The Strategic Use of Private Quality Standards in Vertical Relations*

Very Preliminary Version

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Abstract

This paper highlights the strategic role of private quality standards in vertical relations. Considering two symmetric downstream firms that are exclusively supplied by a finite number of upstream firms, we show that there exist asymmetric equilibria in the downstream firms' quality requirements. While one downstream firm has an incentive to exaggerate her quality requirements to weaken her suppliers' outside options, the competitor's best response is to reduce her own quality requirements. The higher (lower) quality standard is set above (below) the social optimum. It turns out that the use of private quality standards induces a decrease in social welfare.

JEL-Classification: L15, L42, Q13

Keywords: Private Quality Standards, Vertical Relations, Buyer Power, Food Supply Chain

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In recent years, food quality has become a major concern for consumers. Particularly, consumers' expectations regarding food safety have increased (Fulponi, 2006). To contain any revenue losses associated with the failure to meet these expectations, firms have an interest to assure the quality of their products.

Thereby, a challenge is that the quality of food products relies on the quality of all the inputs that are used within the value chain. Faulty inputs as well as inappropriate handling at any stage of the food value chain may negatively affect food quality. This is particularly true for pathogen contamination caused by animal manure and irrigation water in plant production as well as improper harvesting, processing, transporting and storing of agricultural products. For example, in the U.S. about 40,000 salmonella cases occur every year.[1] In addition, criminal conduct may reduce the quality of food products. In 2008, for instance, Chinese dairy processors added melamine to raw milk in order to increase its protein level, resulting in a widespread poisoning of 300,000 people and the death of at least six babies. As a result, firms such as Arla, Nestlé and Cadbury were forced to recall all of their products based on Chinese milk.[2] Consequently, quality assurance along the entire value chain is of utmost importance for the economic success of the value chain.

The private sector and, hereby, especially the retail industry have responded to the consumers' expectations concerning food quality by increasingly implementing private quality standards that complement the existing public minimum standards (Fulponi, 2006). These private quality standards can either be developed on a business-to-business (e.g., Global GAP, SQF100) or a business-to-consumer basis (e.g., Tesco's Nature's Choice, Carrefour's Filière Qualité). They clarify product and process specifications, stipulate how these specifications are met and define each trading partner's responsibilities.[3]

[1] www.cdc.gov/nczved/dfbmd/disease_listing/salmonellosis_gi.html (Centers for Disease Control & Prevention)

[2] http://www.food-business-review.com/article_news.asp?guid=BFA77A40-A4E9-4674-AA62-3A65EAE69EDD

[3] Product standards, on the one hand, refer to the physical properties of the final products. Concerning food products, such product standards comprise, for example, maximum residue levels for pesticides and herbicides, treshold values for additives or other contaminants, bans of certain inputs and requirements for packaging and packaging material. Process standards, on the other hand, relate to properties of the production process. They cover requirements for handling and storage, hygiene, sanitary and pest-control measures, animal-welfare standards as well as food quality and safety managements systems, such as the HACCP system (Hazard Analysis and Critical Control Point).

Currently, there is a strong debate on the strategic aspects of private standards. Thereby, the focus is mainly on the potential exclusion and exploitation of the upstream firms. First, private quality standards may be exclusionary for manufacturers as they do not get their products listed by large retail companies unless they comply with their increasingly demanding quality standards. In particular, the quality requirements of the large retail chains in developed countries could exclude small-scale suppliers in developing countries from delivery as they cannot easily meet the strict quality requirements (e.g., OECD, 2006, 2007; GTZ, 2007; EC, 2006). However, high quality standards are not only implemented in developed countries. With the emergence of supermarkets in Latin America, Asia and Africa, private standards have gained relevance in developing countries themselves (e.g., Balsevich et al., 2003; Boselie et al., 2003). Second, another major concern is whether the retailers can exploit their suppliers by implementing private quality requirements. It is argued, in particular, that retailers can use private standards to weaken the bargaining strength of their respective suppliers. This aspect is relevant for producers in both developing and developed countries.

Against this background, we analyze the retailers' quality choice and its implications for market structure and social welfare. We have developed a four-stage game where we consider two differentiated retailers that compete for final consumers and that are supplied by a finite number of upstream firms. After both retailers have decided about their quality requirements, the suppliers decide according to which standard they produce. Thereby, compliance with a higher quality standard is associated with higher quality costs.[4] Both retailers negotiate with their respective suppliers about non-linear delivery tariffs. If the suppliers fail to achieve an agreement with the preferred retailer, they can switch their delivery to the other retailer. However, there are some restrictions. As the quality standard of production cannot be adjusted in the short-run, producers that have initially decided to produce according to a higher quality can switch to the retailer with less demanding quality requirements. The other suppliers, however, have no outside option as they cannot increase

[4]Quality assurance may, for example, entail investments in specific technologies, the development and implementation of a particular quality-management system and third-party certification of the quality system (Reyniers and Tapiero, 1995; Baiman, Fischer and Rajan, 2000). These can be associated with fixed costs. Further quality costs comprise, for instance, labour costs for additional quality-management personnel, costs associated with the inventory policy, the quality of inputs used by the supplier, hygiene requirements as well as documentation and sampling requirements (Gattoni and Sayre, 2007; Reyniers and Tapiero, 1995). These are variable costs which depend on the desired quality.

the quality of their production in the short-run. That is, production is only downward compatible.

