# The Strategic Use of Private Quality Standards in Food Supply Chains[†]

**Isabel Teichmann*, Vanessa von Schlippenbach****

* DIW Berlin, Information Society and Competition,
Mohrenstr. 58, D-10117 Berlin, e-mail: iteichmann@diw.de
** DIW Berlin, Information Society and Competition,
Mohrenstr. 58, D-10117 Berlin, e-mail: vschlippenbach@diw.de


**Paper prepared for presentation at the EAAE 2011 Congress**
**Change and Uncertainty**
Challenges for Agriculture,
Food and Natural Resources

August 30 to September 2, 2011
ETH Zurich, Zurich, Switzerland



[†] We thank Pio Baake, Özlem Bedre-Defolie, Stéphane Caprice, Claire Chambolle and Vincent Réquillart, participants of the Annual Conference of the Verein für Socialpolitik (Kiel, 2010) and seminar participants at DIW Berlin, Humboldt Universität zu Berlin and Toulouse School of Economics for their helpful comments and suggestions. Financial support from the Deutsche Forschungsgemeinschaft (FOR 986 and "Market Power in Vertically Related Markets") is gratefully acknowledged.

# 1 Introduction

Food scandals like the BSE crisis, the melamine found in Chinese milk in 2008 and the dioxin contamination of animal feed in Germany in 2010 have given rise to serious consumer concerns over food quality. In response, both governments and food industries have tightened food safety regulations. In particular, food retailers have implemented either collectively or individually private quality standards, which add to public regulation. These quality standards do not only cover safety aspects, but also refer to social and environmental issues. They clarify product and process specifications, stipulate how these specifications are met and define each trading partner's responsibilities. Thereby, product standards refer to the physical properties of the final products, such as maximum residue levels (MRLs) for pesticides and herbicides, threshold values for additives and requirements for packaging material. Process standards, in turn, relate to properties of the production process, including hygiene, sanitary and pest-control measures, the prohibition of child labor, animal-welfare standards and food quality management systems. Particularly, the quality of fresh fruits, vegetables and meat products is regulated by retailers' private quality standards. Examples include the British Retail Consortium (BRC) Global Standard for Food Safety and GlobalGAP as collective private standards and Tesco's Nature's Choice and Carrefour's Filière Qualité as individual private standards.[1] As retailers tend to supplement them with individual requirements (OECD 2006), quality requirements may differ widely among the individual retailers. In Germany, for example, the MRLs for pesticides established by some large retail chains in 2008 ranged from 80% of the public MRL (Aldi, Norma), to 70% (REWE, Edeka, Plus), to as low as 33% (Lidl) (PAN Europe 2008). The British retailer Marks & Spencer even plans to have all of its fruit, vegetables and salads free of any pesticide residues by 2020 (Marks & Spencer 2010). It is controversial whether retailers use private quality standards as a strategic instrument to gain buyer power in procurement markets.[2] This might be especially true when suppliers must use specific technologies in order to comply with the individual quality standards of the retailers. So far, this conjecture has not been formally proven.[3] We intend to narrow this gap with a theoretical analysis of retailers' quality choice and its implications for market structure and social welfare.

We consider a vertical structure with two independent downstream retailers that are supplied by a finite number of upstream suppliers.[4] First, the retailers decide upon their quality requirements. Then, the suppliers choose which quality standard they meet and which retailer they supply. Thereby, compliance with a higher quality standard is associated with higher quality costs. Given the retailers' quality requirements and the suppliers' delivery decision, both

[1] Besides the prevention of potential revenue losses due to reputation (OECD 2006), retailers' incentives for private standard setting might be to respond to public minimum standards (e.g., Valletti 2000; Crampes and Hollander 1995; Ronnen 1991), to pre-empt or influence public regulation (e.g., McCluskey and Winfree 2009; Lutz et al. 2000), to substitute for inadequate public regulation in developing countries (e.g., Marcoul and Veyssiere 2010), and to safeguard against liability claims (e.g., Giraud-Héraud et al. 2006b, 2008).

[2] There is also a strong debate on whether increasing quality requirements by large retailers may impose entry barriers for suppliers in developing countries, in particular for small-scale producers (e.g., OECD 2007, 2006; EC 2006; García Martinez and Poole 2004; Balsevich et al. 2003; Boselie et al. 2003).

[3] Generally, the understanding of the strategic aspects of private quality standards in vertical relations is still underdeveloped (Hammoudi et al. 2009).

[4] An upstream firm can be any kind of supplier, such as a primary producer, a processor or an export organization abroad. The industry structure reflects the situation in many countries where a relatively large number of suppliers face a highly concentrated retail sector (e.g., Dobson et al. 2003; OECD 2006).

retailers enter into bilateral negotiations with their respective suppliers about quantity forcing delivery tariffs. These consist of the quantity to be delivered by the supplier and a fixed payment to be made in return by the retailer. Upon successful completion of the negotiations with the selected retailer, manufacturers produce and deliver their products to the selected retailer. Finally, the retailers sell the goods to final consumers.

