dominates the second one.

The second term ($\gamma_{21}\frac{\partial C_1}{\partial q_2}$) corresponds to the "reducing its own cost" strategy identified in Proposition 1 when bilateral bargaining are simultaneous. Both the first and the second terms work in the same direction, that is below marginal cost pricing as a rule in case of substitutes.

However, there is the first term ($(1-\lambda_2)(1-\eta)\frac{\partial C_2}{\partial q_1}$) which is non negative because $|\gamma_{ji}| < 1$ and thus $1-\eta > 0$, $\frac{\partial C_2}{\partial q_1} > 0$ and $0 \leq \lambda_2 \leq 1$. As indicated by (12), the joint profit of the retailer and M_1 takes into account the incremental gain coming from the relationship between the retailer and the second manufacturer M_2 (i.e. $(1-\lambda_2)(R - C_2)$). This provides the retailer with incentives to partially internalize the negative externality of the quantity exchanged q_1^* on this surplus and in particular the cost C_2 of the second manufacturer. This consideration tends to above marginal cost pricing as long as the retailer retains some surplus in its negotiation with M_2 ($\lambda_2 < 1$).

Overall, Proposition 5 indicates that wholesale price may be or not under marginal cost, contrary to the case under simultaneous bilateral bargaining (see Proposition 1). For example, if products are independent (i.e. $\eta = \gamma_{21} = 0$) and if manufacturer M_2 has no bargaining power ($\lambda_2 = 0$) then only the first positive term remains and above marginal cost pricing is the rule. On the contrary, if the retailer has no bargaining power within its relationship with the second manufacturer ($\lambda_2 = 1$), then the first term disappears and below marginal cost pricing is the rule.

Finally, once again, both players divide the incremental gains from trade so that each receives its disagreement payoff plus a share of the gains, with proportion λ_1 accruing to M_1. Consequently, the optimal fee F_1^* is given by:

$$F_1^* = \left(w_1^* - \frac{C_1}{q_1^*}\right) q_1^* - \lambda_1 \left(\Pi^1 - \pi_{-1}^R\right)$$

where $\pi_{-1}^R = (1-\lambda_2)\left(R(0,\hat{q}_2) - C_2(0,\hat{q}_2)\right)$ and where $\hat{q}_2$ is the maximizer of $R(0,q_2) -$

$C_2(0, q_2)$.

6 Conclusion

The goal of this paper has been to analyze vertical contracts between manufacturers and retailers in a channel including the upstream input market. Using a Nash bargaining framework, we have studied the contract negotiations between manufacturers and the common retailer, both in a simultaneous and sequential game. The oligopsonistic behavior of manufacturers on the upstream market provides a new explanation for predatory accommodation. With two-parts tariff, we have shown that joint profit of the industry is not maximised at simultaneous bilateral bargaining equilibria and that below marginal cost pricing in the intermediate goods market arises, when final products are substitutes, and may be welfare improving. When negotiations occurs sequentially, we have shown, in the two-manufacturers case, that the first manufacturer which enters into negotiations and the retailer may jointly prefer above marginal cost pricing or not, depending on the distribution of bargaining power in the channel. However, the second manufacturer equilibrium wholesale price is set below marginal cost.

Further research will be devoted to analyse the optimal order of negotiations in the sequential case. Also, in both sequential and simultaneous bargaining, it is important to extend these results by considering more general form of contract (non linear with discount, market share contracts). Finally, in a companion paper (Bontems and Bouamra-Mechemache, 2003), we perform comparative statics related to shocks on raw product supply and final demand. We show how these shocks affect pricing, prices transmission along the channel, surplus sharing in the channel and welfare.

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Appendix

A Below average cost pricing

Recalling that $C_i = \left[P_x\left(\sum_i f_i^{-1}(q_i)\right)\right] f_i^{-1}(q_i)$ with $q_i = f_i(x_i)$ and assuming symmetry, we have:

$$\frac{\partial C_i}{\partial q_i} = \frac{\partial C_i}{\partial q_j} + \frac{P_x}{f_i'(x_i)}.$$