Our results indicate that retailers may well exaggerate in their quality choice for strategic purposes. If two retailers with a fixed base of suppliers compete with each other, their individual quality decisions will be strategic complements. Hence, both retailers set their quality standards above the socially optimal level. Taking additionally into account that suppliers may transfer their delivery to the competing retailer in the case of disagreement with the preferred retailer, we find that there exist two asymmetric equilibria. That is, one retailer implements a quality standard that heavily exceeds the socially optimal quality, while the competing retailer demands a quality standard below the social optimum. The retailer with the higher quality increases her requirements in an inefficient way in order to reduce the value of the suppliers' outside option. Although suppliers delivering to the retailer with the higher quality standard can switch to the retailer with the lower quality requirements, they cannot downwards adjust their production costs in the short-run. Accordingly, the higher the production costs, the lower the value of the outside option and, thus, the higher the bargaining power of the retailer vis-à-vis her suppliers. In other words, retailers increase the requirements of their individual private standards to improve their bargaining position in the negotiations with their suppliers. The downstream competitor's best response to the exaggerated quality decision of the retailer with the higher quality standard is to reduce her own quality requirements. This is due to the fact that a more demanding quality standard induces higher marginal costs of production. Accordingly, the quantity sold in the final consumer market is decreasing in the extent of quality requirements. Thus, the downstream firm that has the higher quality requirements tends to reduce her quantity. The best response of her competitor is to increase his quantity by reducing his quality requirements.

Quality standards have received growing attention in the theoretical economic literature. However, most of the literature tackles mainly public minimum quality standards (MQS). With regard to public MQS, it has been shown both for fixed (Ronnen, 1991) as well as for variable (Crampes and Hollander, 1995) costs of differentiation that the introduction of a public MQS will lead to an increase in welfare under price competition. As the public MQS will reduce the differentiation among the competitors, the competition

will become more intense and, thereby, lead to both an increase in the quality levels and a decrease in prices. However, these results are only robust for price competition. If firms, instead, compete in quantities, public MQSs will decrease overall welfare (Valletti, 2000). Furthermore, Ecchia and Lambertini (1997) show that public MQS impede collusion. So far, there is only little work on private quality standards. Giraud-Héraud et al. (2003) have derived the results that the incentive for retailers to differentiate their businesses via private labels is the higher the lower the public MQS. Finally, Bazoche et al. (2005) analyze the effects of private quality standards on supply contracts, market segmentation and the spot-market price of the low-quality product. In a numerical simulation, they show that a private standard can raise the spot-market price for the low-quality product and that the introduction of a private standard in the meat and fresh produce sector is favourable for the suppliers. The literature that analyzes public MQS (Ronnen, 1991; Crampes and Hollander, 1995; Valletti, 2000) uses the framework of standard duopolistic vertical differentiation, which neglects the vertical structure between retailers and suppliers. Bazoche et al. (2005) and Giraud-Héraud et al. (2003), however, place their analysis of private quality standards within the context of vertical relations and, therefore, buyer power. This enables them to analyze the strategic role of private quality standards in the retailer-supplier relationship in a vertically differentiated market.

Our paper also refers to the large literature on buyer power that analyzes the sources of buyer power and the impact of buyer power on the overall efficiency of vertical relations.[5] Considering the sources of buyer power, credible threats to vertically integrate or to support market entry at the upstream level are analyzed by Katz (1987) and Sheffman and Spiller (1992). Inderst and Shaffer (2007) focus on potential delisting strategies after downstream mergers. With regard to the efficiency effects of buyer power, Inderst and Wey (2003, 2007) point out that the formation of large buyers and, thus, the emergence of buyer power may increase consumer surplus as well as overall welfare since suppliers' investment incentives increase. Montez (2008) shows that an upstream firm may choose higher capacities when buyers merge as long as the costs of capacity are sufficiently low. Negative welfare effects due to increased buyer power are analyzed by Inderst and Shaffer

[5] For a survey on the sources and consequences of buyer power, please see Inderst and Mazarotto (2008) as well as Inderst and Shaffer (2008).

(2007). They show that a retail merger can induce the manufacturers to reduce the variety of their products in order to comply with 'average' preferences (see also Chen (2004)). Battigalli et al. (2007) find that buyer power weakens a supplier's incentive to invest in quality improvement. Baake and von Schlippenbach (2009) analyze the efficiency effects of buyer power on the setting of private standards. Their results point out that the efficiency effects of increased buyer power strongly depend on the sources of buyer power. Buyer power due to more concentrated downstream markets leads to more efficient contracts, while buyer power based on credible threats to vertically integrate or on global sourcing strategies induces less efficient contracts.

The remainder of the paper is organized as follows: In Section 2, we present our model. The equilibrium of the model is analyzed in Section 3. Section 4 compares the equilibrium solution to a benchmark case to highlight the strategic use of private standards. In Section 5, welfare implications are analyzed. Finally, we conclude.

1 The Model

We consider a vertically related industry with two symmetric downstream firms, D_i, $i = 1, 2$, and $N \geq 2$ symmetric upstream firms, $U_{ij}, j = 1, ..., N$. Each downstream firm implements a quality requirement, q_i, that has to be met by her suppliers.[6] Given the downstream firms' choice of quality requirements, the upstream firms decide which retailer they deliver to and, thus, which quality standard they comply with. Assume without loss of generality that $2 \leq M \leq N$, M upstream firms, $U_{11}, ..., U_{1M}$, produce a homogenous intermediate good that they sell to the downstream firm D_1. Likewise, the remaining $N - M$ upstream firms, $U_{2,M+1}, ..., U_{2N}$, produce a homogenous intermediate good that they deliver to the downstream firm D_2. After delivery, both downstream firms transform their respective inputs into a uniform good on a one-to-one basis and sell it to the final consumers. More precisely, D_1 sells good 1 and D_2 sells good 2. Both goods constitute substitutes and differ in quality, q_i. The consumers' willingness to pay for the goods is positively correlated with the goods' respective quality parameter. While the downstream firms' marginal costs of distribution to the final consumers are normalized

[6] Please note that we use the terms 'downstream firm' and 'retailer' interchangeably. The same holds for 'upstream firm' and 'supplier'.

to zero, compliance with the downstream firms' quality requirements induces costs of $c(x_{ij}, q_i) = q_i^2 x_{ij}^2 / 2(2 - q_i^2)$ for producing the quantity x_{ij} at the quality q_i. For simplicity, we assume that the marginal costs are the same for each upstream firm. They are strictly convex and inceasing in x_{ij} and q_i, i.e.