Our results show that there exist two asymmetric equilibria in the retailers' quality choice as long as production costs are sufficiently high and increasing in the retailers' quality requirements. This result is driven by the retailers' incentive to weaken the suppliers' outside option and, thus, to reduce their bargaining strength. In other words, the retailer strategically use the private quality standards to obtain a better bargaining position vis-à-vis the suppliers. Suppose that the retailers implement the same quality standard, than—in case of negotiation breakdown—the suppliers can easily switch their delivery from one to the other retailer. In the case of differing quality requirements, suppliers complying with the lower quality standard cannot switch their delivery to the retailer with the higher quality requirements. However, suppliers producing according to the higher quality standard can opt to deliver to the retailer with the less demanding quality requirements. However, the low-quality retailer does not reward overcompliance with its quality standard. Thus, the value of the supplier's outside option is decreasing in the difference in quality standards. Thus, a retailer has always an incentive to either exceed or undercut a given quality standard of the other retailer. By decreasing its quality requirements, the retailer turns its suppliers' outside option to zero. At the same time, the retailer's joint profit with the suppliers is decreasing. In turn, by increasing its quality requirements the retailer only reduces the suppliers' outside option but increases its joint profit with the suppliers. In comparison, the low-quality retailer gets a larger share of a smaller pie, while the high-quality retailer gets a smaller share of a larger pie.

Our analysis is related to the large theoretical literature on buyer power, which studies the sources of buyer power and its implications for the overall efficiency of vertical relations.[5] Potential sources of buyer power analyzed so far include credible threats to vertically integrate or to support market entry at the upstream level (e.g., Katz 1987; Sheffman and Spiller 1992), potential delisting strategies after downstream mergers (e.g., Inderst and Shaffer 2007) as well as producers' differentiation (Chambolle and Berto Villas-Boas 2010). We show that downstream firms' private quality standards may constitute an additional source of buyer power. 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 (2007). They find 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)). Moreover, Battigalli et al. (2007) derive the result that buyer power weakens a supplier's incentive to invest in quality improvement. We show that buyer power due to private standard setting decreases social welfare.

Although quality standards receive growing attention in the theoretical economic literature,

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

few papers address private standards in vertical relations.[6] Among the papers covering private quality standards, Bazoche et al. (2005) and Giraud-Héraud et al. (2006a) analyze individual private standards. Giraud-Héraud et al. (2006a) show that the incentive for a retailer to differentiate its business via a premium private label (PPL) is the higher the lower the public MQS. Bazoche et al. (2005), in turn, analyze the effects of a retailer's PPL for a given level of the public MQS. In their model, the retailer introducing the PPL would choose an intermediate level of the private quality standard to segment the market. Furthermore, Giraud-Héraud et al. (2006b and 2008) study collective standard setting. Both papers analyze the introduction of a collective standard for a given public MQS, assuming that retailers are price takers in the procurement market. In their models, the retailers' incentive to implement a collective standard depends on the existence of a legal liability rule.

## 2 The Model

We consider a food supply chain with two symmetric downstream retailers $D_i$, $i = 1, 2$, and $N \geq 2$ symmetric upstream suppliers $U_{ij}$, $j = 1, ..., N$. Note that the index $i$ refers to the retailer $i$ the upstream firm $U_{ij}$ delivers to. We assume without loss of generality that $N_1$ upstream firms, $U_{11}, ..., U_{1N_1}$, produce a homogeneous intermediate good and sell it exclusively to the downstream firm $D_1$, while the remaining $N_2 = N - N_1$ upstream firms, $U_{2N_1+1}, ..., U_{2N}$, manufacture a homogeneous intermediate good and deliver it exclusively to the downstream firm $D_2$. The retailers transform the received inputs on a one-to-one basis into a single consumer good each. That is, retailer $D_1$ produces good 1 and retailer $D_2$ produces good 2. Both retailers operate as local monopolists in two independent markets.[7] This allows us to analyze the quality decision of the retailers abandoning any impact of downstream competition.[8]

Each retailer implements a private quality standard $q_i$, $i = 1, 2$, which has to be fulfilled by the suppliers. This implies that the suppliers do not get their products sold to the retailers unless they comply with the respective quality standards. Hence, the $N_1$ upstream firms delivering to retailer $D_1$ produce at the quality level $q_1$, while the $N_2$ upstream firms supplying retailer $D_2$ adhere to the quality standard $q_2$. We assume that the product quality is observable to all agents, i.e. suppliers, retailers, and consumers.[9]

**Demand.** Each retailer $D_i$ faces an inverse demand

$$p_i(q_i, X_i) = \max\{q_i - X_i, 0\}, \ \forall i = 1, 2, \tag{1}$$

where $X_i$ denotes the overall quantity the retailer $D_i$ sells to final consumers. The overall quantity the retailer sells consists of the sum of intermediate inputs delivered by the upstream

[6] For example, Valletti (2000), Crampes and Hollander (1995) and Ronnen (1991) analyze private standard setting in response to the introduction of a public minimum standard. Focussing on product differentiation, private quality decisions of firms are also studied by Motta (1993) and Gal-Or (1985, 1987), for example. However, all these papers neglect vertical supply structures.

[7] Local monopolies in retailing may, for example, result from consumers' one-stop shopping preferences.

[8] This assumption will be relaxed in Section 5, where we consider Cournot competition at the downstream level.

