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Abstract

This paper focus's on the third-party certifiers' strategy when choosing a required label quality, and the consequent market outcome. We consider two different objectives of the certifier: maximizing global demand for the labeled product (wide public policy), or maximizing global quality of the market (global quality policy). In a duopoly set up with firms bearing different costs with respect to quality provision, firms always opt for differentiation strategies: only one adopts the label. However, the labeling firm is not necessarily the most efficient one. In the case of a wide public policy, the efficient firm will produce labeled products only if costs of labeling are sufficiently low. In the case of a global quality policy, the low cost firm will always push the high-cost firm into the labeling program.

KEYWORDS: labeling, product quality, Bertrand duopoly

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1. Introduction

Responsible consumption has recently emerged as a major tool used by citizens to express their environmental and social preferences, and to consume accordingly to their political convictions. Among this tendency, labeling has acquired a key role in signaling to consumers unobservable attributes of the sold products. Overall, labels exist to signal environmental standards, food safety and quality, social practices. The existence of such schemes allows for alternative production and consumption markets, incorporating ethical practices into existing systems.

In this context, certifiers have a central role. Their main duty is to certify that a particular good has been produced accordingly to a set of standards. These organizations need independence, objectivity and transparency, in order to induce consumers' trust. Labels are adopted to overcome the informational problem when consumers are not able to induce the quality level of the product. In most cases, it concerns credence attributes of the product. Credence attributes are those that are unobservable either before or after purchase and use.[1] The information asymmetry is not necessarily solved as low quality firms might have possibilities and incentives to usurp the high quality firm. Dissuasion costs is a necessary condition but however not a sufficient condition for free-riding on the label (Mason (2006), Ibanez and Grolleau (2008)).

A large part of the economic literature concentrates on firms' strategies towards the adoption of labels. The (eco)label models relate to frameworks of vertical product differentiation. In a duopoly set up, price competition is released through the adoption of an ecolabel by one of the firms. In general quality provision is costly. Amacher et al. (2004) consider the production technology to be endogenous. The cost of high quality provision features both variable and fixed components. The fixed component is related to audit cost, paid by the firm to obtain the ecolabel. The relative cost structure determines whether firms invest into green technologies as well as the quality level of the label. In general, the literature focuses on the market behavior of firms towards voluntary quality labels.

However, in many cases, third party organizations are those that set up the labeling schemes and define quality levels in order to promote public interests. Firms might adopt voluntarily the label against a certain cost in order to differentiate their products from competitors and thus release price competition.

[1]The issue of quality signaling can be better understood once different categories of goods are acknowledged. Nelson (1970) developed a useful categorization between search, experience and credence attributes.

As far as we know, the labeling literature omits one crucial component : how do third party certifiers settle the quality standard of the label, and then, what impact these quality level choices have on market behavior by firms?

This paper proposes to analyze standard setting of the label and studies the impact of different optimization behaviors of the third party certifier on firms' label adoption choices. We consider two different policies: maximizing the global demand for the labeled product (*wide public policy*), or maximizing the global quality of the economy (*global quality policy*). The *wide public policy* is to promote quality within a wide audience. To do so, the objective of the certifier will be the maximization of the high quality demand. An illustrative example of such a policy might be the promotion of health through food safety certification programs. GMO-free, mercury-free or dioxin-free guaranties are some examples of health policies that are made up by the market. Such policies aim to reach as much consumers as possible in order to reduce contamination risks. Another example that can illustrate is the reply of the European forest sector towards the existing labeling program of sustainable forest management (FSC) being judged to be too severe and dissuasive. One of the objectives of the implementation of a new standard through a new certification program (PEFC) was to allow more wood to be certified. The *global quality policy* aims at maximizing the overall quality of the market, independently of how many consumers will benefit from the high quality product. For example, in the case of environmental quality, the objective of the certifier (supported by governmental incentives) is the optimization of the global environmental benefits within the society and thus the global quality of environmental products.