$$c_\tau(x_{ij}, q_i) > 0,\ c_{\tau\tau}(x_{ij}, q_i) > 0 \text{ with } \tau = x_{ij}, q_i \text{ and } c_{x_{ij},q_i}(x_{ij}, q_i) > 0. \tag{1}$$

The delivery tariffs between the downstream firms and their respective suppliers are bilaterally negotiated. More precisely, each downstream firm D_i negotiates simultaneously with each of her suppliers U_{ij} about a quantity forcing contract $T_{ij}(x_{ij}, F_{ij})$. The contract specifies the fixed payment F_{ij} for the quantity x_{ij} the downstream firm D_i purchases at the upstream firm U_{ij}. In the case of a negotiation breakdown, the downstream firm is left to sell the quantities she has purchased from her remaining $M-1$ or, respectively, $N-M-1$ suppliers. The upstream firm, however, may sell to the other downstream firm if she also complies with the respective quality standard of that firm. As the compliance with higher quality standards requires more careful production and, therefore, higher marginal costs of production, an upstream firm producing at the higher quality standard can switch to the retailer with the lower quality requirements, while an upstream firm producing at the lower quality standard cannot switch to the retailer with the higher standard. Accordingly, the products are only downward compatible with respect to quality.

In the downstream market, we consider a representative consumer with the utility function[7]

$$\begin{aligned} u(X_i, X_k) &= \sum_{i=1}^{2} q_i X_i - \frac{1}{2}\left(\sum_{i=1}^{2} X_i^2 + 2\sigma X_i X_k\right) - \sum_{i=1}^{2} p_i(X_i, X_k) X_i, \\ \forall i, k &= 1, 2, i \neq k, \\ \text{with} \quad : \quad X_i &= \sum_{j=a}^{A} x_{ij} \text{ and } \begin{cases} a = 1, A = M & \text{for } i = 1 \\ a = M+1, A = N & \text{for } i = 2 \end{cases}, \end{aligned} \tag{2}$$

where X_i denotes the total quantity of good i and p_i denotes its price. The degree of substitutability between both goods is given by $\sigma \in [0, 1)$. Accordingly, the indirect demand

[7] In order to simplify the notation, we omit the arguments of the functions where this does not lead to any confusion.

functions refer to

$$p_i(X_i, X_k) = q_i - X_i - \sigma X_k, \ \forall i, k = 1, 2, i \neq k. \tag{3}$$

Using (3) and our assumptions, we write the profits of the downstream firms as:

$$\pi^{D_i} = p_i(X_i, X_k)X_i - \sum_{j=a}^{A} F_{ij}, \tag{4}$$

$$\text{with} \quad : \quad \begin{cases} a = 1, A = M & \text{for } i = 1 \\ a = M + 1, A = N & \text{for } i = 2 \end{cases}. \tag{5}$$

For the upstream firm U_{ij} supplying the downstream firm D_i, the profit refers to

$$\pi^{U_{ij}} = F_{ij} - c(x_{ij}, q_i)x_{ij}, \ \forall i = 1, 2, \ j = 1, ..., N. \tag{6}$$

In summary, we consider the following four-stage game: In the first stage, the retailers D_i each establish a private quality standard for the good they offer to the final consumers. In the second stage of the game, the N upstream firms decide which downstream firm they intend to supply. In the third stage, both retailers negotiate with their respective suppliers about the delivery tariffs and production takes place upon successful completion of the negotiations. Finally, the retailers compete à la Cournot when distributing their products to the final consumers. As we analyze subgame-perfect equilibria, the game is solved by backward induction.

2 Equilibrium Analysis

In this section, we solve for the equilibrium strategies of the various players in the industry.

Downstream Competition. In the last stage of the game, the downstream firms compete à la Cournot taking the contracts with their suppliers as given. Maximizing (4) with respect to X_i, we obtain the profit-maximizing quantities $X_1^*(x_{11}, ..., x_{1M})$ and $X_2^*(x_{1,M+1}, ..., x_{1N})$, respectively[8]. Correspondingly, the reduced profit functions of the

[8] Note that in the equilibrium, the overall quantities $X_i^*(\cdot)$ constitute the sum of the negotiated quantities x_{ij} with the respective suppliers.

downstream firms are given by:

$$\pi^{D_i} = p_i(X_i^*, X_k^*)X_i - \sum_{j=a}^{A} F_{ij}, \tag{7}$$

Negotiations. Given that the downstream firms have set their respective quality standards and given that the upstream firms have decided which downstream firm to deliver to, each downstream firm negotiates with her suppliers about a quantity forcing contract in the form of $T_{ij}(x_{ij}, F_{ij})$. That is, the downstream firm D_i agrees with her suppliers U_{ij} about the delivery of the quantity x_{ij} and the fixed payment F_{ij}. Negotiations between the downstream firms and their suppliers are bilateral and take place simultaneously. Furthermore, we assume that contracts are binding and not contingent on other contracts (Horn and Wolinsky, 1988 a, b; McAfee and Schwartz, 1994). Accordingly, we do not allow for renegotiation in case of negotiation breakdown with one supplier. Similarly to Chipty and Snyder (1999), we assume further that the agents believe that efficient trade will occur between the downstream firm and all the other upstream firms.

To determine the bargaining problem between the downstream firm and each of her suppliers, we have to specify the disagreement payoff of all agents. If the downstream firm fails to achieve an agreement with one of her suppliers, she still sells the quantities purchased from the remaining suppliers to the final consumers. The upstream firm, however, is only able to sell to the other retailer if her production complies with the respective quality requirements. However, an upstream firm complying with the lower quality standard cannot deliver to the downstream firm with the higher quality standard and, therefore, will have no trading alternative. This constraint is due to the firms' inability to adjust their production quality in the short-run. For example, certain production processes cannot be modified in the short-run. Furthermore, labour costs for quality-management personnel cannot be immediately reduced as certain cancellation periods have to be observed. If both downstream firms implement the same quality requirements, i.e. $q_1 = q_2$, the upstream firms delivering to $D_i, i = 1, 2$, always comply with the quality requirements of $D_k, k = 1, 2, k \neq i$. In case of disagreement with D_i, the upstream firms can easily sell to the other downstream firm, D_k. In the case of $q_i > q_k$, however, the $N - M$ upstream

firms U_{kj} who have decided to supply D_k have no outside option in the case of negotiation breakdown. In turn, any of the M upstream firms U_{ij} originally intending to supply D_i can enter into negotiations with D_k after negotiations with D_i have failed.