[9] Note that the product quality is not necessarily directly communicated to consumers, but consumers might be indirectly informed about the standards through third-party investigations, such as those led by environmental lobby groups.

suppliers, i.e.

$$X_i = \sum_{j=a}^{A} x_{ij} \text{ with: } \begin{cases} a = 1,\ A = N_1 & \text{for } i = 1 \\ a = N_1 + 1,\ A = N & \text{for } i = 2 \end{cases}, \tag{2}$$

where $x_{ij}$ refers to the quantity the supplier $U_{ij}$ sells to the retailer $D_i$. Furthermore, we assume that consumers' willingness to pay for a good $i$ is positively correlated with the respective quality parameter $q_i$.[10]

**Negotiations.** Given the retailers' quality requirements, the upstream firms decide which quality standard they comply with and, thus, which retailer they supply. Before production takes place, each retailer negotiates bilaterally and simultaneously with each of its respective suppliers a delivery contract $T_{ij}$. Referring to the fact that vertical relations are often based on more complex contracts than simple linear pricing rules (Rey and Vergé 2008), we assume that the delivery contract has the form of a quantity-forcing contract.[11] Such a contract specifies both the quantity $x_{ij}$ the supplier $U_{ij}$ has to deliver to the retailer $D_i$ and the fixed payment $F_{ij}$ the supplier $U_{ij}$ receives from the retailer $D_i$ in exchange for the delivery. The delivery contracts are considered to be short-term.[12] Note that we do not allow for renegotiation in the case of negotiation breakdown between any retailer-supplier pair. Negotiation outcomes are observable to all players. Moreover, both the suppliers and the retailers are fully committed to these contracts.

**Costs.** While the downstream retailers' costs of transformation and distribution are normalized to zero, each upstream supplier incurs total costs of $C(x_{ij}, q_i)$ for producing the quantity $x_{ij}$ at the quality level $q_i$, where $C(0, q_i) = 0$ and $C_{x_{ij}}(0, q_i) = 0$. The cost functions are twice continuously differentiable, increasing and strictly convex in both $x_{ij}$ and $q_i$, i.e. for all $x_{ij}, q_i > 0$ it holds that

$$C_\tau(x_{ij}, q_i),\ C_{\tau\tau}(x_{ij}, q_i), C_{x_{ij}q_i}(x_{ij}, q_i) > 0 \text{ with } \tau = x_{ij}, q_i. \tag{3}$$

Note that the convexity in quantities reflects decreasing returns to scale and implies that the suppliers are capacity-constrained, while the convexity in qualities characterizes a decreasing marginal revenue from quality investments.[13] For later reference, note that we apply the following cost function

$$C(x_{ij}, q_i) = \frac{q_i^2}{2(2 - q_i^2)} x_{ij}^2 \text{ for } 0 < q_i < \sqrt{2},\ \forall i = 1, 2. \tag{4}$$

Besides the usage of more sophisticated variable inputs like high-quality raw materials (Motta 1993), the adherence to a higher quality standard requires different production technologies (e.g., Mayen et al. 2009) and changes in the production processes (e.g., Codron et al. 2005). For the sake of simplicity, we normalize any quality-related fixed costs to zero. Nevertheless, we take into account that the decision to produce according to a particular quality standard is associated

[10] It has been shown, for example, that consumers are willing to pay a premium for eco-labeled food (Bougherara and Combris 2009), for organic products (Gil et al. 2000), for milk quality attributes (Bernard and Bernard 2009; Brooks and Lusk 2010; Kanter et al. 2009), and for beef quality attributes (Gao and Schroeder 2009).

[11] Note that non-linear tariffs are commonly used in intermediate goods markets. Empirical evidence is provided by Bonnet and Dubois (2010) and Berto Villas-Boas (2007).

[12] This is in accordance with observations that "a large portion of the contracts observed in the agro-food sector are short-term or single-season contracts" (Jang and Olson 2010, p. 252).

[13] Decreasing quality gains are considered to be more realistic than constant or even increasing ones (Bazoche et al. 2005). For the suppliers' profit functions to be concave in quality, however, the cost functions have to be *sufficiently* convex in quality (cp. Bazoche et al. 2005).

with specific technologies, production facilities, or the development and implementation of a particular quality-management system. This precludes any short-term changes in the quality-related production process. As a consequence the variable costs of quality cannot be adjusted in the short-term, neither upwards nor downwards, since they at least partly hinge on the production process implemented to fulfill a certain quality standard.[14]

**Profits.** The downstream firms' profits are given by[15]

$$\pi^{D_i}(\cdot) = R_i(X_i, q_i) - \sum_{j=a}^{A} F_{ij} \text{ with: } \begin{cases} a = 1,\ A = N_1 & \text{for } i = 1 \\ a = N_1 + 1,\ A = N & \text{for } i = 2 \end{cases}, \tag{5}$$

where $R_i(X_i, \cdot) = p_i(X_i, q_i)X_i$ denotes the revenue of retailer $D_i$. Our assumptions on the inverse demand guarantee that the profit $\pi^{D_i}(\cdot)$ is strictly concave in $X_i$.

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

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

In summary, we consider the following four-stage game. First, the two retailers $D_i$ impose a private quality standard $q_i$. Given the quality choice of the retailers, the $N$ upstream firms $U_{ij}$ decide which downstream firm they supply and, therefore, which quality standard they comply with. This decision determines the suppliers' quality-related production costs. In the third stage, both retailers negotiate with their respective suppliers about quantity-forcing delivery contracts $T_{ij}(x_{ij}, F_{ij})$. Production takes place upon successful completion of the negotiations. Finally, the retailers sell to consumers, whereby each retailer's total quantity $X_i$ offered is restricted by the quantity-forcing contracts negotiated before.