We consider a Bertrand duopoly, with firms bearing different costs with respect to quality provision. Firms choose sequentially whether to adopt the label or not in a first stage and compete in prices in a second stage. The introduction of a label system may induces a split in the market, creating some market power for both firms. We show that firms will always opt for differentiation strategies : only one adopts the label. Labeling strategies by firms depend on the quality standard of the label and the relative cost to stick the label on the product. Furthermore, the quality level of the label set by the third party certifier is a trade off between the unit cost of labeling and the marginal cost of improving quality if it aims a *wide public policy*. In the case of a *global quality policy*, the optimal quality of the label is independent of certification costs. According to third party certifier's label quality choice, the label adoption can either be done by the low-cost firm or the high-cost firm. Again conditions are stated and include both labeling and quality provision costs. We show that under a global quality policy, the regulator fixes a stan-

dard always leading the low-cost firm to push the high-cost firm into the the labeling process.

The rest of the paper is organized as follows. In section 2, we present the model and look at the market equilibrium and firms' conditions to certify their production. In section 3, we investigate the impact of certifier's objective on the standard quality level and on firm's decision to adopt or not the label. Two policies are considered: a wide public policy and a global quality policy. Section 4 concludes.

2. The model: Bertrand duopoly with certification system

Our model consists in a Bertrand duopoly model with firms bearing different costs for quality provision. We consider the following game: in the first stage, a third-party certifier fixes the quality level required for obtaining the label. The certifier may either maximize global certified demand or global quality of the market. In the second stage, firms choose sequentially whether to certify or not. In a third stage, they fix simultaneously prices. Finally, consumers make their consumption choices. We solve the model backwards and we begin by the description of consumer side.

2.1. Consumers with different tastes for quality

We consider a continuum of consumers indexed by θ. Parameter θ represents consumers' taste for quality and is uniformly distributed over $[0, 1]$. Consumers decide to buy one unit or zero of the good, which can be either certified (subscript c) or uncertified (subscript u). Quality may take several forms: environmental friendliness, social conditions, child labor, health considerations...

Quality of the consumed good is not observable to consumers. However, a labeling system allows consumers to perfectly induce the quality level $\overline{q}$ of certified products. Thus, consumers expect a non-certified good to be of quality $q_u = 0$ and a certified good to be of quality $q_c = \overline{q}$.

Consumer j's indirect utility function is:

$$v_j(p_i, q_i, \theta_j) = m - p_i + \theta_j q_i \quad for \quad i = u, c \tag{1}$$

p_c and p_u represent the market prices for the certified and uncertified good, respectively. m denotes the consumers reservation price for an uncertified good. We consider that the market is fully covered, implying that the indirect utility function needs to be positive: $p_u \leq m$. With this restriction, we focus thus on current consumption goods with prices lower than consumers income.

Finally, we are interested in situations in which certified demand is strictly positive. Thus we assume that condition $p_c \leq m + \theta_j \overline{q}$ is met for at least one consumer (i.e $\theta_j \leq 1$). This condition will impose a restriction on the value of the label standard $\overline{q} \leq q_{max}$ and on the value of the labeling cost denoted by k (see appendix A).

Consumer j prefers a certified good to an uncertified good whenever: $v_j(p_c, \overline{q}, \theta_j) \geq v_j(p_u, 0, \theta_j)$. The indifferent consumer between the certified and uncertified good is thus defined by:

$$\widetilde{\theta} = \frac{p_c - p_u}{\overline{q}} \tag{2}$$

As consumers are uniformly distributed over θ, demand for certified (D_c) and uncertified (D_u) goods are given by:

$$\begin{cases} D_c = 1 - \widetilde{\theta} = \frac{\overline{q} + p_u - p_c}{\overline{q}} \\ D_u = \widetilde{\theta} = \frac{p_c - p_u}{\overline{q}} \end{cases} \tag{3}$$

For certified demand to be positive, $p_c \leq p_u + \overline{q}$ has to hold. [2]