Thus, to specify the bargaining outcome between D_i and her respective suppliers, we have to determine the outside options of the upstream firms U_{ij}. That is, any U_{ij} is able to sell to D_k after her negotiations with D_i have failed if she fulfills the respective quality level q_k. For later reference, we denote the switching firm as $\widetilde{U}_{ij}$. The switching upstream supplier $\widetilde{U}_{ij}$ negotiates with D_k about a delivery tariff in the form of $\widetilde{T}_{kj}(\widetilde{x}_{kj}, \widetilde{F}_{kj})$, taking the contracts between D_k and her initial suppliers U_{kj} as given. Note that the quantities delivered by the initial suppliers cannot be adjusted in the case of disagreement with one supplier or in the case of delivery by an additional supplier as we do not allow for renegotiations. Moreover, the upstream firms cannot completely adjust their quality-related production costs when switching to a downstream firm with lower quality requirements. We, therefore, assume that any of the switching firms still incurs her initial marginal costs of production when switching her delivery to the other downstream firm, i.e. $c(\widetilde{x}_{kj}, q_i)$ with $i, k = 1, 2, k \neq i, j = 1, ..., M$ for $i = 1$ and $j = M+1, ..., N$ for $i = 2$.

Taking the contracts negotiated before as given, D_k agrees with the switching firm $\widetilde{U}_{ij}$ on a quantity that maximizes their joint profit, i.e. $\pi^{D_k}(X_k + \widetilde{x}_{kj}, \cdot) + \widetilde{\pi}^{\widetilde{U}_{ij}}\left(\widetilde{x}_{kj}, \widetilde{F}_{kj}\right)$, where $\widetilde{\pi}^{\widetilde{U}_{ij}}\left(\widetilde{x}_{kj}, \widetilde{F}_{kj}\right) = \widetilde{F}_{kj} - c(\widetilde{x}_{kj}, q_i)$ indicates the profit of the upstream firm $\widetilde{U}_{ij}$ when selling to D_k. Thus, the equilibrium quantity $\widetilde{x}^*_{kj}$ is given by

$$\widetilde{x}^*_{kj} := \arg\max \left(q_k - \sum_{j=a}^{A} x_{kj} - \widetilde{x}_{kj} - \sigma \sum_{j=b}^{B} x_{kj} \right) \left(\widetilde{x}_{kj} + \sum_{j=a}^{A} x_{kj} \right) - c(\widetilde{x}_{kj}, q_i) \qquad (8)$$

$$\text{with: } \begin{cases} a = 1, A = M-1, b = M+1, B = N-1 & \text{for } k = 1 \\ a = M+1, A = N-1, b = 1, B = M-1 & \text{for } k = 2 \end{cases}.$$

The fixed fee shares the incremental gains from trade, such that each negotiating party gets her disagreement payoff plus half of the joint profit. While the switching upstream firm as no futher alternative to get her products distributed when these negotiations fail, the downstream firm still sells the quantities of her remaining suppliers in the case of negotiation breakdown. Accordingly, the fixed fee the downstream firm pays to the

switching upstream firm is implicity given by

$$\pi^{D_k}(X_k + \widetilde{x}^*_{kj}, \widetilde{F}^*_{kj}, \cdot) - \pi^{D_k}(X_k, \cdot) - \widetilde{\pi}^{\widetilde{U}_{ij}}\left(\widetilde{x}^*_{kj}, \widetilde{F}^*_{kj}\right) \equiv 0, \tag{9}$$

yielding

$$\widetilde{F}^*_{kj} = \frac{1}{2}\left[\left(q_k - \sum_{j=a}^{A} x_{kj} - 2\widetilde{x}^*_{kj} - \sigma\sum_{j=b}^{B} x_{ij}\right)\widetilde{x}^*_{kj} + \sigma x_{ij}\sum_{j=a}^{A} x_{kj} + c(\widetilde{x}^*_{kj}, q_i)\right] \tag{10}$$

$$\text{with: } \begin{cases} a = 1, A = M, b = M+1, B = N-1 & \text{for } k = 1 \\ a = M+1, A = N, b = 1, B = M-1 & \text{for } k = 2 \end{cases}.$$

Using our previous results, we now determine the negotiation problems between the downstream firms D_i and their respective suppliers U_{ij}. Each supplier-buyer pair intends to agree on a quantity x^*_{ij} that maximizes its respective joint profit, i.e. $\pi^{D_i}(X_i, \cdot) + \pi^{U_{ij}}(x_{ij}, F_{ij})$. Thus, we get

$$x^*_{ij} := \arg\max_{x_{ij}} \left(q_i - x_{ij} - \sum_{j=a}^{A} x_{ij} - \sigma\sum_{j=b}^{B} x_{ij}\right)\left(x_{ij} + \sum_{j=a}^{A} x_{ij}\right) - c(x_{ij}, q_i), \tag{11}$$

$$\text{with: } \begin{cases} a = 1, A = M-1, b = M+1, B = N & \text{for } i = 1 \\ a = M+1, A = N-1, b = 1, B = M & \text{for } i = 2 \end{cases}.$$

Thus, the overall quantity the downstream firm D_i sells to final consumers is given by

$$X^*_i = \sum_{j=a}^{A} x^*_{ij}, \text{ with: } \begin{cases} a = 1, A = M & \text{for } i = 1 \\ a = M+1, A = N & \text{for } i = 2 \end{cases}. \tag{12}$$