## 3 Equilibrium Analysis

Using subgame perfection as our solution concept, we proceed by backward induction.[16] Given the described outside option, the negotiations in the intermediate goods market proceed as follows. Each supplier $U_{ij}$ negotiates with its selected retailer $D_i$ about a quantity-forcing contract. In the case of disagreement with $D_i$, the supplier $U_{ij}$ can switch to the other retailer $D_k$ when complying with the respective quality requirements $q_k$. Hence, the supplier $U_{kj}$ can only switch to $D_i$ if $q_i \leq q_k$, while it has no outside option in the case of $q_i > q_k$. Using subgame perfection as our equilibrium concept, we first analyze the negotiation outcome when the supplier $U_{ij}$ has switched from $D_i$ to $D_k$ and then turn to the negotiations between the supplier and its initially chosen retailer $D_i$.

**Specification of the Disagreement Payoffs.** We denote an upstream firm that switches

[14] For example, improved quality-management systems require higher-skilled personnel as well as more frequent documentation and sampling requirements (Rau and van Tongeren 2009; Preidl and Rau 2006). The decision for a particular inventory method applied to perishable goods is another case in point. While the FIFO (first in, first out) policy is associated with higher variable costs, the LIFO (last in, first out) policy entails lower quality-related variable costs (Reyniers and Tapiero 1995).

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

[16] The quantity choice of the downstream retailers is constrained by the negotiation outcome with the upstream suppliers. This constraint is always binding.

from $D_i$ to $D_k$ by $\widetilde{U}_{kj}$ with $j = 1, ..., N_1$. The switching supplier $\widetilde{U}_{kj}$ 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 the initial suppliers $U_{kj}$ as given. As the switching upstream firm can adjust its quantity but not its quality-related production costs, the switching supplier's production costs amount to $C(\widetilde{x}_{kj}, q_i)$. Thus, the profit of the switching supplier $\widetilde{U}_{kj}$ refers to

$$\widetilde{\pi}^{\widetilde{U}_{kj}}(\cdot) = \widetilde{F}_{kj} - C(\widetilde{x}_{kj}, q_i). \tag{7}$$

The profit of the downstream retailer $D_k$ is, then, given by

$$\widetilde{\pi}^{D_k}(\cdot) = R_k(X_k + \widetilde{x}_{kj}, \cdot) - \sum_{l=a}^{A} F_{kl} - \widetilde{F}_{kj} \text{ with: } \begin{cases} a = 1,\ A = N_1 & \text{for } i = 1 \\ a = N_1 + 1,\ A = N & \text{for } i = 2 \end{cases} \tag{8}$$

Note that the switching upstream firm $\widetilde{U}_{2j}$ has no further outside option when it fails to achieve an agreement with $D_2$. In turn, $D_2$ still sells the quantities of those suppliers it has already made an agreement with, i.e. suppliers $U_{2j}$. The disagreement payoff of retailer $D_2$ is, thus, given by

$$\pi^{D_k}(\cdot) = R_k(X_k, \cdot) - \sum_{l=a}^{A} F_{kl} \text{ with: } \begin{cases} a = 1,\ A = N_1 & \text{for } i = 1 \\ a = N_1 + 1,\ A = N & \text{for } i = 2 \end{cases} \tag{9}$$

Using (7), (8) and (9), the equilibrium bargaining outcome between $D_k$ and the switching firm $\widetilde{U}_{kj}$ can be characterized by the solution of

$$\max_{\widetilde{x}_{kj}, \widetilde{F}_{kj}} \left[\widetilde{\pi}^{D_k}(\cdot) - \pi^{D_k}(\cdot)\right] \widetilde{\pi}^{\widetilde{U}_{kj}}(\cdot). \tag{10}$$

Taking as given the negotiated quantities with the initial suppliers, the equilibrium quantity $\widetilde{x}^*_{kj}$ of the switching supplier is implicitly determined by

$$\frac{\partial p_k(X_k + \widetilde{x}^*_{kj}, \cdot)}{\partial \widetilde{x}_{kj}}(X_k + \widetilde{x}^*_{kj}) + p_k(X_k + \widetilde{x}^*_{kj}, \cdot) - \frac{\partial C(\widetilde{x}^*_{kj}, q_i)}{\partial \widetilde{x}_{kj}} = 0. \tag{11}$$

Thus, $\widetilde{x}^*_{kj}$ maximizes the joint profit of retailer $D_k$ and the switching supplier.