Thus, we can write, using (5):

$$\begin{aligned}
w_i - \frac{C_i}{q_i} &= \frac{\partial C_i}{\partial q_i} + \sum_{j\neq i}\gamma_{ji}\frac{\partial C_i}{\partial q_j} - \frac{C_i}{q_i} \\
&= \left(1 + \sum_{j\neq i}\gamma_{ji}\right)\frac{\partial C_i}{\partial q_i} - \sum_{j\neq i}\left[\gamma_{ji}\frac{P_x}{f_i'(x_i)}\right] - \frac{C_i}{f_i(x_i)} \\
&= \left(1 + \sum_{j\neq i}\gamma_{ji}\right)\frac{\partial C_i}{\partial q_i} - \sum_{j\neq i}\left[\gamma_{ji}\frac{C_i}{x_i f_i'(x_i)}\right] - \frac{C_i}{f_i(x_i)} \\
&= \left(1 + \sum_{j\neq i}\gamma_{ji}\right)\frac{\partial C_i}{\partial q_i} - \left(1 + \frac{f_i(x_i)}{x_i f_i'(x_i)}\sum_{j\neq i}\gamma_{ji}\right)\frac{C_i}{q_i}
\end{aligned}$$

Because f_i is concave, we have $\frac{f_i(x_i)}{x_i f_i'(x_i)} > 1$ and consequently with $\gamma_{ji} < 0$:

$$1 + \sum_{j\neq i}\gamma_{ji} > 1 + \frac{f_i(x_i)}{x_i f_i'(x_i)}\sum_{j\neq i}\gamma_{ji}.$$

Thus, as marginal cost is always greater than average cost, we obtain:

$$w_i - \frac{C_i}{q_i} < (>) 0 \Leftrightarrow 1 + \sum_{j\neq i}\gamma_{ji} < (>) 0,$$

and the conclusion follows.

B BMCP is welfare improving

Using the specification in the text, we obtain at the optimum, after straightforward but cumbersome computations, the following expressions:

$$PS = \frac{2\phi(\delta - k\alpha)^2}{\left[\phi(\nu - 3) - 2k^2(1+\nu)\right]^2}$$

$$IS = \frac{2(\delta - k\alpha)^2(k^2(1+\nu) + \phi - \nu\phi)}{[\phi(\nu-3) - 2k^2(1+\nu)]^{\,2}}$$

$$CS = \frac{k^2(\delta - k\alpha)^2}{[\phi(\nu-3) - 2k^2(1+\nu)]^{\,2}}$$

and consequently,

$$W^{BMCP} = \frac{(\delta - k\alpha)^2 \left[k^2(3+2\nu) + 2\phi(2-\nu)\right]}{[\phi(3-\nu) + 2k^2(1+\nu)]^{\,2}} > 0$$

When marginal cost pricing is imposed, we obtain the following expression for welfare:

$$W^{MCP} = \frac{(\delta - k\alpha)^2 \left[k^2(3+2\nu) + 4\phi\right]}{[3\phi + 2k^2(1+\nu)]^{\,2}} > 0$$

Note that when $\phi = 0$, then $W^{BMCP} = W^{MCP} > 0$. Denote $\Gamma = k^2(3+2\nu) + 2\phi(2-\nu)$ and $\Delta = \phi(3-\nu) + 2k^2(1+\nu)$. Thus, $W^{BMCP} = (\delta - k\alpha)^2\Gamma/\Delta^2$. Similarly, denote $\Psi = k^2(3+2\nu) + 4\phi$ and $\Omega = 3\phi + 2k^2(1+\nu)$ so that $W^{MCP} = (\delta - k\alpha)^2\Psi/\Omega^2$. We have $\Omega = \Delta + \nu\phi$ and $\Gamma = \Psi - 2\nu\phi$. Then, we obtain:

$$\begin{aligned}
W^{BMCP} - W^{MCP} &= (\delta - k\alpha)^2\left[\frac{\Gamma}{\Delta^2} - \frac{\Psi}{\Omega^2}\right] \\
&= \frac{2(\delta - k\alpha)^2}{\Delta^2\Omega^2}\left[\Gamma(\Delta + \nu\phi)^2 - (\Gamma + 2\nu\phi)\Delta^2\right] \\
&= \frac{2(\delta - k\alpha)^2}{\Delta^2\Omega^2}\left[\Gamma\nu^2\phi^2 + 2\nu\phi\Delta(\Gamma - \Delta)\right] \\
&= \frac{2(\delta - k\alpha)^2}{\Delta^2\Omega^2}\left[\Gamma\nu^2\phi^2 + 2\nu\phi\Delta(k^2 + (1-\nu)\phi)\right] \geq 0
\end{aligned}$$

with equality for $\phi = 0$, which states the conclusion.