The fixed fee divides the incremental gains from trade of each supplier-buyer pair, where each party gets her disagreement payoff and half of the joint profit. Accordingly, in the negotiations between D_i and her suppliers U_{ij} the fixed fee F_{ij} is implicitly given by

$$\left[\pi^{D_i}(X_i, F^*_{ij}, \cdot) - \pi^{D_i}(X_i - x^*_{ij}, \cdot)\right] \equiv \left[\pi^{U_{ij}}\left(x^*_{ij}, F^*_{ij}\right) - \widetilde{\pi}^{\widetilde{U}_{ij}}\left(\widetilde{x}^*_{kj}, \widetilde{F}^*_{kj}\right)\right] \tag{13}$$

$$\text{with: } \widetilde{\Pi}^{\widetilde{U}_{ij}}\left(\widetilde{x}^*_{kj}, \widetilde{F}^*_{kj}\right) = \begin{cases} 0 & \text{if } q_i < q_k \\ \widetilde{F}^*_{kj} - c\left(\widetilde{x}^*_{kj}, q_i\right) & \text{if } q_i \geq q_k \end{cases},$$

yielding

$$F^*_{ij} = \begin{cases} \frac{1}{2}\left[\Psi + \widetilde{F}^*_{kj} - c\left(\widetilde{x}^*_{kj}, q_i\right)\right] & \text{if } q_i \geq q_k \\ \frac{1}{2}\Psi & \text{if } q_i < q_k \end{cases} \tag{14}$$

$$\text{with} \quad : \quad \Psi = \left(q_i - 2\sum_{j=a}^{A} x^*_{ij} - x^*_{ij} - \sigma\sum_{j=b}^{B} x^*_{kj}\right) x^*_{ij} + c\left(x^*_{ij}, q_i\right)$$

$$\text{and with:} \quad \begin{cases} a = 1, A = M-1, b = M+1, B = N & \text{for } i = 1 \\ a = M+1, A = N-1, b = 1, B = M & \text{for } i = 2 \end{cases}.$$

The fixed payments are increasing in the upstream firms' outside option (see 14). As long as an upstream firm U_{ij} has the possibility to sell to the other downstream firm D_k in the case of disagreement with D_i, i.e. $\widetilde{\pi}^{\widetilde{U}_{ij}}\left(\widetilde{x}_{kj}, \widetilde{F}_{kj}\right) = \widetilde{F}^*_{kj} - c\left(\widetilde{x}^*_{kj}, q_i\right) > 0$, the downstream firm D_i has to pay more to get delivered to by her upstream suppliers. In other words, the existing outside option strengthens the bargaining power of the upstream firm vis-à-vis the downstream firm. From (14), we immediately see that the upstream firm benefits less from her outside option the higher the marginal costs of production after switching to the competing retailer. That is, $\widetilde{\pi}^{\widetilde{U}_{ij}}\left(\widetilde{x}_{kj}, \widetilde{F}_{kj}\right)$ is decreasing in $c\left(\widetilde{x}^*_{kj}, q_i\right)$.

Delivery choice of upstream firms. Taking the quality choice of the downstream firms as given, the upstream firms decide which of the two downstream firms to supply and, thereby, which quality standard to adhere to. The optimal number M^* of those upstream firms who deliver to D_1 is implicitly given by the following condition

$$\pi^{U_{1j}}(x^*_{1j}, F^*_{1j}, M^*, \cdot) \equiv \pi^{U_{2j}}(x^*_{2j}, F^*_{2j}, M^*, \cdot), \forall j = 1, ..., N. \tag{15}$$

Quality decisions of downstream firms. Using M^* obtained from equation (15), the respective quality levels which maximize the downstream firms' profits are given by

$$q^*_i := \arg\max \Pi^{D_i}(x^*_{ij}, F^*_{ij}, M^*, \cdot), \ \forall i = 1, 2. \tag{16}$$

There exist two asymmetric equilibria in the downstream firms' quality choice. Precisely, the quality required by D_i heavily exceeds the quality standard imposed by D_k, i.e. $q_i^* > q_k^*$ for all $i, k = 1, 2, i \neq k$ (see Figure 1).

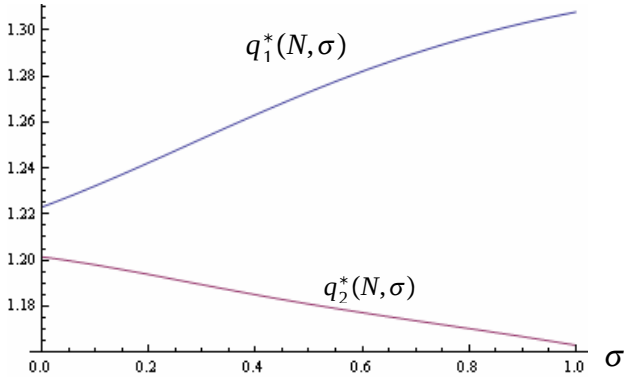

Figure 1: $q_1^*(N, \sigma)$ and $q_2^*(N, \sigma)$ for $N = 10$

For simplicity and without loss of generality, we only consider the case $q_1^* > q_2^*$. The asymmetry in the quality choice can be explained as follows: D_1 has an incentive to increase her quality requirements as this raises her suppliers' production costs and, thereby, lowers the value of their outside option. In turn, a lower outside option of her suppliers improves the buyer's bargaining power. Note that an increase in the quality requirements q_i comes along with a reduction of the overall quantity offered by the downstream firm D_1. Numerical analyses show that $\partial X_i^*/\partial q_i < 0$ if $q_i > q_k$. Accordingly, the best response of D_2 to the increasingly demanding quality standard of D_1 is to implement lower quality requirements and, thus, to increase her own quantity offered in the final consumer market, i.e. $\partial X_k^*/\partial q_i > 0$ if $q_i > q_k$.

The spread between q_1^* and q_2^* increases in σ because the emphasize on quality as a means of product differentiation becomes more pronounced as the goods become closer substitutes. This is due to the fact that a higher degree of substitutability increases the downstream competition. Thus, a stricter quality requirement by D_1 is responded by a larger decrease in the quality requirements by D_2 in order to enable D_2 to sufficiently enlarge her quantity in the final consumer market.