The gains from trade are shared by the fixed fee. That is, each negotiating party gets its disagreement payoff plus half of the incremental gains from trade. In particular, the retailer and the switching supplier share equally the marginal contribution of the supplier's delivery to the overall revenue of the retailer, i.e. $R_k(X_k + \widetilde{x}^*_{kj}, \cdot) - R_k(X_k, \cdot)$, as well as the supplier's total costs of $C(\widetilde{x}^*_{kj}, q_i)$. Hence, the fixed fee is given by

$$\widetilde{F}^*_{kj}(\cdot) = \frac{1}{2}\left[R_k(X_k + \widetilde{x}^*_{kj}, \cdot) - R_k(X_k, \cdot) + C(\widetilde{x}^*_{kj}, q_i)\right]. \tag{12}$$

**Lemma 1** *For given $N_i$, there exists an equilibrium delivery contract $\widetilde{T}_{kj}(\widetilde{x}^*_{kj}, \widetilde{F}^*_{kj})$, where $\widetilde{x}^*_{kj}$ maximizes the joint profit of the retailer-supplier pair $D_k - \widetilde{U}_{kj}$ and the fixed fee shares the joint profit.*

**Proof.** Upon Request. ■

**Negotiations.** We turn now to the negotiations between any upstream firm $U_{ij}$ and its initially selected retailer $D_i$. If the retailer does not reach an agreement with one of its suppliers, it can still sell the quantities delivered by the remaining suppliers. Thus, the retailer's disagreement payoff is given by

$$\widehat{\pi}^{D_i}(\cdot) = R_i(X_i - x_{ij}, \cdot) - \sum_{l=a}^{A-1} F_{il} \text{ with: } \begin{cases} a = 1,\ A = N_1 & \text{for } i = 1 \\ a = N_1 + 1,\ A = N & \text{for } i = 2 \end{cases} \tag{13}$$

Referring to Lemma 1, we specify the disagreement payoff of the upstream firm $U_{ij}$ as

$$\widetilde{\pi}^{\widetilde{U}_{kj}*}(\cdot) = \widetilde{F}^*_{kj}(\cdot) - C(\widetilde{x}^*_{kj}, q_i). \tag{14}$$

Using (13) together with (5),(6) and (14), the equilibrium bargaining outcome between $D_i$ and $U_{ij}$ can be characterized by the solution of

$$\max_{x_{ij}, F_{ij}} \left[\pi^{D_i}(\cdot) - \widehat{\pi}^{D_i}(\cdot)\right] \left[\pi^{U_{ij}}(\cdot) - \widetilde{\pi}^{\widetilde{U}_{kj}*}(\cdot)\right]. \tag{15}$$

Analoguously to $x^B_{ij}$ defined in (**??**), the equilibrium quantity $x^*_{ij}$ each supplier $U_{ij}$ delivers to $D_i$ is implicitly given by

$$\frac{\partial p_i(X^*_i, \cdot)}{\partial X_i} X^*_i + p_i(X^*_i, \cdot) - \frac{\partial C(x^*_{ij}, q_i)}{\partial x_{ij}} = 0. \tag{16}$$

The fixed fees $F^*_{ij}$ sharing the joint profits refer to

$$F^*_{ij}(\cdot) = \begin{cases} \frac{1}{2}\left[\Delta R_i(X^*_i, \cdot) + C(x^*_{ij}, q_i) + \widetilde{F}^*_{kj} - C\left(\widetilde{x}^*_{kj}, q_i\right)\right] & \text{if } q_i \geq q_k \\ \frac{1}{2}\left[\Delta R_i(X^*_i, \cdot) + C(x^*_{ij}, q_i)\right] & \text{if } q_i < q_k \end{cases}, \tag{17}$$

where $\widetilde{\pi}^{\widetilde{U}_{kj}} = \widetilde{F}^*_{kj} - C\left(\widetilde{x}^*_{kj}, q_i\right)$ denotes the outside option of supplier $U_{ij}$ if switching to $D_k$ is possible, i.e. if $q_i \geq q_k$.

**Lemma 2** *For given $N_i$, there exists an equilibrium delivery contract $T_{ij}(x^*_{ij}, F^*_{ij})$, $i = 1, 2$, where $x^*_{ij}$ maximizes the joint profit of the retailer-supplier pair and the fixed fee $F^*_{ij}$ shares the joint profit. Furthermore, $x^*_{ij}$ is decreasing in $N_i$ and increasing in $N_k$, $i = 1, 2$, $k \neq i$.*

**Proof.** Upon Request. ■

Using our previous results, the retailers' reduced-profit functions are given by

$$\pi^{D_i*} = \begin{cases} R_i(X^*_i, \cdot) - \frac{1}{2}\left[\Delta R_i(X^*_i, \cdot) + C(x^*_{ij}, q_i) + \widetilde{F}^*_{kj} - C\left(\widetilde{x}^*_{kj}, q_i\right)\right] & \text{if } q_i \geq q_k \\ R_i(X^*_i, \cdot) - \frac{1}{2}\left[\Delta R_i(X^*_i, \cdot) + C(x^*_{ij}, q_i)\right] & \text{if } q_i < q_k \end{cases}, \tag{18}$$

There exists a discontinuity in the retailers' reduced-profit functions when suppliers' outside options are taken into account. Suppliers delivering to the high-quality retailer have an outside option in the case of negotiation breakdown, while the suppliers delivering to the low-quality retailer do not. As a consequence, suppliers delivering to high-quality get a larger share of their

joint profit with the retailer. Hence, a high-quality retailer pays a larger fixed fee to its suppliers than a low-quality retailer.