Our findings based on numerical analyses are summarized in the following proposition:

Proposition 1 *There exist two aymmetric equilibria in the downstream firms' quality*

choice, i.e. $q_i^* > q_k^*$, $i, k = 1, 2, i \neq k$. *Comparative statics show that* q_i^* *is increasing in* σ, *while* q_k^* *is decreasing in* σ.

Although the quality requirements are more demanding by D_i than by D_k, i.e. $q_i^* > q_k^*$, a larger share of the upstream firms decides to deliver to D_i. That is, $M^* > N/2$. This is due to the fact that the existing possibility to switch to the competing downstream firm in the case of negotiation breakdown makes it more attractive for the upstream firms to deliver to D_i.

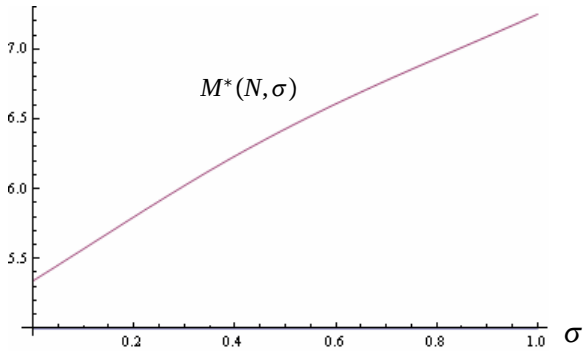

Figure 2: $M^*(N, \sigma)$ for $N = 10$

However, the more firms supply D_i the lower their respective marginal contribution to the overall profit. Accordingly, not all suppliers intend to deliver to D_i, such that there exists an asymmetry in the delivery structure to the benefit of D_i. It turns out that the higher the degree of substitutability the more firms tend to sell to D_i, i.e. $dM^*/d\sigma > 0$ (see Figure 2).

3 Comparison with Benchmark

To highlight the strategic aspects of the downstream firms' quality choice, we compare our results with a benchmark case. In contrast to our previous analysis, we assume now that the upstream firms have no trading alternatives in the case of a negotiation breakdown. That is, after the upstream firms have failed to achieve an agreement with their selected downstream firm, they can not sell to the downstream competitor. This

holds even if the upstream firms would comply with the downstream competitor's quality requirements. Accordingly, the disagreement payoff of the upstream firms equals zero, while the disagreement payoff of the downstream firms is strictly positive as they can distribute the quantity purchased from the remaining suppliers in the case of a negotiation breakdown with one supplier.

Again, the downstream firms negotiate simultanously with each of their suppliers about a quantity-forcing tariff $T_{ij}(x_{ij}, F_{ij})$ specifying quantity x_{ij} and payment F_{ij} of the delivery. The quantity each supplier delivers to the retailer is determined in order to maximize the joint profit of each supplier-retailer pair, i.e. $\pi^{D_i}(\cdot) + \pi^{U_{ij}}(\cdot)$. Using (3), the equilibrium quantities are characterized by

$$\widehat{x}_{ij}^{*} := \arg\max_{x_{ij}} \left(q_i - x_{ij} - \sum_{j=a}^{A} x_{ij} - \sigma \sum_{j=b}^{B} x_{kj} \right) \left(x_{ij} + \sum_{j=a}^{A} x_{ij} \right) - c(x_{ij}, q_i), \tag{17}$$

$$\text{with: } \begin{cases} a = 1, A = M - 1, b = M + 1, B = N & \text{for } i = 1 \\ a = M + 1, A = N - 1, b = 1, B = M & \text{for } i = 2 \end{cases}.$$

Accordingly, the overall quantity each downstream firm sells to final consumers is given by

$$\widehat{X}_i^{*} = \sum_{j=a}^{A} \widehat{x}_{ij}^{*}, \text{ with: } \begin{cases} a = 1, A = M - 1 & \text{for } i = 1 \\ a = M + 1, A = N - 1 & \text{for } i = 2 \end{cases}. \tag{18}$$

Note that (17) is similar to (11). However, the quantities negotiated in the previous model and in the benchmark case are the not necessarily the same as the quality levels, i.e. q_i, may differ and the number of upstream firms supplying either D_1 or D_2, i.e. M, may vary in equilibrium. Again, the fixed fees are set as to share the gains from trade, whereby each party gets her disagreement payoff plus half of the joint profit. In the benchmark case, the upstream firms' disagreement payoff equals zero as they are not able to transfer their delivery to the other downstream firm. Accordingly, the fixed fees are given by

$$\widehat{F}_{ij}^{*} = \frac{1}{2} \left[\left(q_i - 2 \sum_{j=a}^{A} \widehat{x}_{ij}^{*} - \widehat{x}_{ij}^{*} - \sigma \sum_{j=b}^{B} \widehat{x}_{kj}^{*} \right) \widehat{x}_{ij}^{*} + c(\widehat{x}_{ij}^{*}, q_i) \right] \tag{19}$$

$$\text{with: } \begin{cases} a=1, A=M-1, b=M+1, B=N & \text{for } i=1 \\ a=M+1, A=N-1, b=1, B=M & \text{for } i=2 \end{cases}.$$

Accordingly, the upstream firm balances her profits when she decides about which downstream firm, i.e. D_1 or D_2, to delivers to. The equilibrium number of firms selling to D_1, i.e. $\widehat{M}^*$, is implicitly given by

$$\pi^{U_{1j}}(\widehat{x}^*_{1j}, \widehat{F}^*_{1j}, \widehat{M}^*, q_1, q_2) \equiv \pi^{U_{2j}}(\widehat{x}^*_{2j}, \widehat{F}^*_{2j}, \widehat{M}^*, q_1, q_2). \tag{20}$$

Using (18), (19) and $\widehat{M}^*$ implicitly given by (20), the optimal quality decision of the downstream firms is given by

$$\begin{aligned} \widehat{q}^*_i \quad &: \quad \arg\max_{q_i} p_i\left(\widehat{X}^*_i, \widehat{X}^*_k\right)\widehat{X}^*_i - \sum_{j=a}^{A}\widehat{F}^*_{ij} \\ \text{with} \quad &: \quad \begin{cases} a=1, A=M & \text{for } i=1 \\ a=M+1, A=N & \text{for } i=2 \end{cases}. \end{aligned} \tag{21}$$

Our results show that there will only be a symmetric equilibrium in the downstream firms' quality decision if the upstream firms have no outside option. That is, both downstream firms implement the same quality requirements. Then, half of the suppliers deliver to the downstream firm D_i, while the other half of upstream firms delivers to the downstream firm D_k.

If the upstream firms have no outside option, the downstream firms' decision about their quality requirements does not underly any strategic considerations. Accordingly, the downstream firms have fewer incentives to distort the quality level than in the case where the upstream firms can switch their delivery to the competitor if negotiations fail. Precisely, our numerical results indicate that one of the downstream firm sets a higher quality standard than in the benchmark case, while the other firm sets a quality level that undercuts the quality level of the benchmark case. These results point to the fact that the downstream firms implement their quality requirements strategically in vertical relations to improve their bargaining position. The economic intuition for this result is as follows: Given the trading alternatives of the upstream firms U_{1j}, the downstream firm D_1 distorts

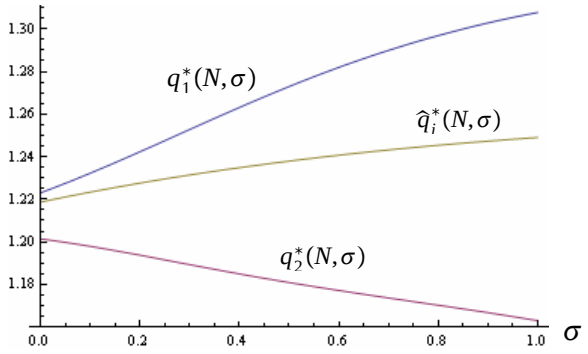

Figure 3: $q_i^*(N,\sigma)$ and $\widehat{q}_i^*(N,\sigma)$ for $N = 10$, $i,k = 1,2, i \neq k$

its quality requirement upwards to raise the upstream firms' quality costs and, thereby, to weaken their outside options.[9] Hence, numerical analysis reveals that $q_1^* > \hat{q}_1^* = \hat{q}_2^* > q_2^*$ (see Figure 3).

Our findings based on the numerical analysis can be summarized in the following proposition:

Proposition 2 *By either upward or downward distorting their quality requirements, the downstream firms will use their quality requirements strategically in order to improve their bargaining position vis-à-vis their suppliers if the suppliers have an outside option in the case of negotiation breakdown.*

Note that the equilibrium profit of the downstream firms will be lower than in the benchmark case if the upstream firms have an outside option , i.e. $\pi^{D_1}(x_{1j}^*, F_{1j}^*, M^*, q_1^*, \cdot) < \pi^{D_1}(\widehat{x}_{1j}^*, \widehat{F}_{1j}^*, \widehat{M}^*, \widehat{q}_1^*, \cdot)$. In turn, the upstream firms gain from their outside option, even though the downstream firms aim at reducing the value of their trading alternatives, i.e. $\pi^{U_{1j}}(x_{1j}^*, F_{1j}^*, M^*, q_1^*, \cdot) > \pi^{U_{1j}}(\widehat{x}_{1j}^*, \widehat{F}_{1j}^*, \widehat{M}^*, \widehat{q}_1^*, \cdot)$, (see Figure 4 a, b). These results are driven by the fact that the bargaining position of the upstream firms will improve if they have an outside option in the case of negotiation breakdown.

[9] Remember that the upstream firms U_{1j} cannot adjust their production costs downwards in the case of a negotiation breakdown with the downstream firm D_1 and subsequent successful negotiations with D_2.

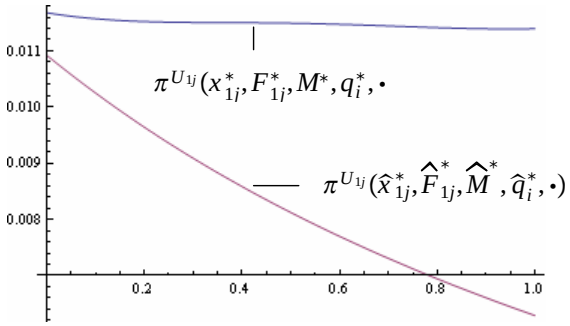

Figure 4 a: Upstream Profits for $N = 10$

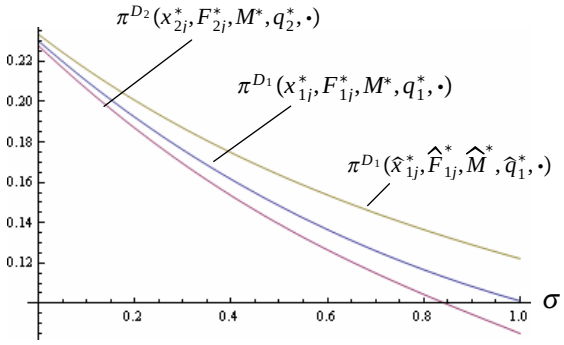

Figure 4 b: Downstream Profits for $N = 10$

4 Social Welfare

We now assess the welfare implications of the downstream firms' quality choice. Given the negotiated delivery tariffs in the intermediate goods markets, we investigate whether the downstream firms have an incentive to deviate from the socially optimal quality. The social welfare W is defined as the difference between the representative consumer's gross utility and the sum of production costs, i.e.

$$W(\cdot) := \sum_{i=1}^{2} q_i X_i - \frac{1}{2}\left(\sum_{i=1}^{2} X_i^2 + 2\sigma X_1 X_2\right) - \sum_{j=1}^{M} c(x_{1j}, q_1) - \sum_{j=M+1}^{N} c(x_{2j}, q_2). \qquad (22)$$

Hence, the quality requirements that would maximize social welfare are given by

$$q_i^w := \arg\max_{q_i} W(X_1^*, X_2^*, M^*, \cdot), \ \forall i = 1, 2. \tag{23}$$

If the upstream firms have an outside option, the profit-maximizing quality choice of the downstream firms will deviate from the socially optimal quality levels. Numerical analysis reveals that $q_1^* > q_1^w > q_2^w > q_2^*$ for all σ (see Figure 5). That is, D_1 exaggerates in her quality requirements by even exceeding the socially optimal quality level, while the best response of D_2 to the quality exaggeration by D_1 leads to quality requirements that even undercut the socially optimal quality level.