**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. Obviously, suppliers improve their bargaining position vis-à-vis the retailer when opting for the high-quality retailer. Thus, delivery to the high-quality retailer is at first more attractive. However, the more upstream manufacturers supply the same retailer the lower their marginal contribution to the retailer's profit. Note also that the quantity they deliver to the retailer is decreasing in the number of other suppliers delivering to the same retailer. Accordingly, we have

**Lemma 3** *The difference in the upstream firms' profits,* $\Delta\pi^U = \pi^{U_{1j}}(x^*_{1j}, F^*_{1j}, N_1, q_1, q_2) - \pi^{U_{2j}}(x^*_{2j}, F^*_{2j}, N_2, q_1, q_2)$, $\forall j = 1, ..., N$, *is monotonically decreasing in* $N_1$.

**Proof.** Upon Request. ■

In equilibrium the firms are indifferent which retailer they deliver. Assuming $\pi^{U_{1j}}(x^*_{1j}, F^*_{1j}, 1, \cdot) > \pi^{U_{2j}}(x^*_{2j}, F^*_{2j}, N-1, \cdot)$ and $\pi^{U_{1j}}(x^*_{1j}, F^*_{1j}, N-1, \cdot) < \pi^{U_{2j}}(x^*_{2j}, F^*_{2j}, 1, \cdot)$, the equilibrium number of firms selling to $D_1$, i.e. $N^*_1(q_1, q_2)$, is, thus, implicitly given by

$$\pi^{U_{1j}}(x^*_{1j}, F^*_{1j}, N^*_1, q_1, q_2) \equiv \pi^{U_{2j}}(x^*_{2j}, F^*_{2j}, N^*_2, q_1, q_2). \tag{19}$$

# 4 Private Quality Standards

We now turn to the analysis of the retailers' quality decision. Using (19) together with our previous results, the equilibrium quality requirements of the retailers are given by the maximization of the retailers' reduced-profit functions, i.e.

$$q^*_i \quad : \quad = \arg\max R_i\left(X^*_i, q_1, q_2\right) - \sum_{j=a}^{A} F^*_{ij}\left(q_1, q_2\right) \tag{20}$$

$$\text{with} \quad : \quad \begin{cases} a = 1,\ A = N^*_1(q_1, q_2) & \text{for } i = 1 \\ a = N^*_1(q_1, q_2) + 1,\ A = N & \text{for } i = 2 \end{cases}.$$

IThere exists no symmetric equilibrium in qualities if the suppliers have an outside option in the case of negotiation breakdown. Taking a relatively high quality standard of retailer $D_k$ as given, the retailer $D_i$ has an incentive to undercut the quality requirement of $D_k$ (see Figure 1a).[17] By this, $D_i$ turns the outside option of its suppliers $U_{ij}$ to zero. At the same time it lowers the value of the suppliers' outside option when delivering to the retailer $D_k$. This is due to the fact that suppliers switching their deliver to the low-quality retailer still incur the production costs associated with the higher quality requirements buth without getting rewarded for the higher quality of their products. This second outside option effect does not outweigh the first outside option effect such that delivery to the low-quality retailer becomes less attractive. Thus, less suppliers intend to deliver to the low-quality retailer. Since less severe quality requirements result in lower production costs, the retailer can compensate the decline of suppliers by purchasing a larger quantity from each supplier. However, a full compensation is not possible as long as

[17] Note that the retailer has neither an incentive to slightly undercut nor to overloop the other retailer's quality requirements as long as the production costs are sufficiently convex in quality and quantity.

the upstream costs are more convex in quantity than in quality (see 4). As consumer prices are also decreasing due to lower quality production, the joint profit of retailer $D_i$ and each of its suppliers is decreasing. Thus, the retailer gets a larger share of a smaller pie by undercutting the other retailer's quality requirements.

Taking instead a relatively low value of $q_k$ as given, retailer $D_i$ has an incentive to increase its quality requirements (see Figure 1b). As a consequence, the outside option of its suppliers becomes less valuable. That is, the larger the difference in quality requirements the less valuable the outside option of suppliers delivering to the high-quality retailer. At the same time, suppliers initially delivering to $D_k$ lose their outside option. Hence, delivery to $D_i$ becomes more attractive even though its bargaining strength has improved. If more suppliers deliver to $D_i$, each supplier $U_{ij}$ delivers less at a lower marginal costs which compensates for the higher production costs in terms of quality. As the stricter quality standards induce higher consumer prices, the joint profit of retailer $D_i$ with each of its suppliers is increasing. Compared to the low-quality retailer, the high-quality retailer gets a smaller share of a larger pie.

Accordingly, numerical simulation show that there exist two asymmetric equilibria in the retailers' quality choice. Assuming $q_1 \geq q_2$ without loss of generality and denoting the reaction functions of retailers $D_1$ and $D_2$ by $r_1(q_2)$ and $r_2(q_1)$, respectively, Figure 1 illustrates that the equilibrium quality set by $D_1$ exceeds the equilibrium quality standard imposed by $D_2$, i.e. $q_1^* > q_2^*$.