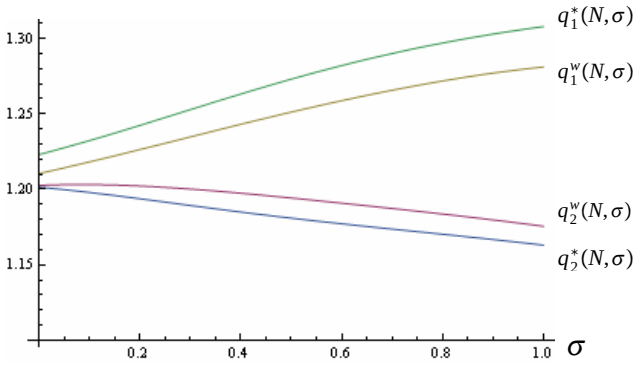

Figure 5: $q_i^*(N, \sigma)$ and $q_i^w(N, \sigma)$ for $N = 10$

Comparing social welfare for q_i^w and q_i^*, we find that the distortion of the quality requirements implies a welfare loss (see Figure 6). Moreover, we find that all the upstream firms lose due to the exaggerated quality requirements, i.e. $\pi^{U_{1j}}(q_1^*, \cdot) < \pi^{U_{1j}}(q_1^w, \cdot)$, as long as the products are sufficiently close substitutes, i.e. σ sufficiently large. Interestingly, numerical calculations reveal that M^* exceeds $N/2$. That is, more than half of the upstream firms deliver to the downstream firm with the higher quality standard. Furthermore, we can show that for very low levels of substitutability, more upstream firms than socially optimal decide to produce according to the higher quality standard, i.e. $M^* > M^w$. For

higher levels of substitutability, the opposite holds, i.e. $M^w > M^*$.

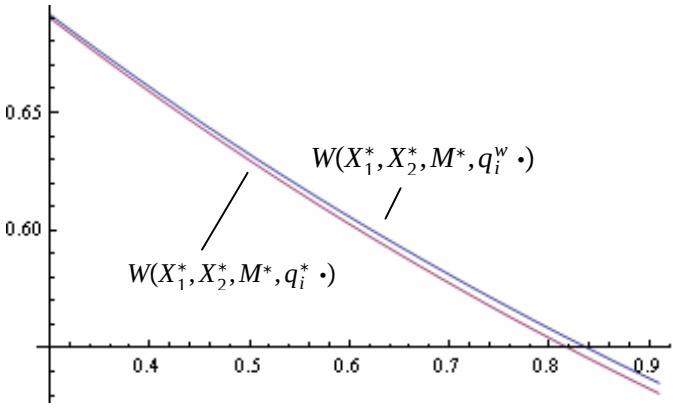

Figure 6: $W(X_1^*, X_2^*, M^*, q_1^w, q_2^w, \cdot)$ and $W(X_1^*, X_2^*, M^*, q_1^*, q_2^*, \cdot)$ for $N = 10$

Our findings based on the numerical analysis can be summarized in the following proposition:

Proposition 3 *The strategic use of quality requirements in vertical relations implies a welfare loss. In particular, the upstream suppliers are harmed by the more demanding quality requirements of the downstream retailers.*

5 Conclusion

We have developed a theoretical model to analyze the strategic role of private quality standards and their impact on the market structure as well as social welfare. We have considered a vertically related industry where two downstream competitors are supplied by a finite number of upstream firms. The downstream firms implement quality requirements before the upstream firms decide which downstream firm they deliver to and, thus, which quality standard they comply with. The delivery is based on a quantity forcing contract that the downstream firm negotiates bilaterally and simultaneously with all of her suppliers. If the upstream firms fail to achieve an agreement with the selected downstream firm, they can only sell to the other downstream firm, given they comply with the respective quality standard.

We find that there exist two asymmetric equilibria in the downstream firms' quality choice. That is, one downstream firm implements higher quality requirements than the other downstream firm. This allows her to use the private quality standard as a means to weaken the outside option of her suppliers and, thus, to strengthen her own bargaining position. This is due to the fact that an upstream firm switching from the high-quality downstream firm to the low-quality downstream firm cannot adjust its production costs to the lower quality level. Therefore, the stronger the high quality standard the higher the upstream firm's quality-related production costs and the lower the value of her outside option. This, in turn, strengthens the downstream firms' bargaining power.

The best response to the increasing quality requirements by one of the downstream firms is to lower the own quality requirements. As an increasingly demanding quality standard implies higher marginal costs of production and, a lower quantity is offered by the downstream firm with the higher quality standard. Accordingly, the best response of the downstream competitor is to increase the quantity she sells to the final consumers. This becomes possible by reducing the quality requirements she imposes on her suppliers. Our results indicate that both firms' quality requirements are inefficient from a welfare perspective. While one downstream firm exaggerates in her quality requirements, the other firm undercuts the socially optimal quality level. It turns out that social welfare is decreasing in the downstream firms' strategic use of their quality requirements.

Note that the strategic effects obtained depend on the availability of positive outside options to the upstream firms. Crucial assumptions with this respect have been the downward compatibility in the quality level and the stickiness of the production costs in the outside option. The downward compatibility can be justified by potential quality investments to be undertaken before the game starts. A potential extension of our model would be to incorporate these investments in our game structure. The potential downward adjustment in the production costs after a negotiation breakdown could also be explicitly modelled in the future. Finally, there is no uncertainty in our model. However, the realization of the desired quality level in the production process is usually not certain. In the food industry, weather conditions are an example of events that influence the quality of the fresh produce but cannot be (entirely) controlled for. Taking these stochastic elements into account is another model extension to be performed in the future.

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