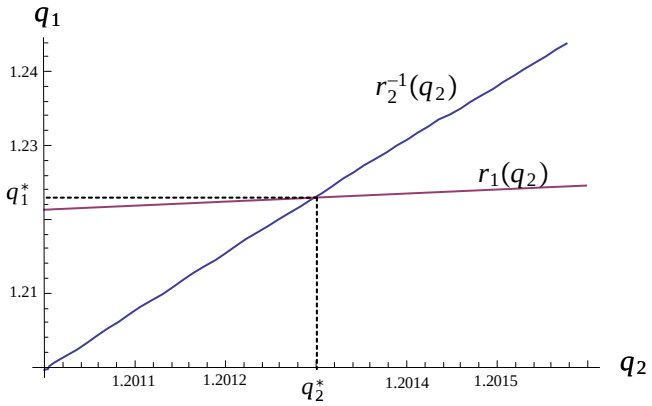


Figure 2: Reaction Functions and Equilibrium Qualities for $N = 10$

In summary, retailers use their private quality standards to improve their bargaining strength in the intermediate goods market. By either exceeding or undercutting the other retailer's quality requirements they weaken the bargaining position of their suppliers. More precisely, suppliers devliering to the low-quality retailer lose their outside option, while the outside option of suppliers delivering to the high-quality retailer gets reduced. Accordingly, both retailers get a larger share of the joint profit with any single supplier.

# 5 Conclusion

Our results show that social welfare is decreasing in the retailers' strategic use of their quality requirements. While the quality requirements set by the high-quality retailer exceed the corresponding socially optimal quality level, those set by the low-quality retailer undercut the welfare-optimal low quality. Public regulation in the form of a MQS can remedy this unfavorable welfare outcome as it increases the lower quality level.

# 6 References


Balsevich, J., Berdegué, A., Flores, L., Mainville, D. and T. Reardon (2003), "Supermarkets and Produce Quality and Safety Standards in Latin America", *American Journal of Agricultural Economics* 85: 1147-1154.

Battigalli, P., Fumagalli, C. and M. Polo (2007), "Buyer Power and Quality Improvement", *Research in Economics* 61: 45-61.

Bazoche, P., Giraud-Héraud, E. and L.-G. Soler (2005), "Premium Private Labels, Supply Contracts, Market Segmentation, and Spot Prices", *Journal of Agricultural and Food Industrial Organization* 3: Article 7.

Bernard, J. C. and D. J. Bernard (2009), "What Is It About Organic Milk? An Experimental Analysis", *American Journal of Agricultural Economics* 91: 826-836.

Berto Villas-Boas, S. (2007), "Vertical Relationships between Manufacturers and Retailers: Inference with Limited Data", *Review of Economic Studies* 74: 625–652.

Binmore et al. (1986), "The Nash Bargaining Solution in Economic Modelling", *Rand Journal of Economics* 17: 176-188.

Boselie, D., Henson, S. and D. Weatherspoon (2003), "Supermarket Procurement Practices in Developing Countries: Redefining the Roles of the Public and Private Sectors", *American Journal of Agricultural Economics* 85: 1155-1161.

Bonnet, C. and P. Dubois (2010), "Inference on Vertical Contracts between Manufacturers and Retailers Allowing for Nonlinear Pricing and Resale Price Maintenance", *RAND Journal of Economics* 41: 139-164.

Bougherara, D. and P. Combris (2009), "Eco-Labelled Food Products: What are Consumers Paying for?", *European Review of Agricultural Economics* 36: 321-341.

Brooks, K. and J. L. Lusk (2010), " Stated and Revealed Preferences for Organic and Cloned Milk: Combining Choice Experiment and Scanner Data", *American Journal of Agricultural Economics* 92: 1229-1241.

Chambolle, C. and S. Berto Villas-Boas (2010), "Buyer Power through Producers' Differentiation", mimeo.

Chen Z. (2004), "Monopoly and Product Diversity: The Role of Retailer Countervailing Power", mimeo, Carleton University.

Codron, J.-M., Giraud-Héraud, E. and L.-G. Soler (2005), "Minimum Quality Standards, Premium Private Labels, and European Meat and Fresh Produce Retailing", *Food Policy* 30: 270-283.

Crampes, C. and A. Hollander (1995), "Duopoly and Quality Standards", *European Economic Review* 39: 71-82.

Dobson, P. W., Waterson, M. and S. W. Davies (2003), "The Patterns and Implications of Increasing Concentration in European Food Retailing", *Journal of Agricultural Economics* 54: 111-125.

EC (2006), *Private Food Standards and Their Impacts on Developing Countries*, European Commission, DG Trade Unit G2, trade.ec.europa.eu/doclib/ html/127969.htm.

Gal-Or, E. (1985), "Differentiated Industries without Entry Barriers", *Journal of Economic Theory* 37: 310-339.

Gal-Or, E. (1987), "Strategic and Non-Strategic Differentiation", *Canadian Journal of Economics* 20: 340-356.

Gao, Z. and T. C. Schroeder (2009), "Effects of Lavel Information on Consumer Willingness-to-Pay for Food Attributes", *American Journal of Agricultural Economics* 91: 795-809.

García Martinez, M. and N. Poole (2004), "The Development of Private Fresh Produce Safety Standards: Implications for Developing Mediterranean Exporting Countries", *Food Policy* 29: 229-255.

Gil, J. M., A. Gracia and M. Sánchez (2000), "Market Segmentation and Willingness to Pay for Organic Products in Spain", *International Food and Agribusiness Management Review* 3: 207-226.

Giraud-Héraud, E., Rouached, L. and L.-G. Soler (2006a), "Private Labels and Public Quality Standards: How Can Consumer Trust Be Restored after the Mad Cow Crisis?", *Quantitative Marketing and Economics* 4 (1): 31-55.

Giraud-Héraud, E., Hammoudi, H. and L.-G. Soler (2006b), "Food Safety, Liability and Collective Norms", Cahiers du Laboratoire d'Econométrie de l'Ecole Polytechnique, No. 2006-06.

Giraud-Héraud, E., Hammoudi, H., Hoffmann, R. and L.-G. Soler (2008), "Vertical Relationships and Safety Standards in the Food Marketing Chain", Working Paper ALISS 2008-07.

Hammoudi, A., Hoffmann, R. and Y. Surry (2009), "Food Safety Standards and Agri-Food Supply Chains: An Introductory Overview", *European Review of Agricultural Economics* 36 (4): 469-478.

Inderst, R. and N. Mazarotto (2008), "Buyer Power in Distribution", in: Collins, W. D. (ed.) ABA Antitrust Section Handbook, Issues in Competition Law and Policy.

Inderst, R. and G. Shaffer (2008), "The Role of Buyer Power in Merger Control", in: Collings, W. D. (2008) ABA Antitrust Section Handbook, Issues in Competition Law and Policy.

Inderst, R. and G. Shaffer (2007), "Retail Mergers, Buyer Power, and Product Variety", *Economic Journal* 117: 45-67.

Inderst, R. and C. Wey (2007), "Buyer Power and Supplier Incentives", *European Economic Review* 51: 647-667.

Inderst, R. and C. Wey (2003), "Bargaining, Mergers, and Technology Choice in Bilaterally Oligopolistic Industries", *RAND Journal of Economics* 34: 1-19.

Jang, J. and F. Olson (2010), "The Role of Product Differentiation for Contract Choice in the Agro-Food Sector", *European Review of Agricultural Economics* 37: 251-273.

Kanter, C., Messer, K. D. and H. M. Kaiser (2009), "Does Production Labeling Stigmatize Conventional Milk?", *American Journal of Agricultural Economics* 91: 1097-1109.

Katz, M. L. (1987), "The Welfare Effects of Third Degree Price Discrimination in Intermediate Goods Markets", *American Economic Review* 77: 154-167.

Lutz, S., Lyon, T. P. and J. W. Maxwell (2000), "Quality Leadership when Regulatory Standards are Forthcoming", *Journal of Industrial Economics* 48: 331-348.

Marcoul, P. and L. Veyssiere (2010), "A Financial Contracting Approach to the Role of Supermarkets in Farmers' Credit Access", *American Journal of Agricultural Economics* 92: 1051-1064.

Marks & Spencer (2010), *How We Do Business Report 2010*, Marks and Spencer Group plc, United Kingdom.

Mayen, C. D., J. V. Balagtas, and C. E. Alexander (2010), "Technology Adaption and Technical Efficiency: Organic and Conventional Dairy Farms in The United States, *American Journal of Agricultural Economics* 92: 181-195.

McCluskey, J. J. and J. A. Winfree (2009), "Pre-Empting Public Regulation with Private Food Quality Standards", *European Review of Agricultural Economics* 36: 525-539.

Milgrom, P. and Roberts, J. (1990), "Rationalizability, learning and equilibrium in games with strategic complementarities", *Econometrica* 58, 1255-1277.

Montez, J. V. (2008), "Downstream Mergers and Producer's Capacity Choice: Why Bake a Larger Pie When Getting a Smaller Slice?", *RAND Journal of Economics* 38: 948-966.

Motta, M. (1993), "Endogenous Quality Choice: Price vs. Quantity Competition", *Journal of Industrial Economics* 41: 113-131.

OECD (2007), "Private Standard Schemes and Developing Country Access to Global Value Chains: Challenges and Opportunities Emerging from Four Case Studies".

OECD (2006), "Final Report on Private Standards and the Shaping of the Agro-food System".

PAN Europe (2008), "Supermarkets", Fact Sheet.

Preidl, M. and M.-L. Rau (2006), "Obligatory and Voluntary Standards in Polish Meat Production/Processing", in: Bokusheva, R. and G. Buchenrieder (eds.), "Contributions to the 4th Young Scientists Workshop on Agricultural Development in Central and Eastern Europe", Discussion Paper No. 98, Halle: Institute for Agricultural Development in Central and Eastern Europe (IAMO).

Rau, M.-L. and F. van Tongeren (2009), "Heterogeneous Firms and Homogenising Standards in Agri-Food Trade: The Polish Meat Case", *European Review of Agricultural Economics* 36 (4): 479-505.

Rey, P. and T. Vergé (2008), "Economics of Vertical Restraints", in: Handbook of Antitrust Economics, Paolo Buccirossi (eds.), The MIT Press 2008: 353-390.

Reyniers, D. J. and C. S. Tapiero (1995), "'The Delivery and Control of Quality in Supplier-Producer Contracts"', *Management Science* 41: 1581-1589.

Ronnen, U. (1991), "Minimum Quality Standards, Fixed Costs, and Competition", *RAND Journal of Economics* 22: 490-504.

Rubinstein, A. (1982), "Perfect Equilibrium in a Bargaining Model", *Econometrica* 50: 97-109.

Sheffman, D. T. and P. T. Spiller (1992), "Buyers' Strategies, Entry Barriers, and Competition", *Economic Inquiry* 30: 418-436.

Valletti, T. M. (2000), "Minimum Quality Standards under Cournot Competiton", *Journal of Regulatory Economics* 18: 235-245.