2.2. Bertrand duopoly with difference in costs of quality

We consider 2 firms h and l sharing the market. They differ in their costs of producing quality. The firms cost function depends on their cost efficiency and their choice of labeling their production or not:

$$C_{zi}(q_i, p_i, k_i, c_z) = (c_z q_i^2 + k_i) D_{zi}, \quad for \quad i = c, u \quad and \; z = h, l \tag{4}$$

$k_u = 0$ and $k_c = k$. c_z is the cost of providing quality for firm z. We define: $c_l = c$ and $c_h = \delta c$, with $\delta > 1$. Thus, l is the low-cost firm, and h is the high-cost firm. k is the unit cost of certifying, paid to the independent certifying organization. D_{zi} is the demand perceived by firm z, when playing strategy i. Firms h and l choose whether to certify or not the good they produced, and then set products price. The choice of certifying is sequential, while price strategies are simultaneous.

Firm z profit function is therefore given by:

$$\Pi_{zi}(q_i, p_i, k_i, c_z) = (p_i - c_z q_i^2 - k_i) D_{zi}, \quad for \quad i = c, u \quad and \; z = h, l \tag{5}$$

At this point four types of market outcome can be considered.

[2] Implications of this assumption are given in appendix A.

No firm certify: If no firm choose to certify, the classic Bertrand game applies. The cost of providing a low-quality good ($q_u = 0$) being null, the price of the uncertified good in this case is $p_u = 0$, which provides zero profit for both firms: $\Pi_{zu} = 0$, $\forall z = h, l$. Obviously, certified demand is null here: $D_c = 0$, $D_u = 1$.

Both firms certify: To make positive profits, firm h needs to sell the good at a price greater than or equal to: $p_c^{min} = c_h \overline{q}^2 + k$. In that case, firm l can fix a price slightly below firm h zero-profit price, to capture all the market demand and to make positive profit:

$$p_c = c_h \overline{q}^2 + k - \epsilon \quad with \quad \epsilon \to 0^+ \tag{6}$$

Non-certified demand is necessarily null $D_u = 0$. Certified demand is thus: $D_c = 1$. As demand is totally captured by firm l, firm h profit is null. Firm l profit is thus:

$$\begin{cases} \Pi_{lc} = \overline{q}^2 c(\delta - 1) \\ \Pi_{hc} = 0 \end{cases} \tag{7}$$

Only one firm certifies: When only one firm chooses to certify its production, both firms have some market power due to product differentiation. Firm z profit maximization programme when choosing to certify (considering that firm $z' \neq z$ does not certify) is:

$$\max_{p_c} \Pi_{zc} = (p_c - \overline{q}^2 c_z - k) \frac{\overline{q} + p_u - p_c}{\overline{q}} \tag{8}$$

Conversely, firm z' profit maximization programme is (considering that firm z certifies):

$$\max_{p_u} \Pi_{z'u} = p_u \frac{p_c - p_u}{\overline{q}} \tag{9}$$

First order conditions give equilibrium prices, demands and profit. Equilibrium prices are:

$$\begin{cases} p_c = \frac{2}{3}(\overline{q}(1 + \overline{q} c_z) + k) \\ p_u = \frac{1}{3}(\overline{q}(1 + \overline{q} c_z) + k) \end{cases} \tag{10}$$

Certified and uncertified demands are in this context:

$$\begin{cases} D_{zc} = \frac{\overline{q}(2 - \overline{q} c_z) - k}{3\overline{q}} \\ D_{z'u} = \frac{\overline{q}(1 + \overline{q} c_z) + k}{3\overline{q}} \end{cases} \tag{11}$$

Table 1: **Equilibrium values when only one firm certifies**

Demand	$D_{z'u}$	$\frac{\overline{q}(1+\overline{q}c_z)+k}{3\overline{q}}$
	D_{zc}	$\frac{\overline{q}(2-\overline{q}c_z)-k}{3\overline{q}}$
Market Prices	p_u	$\frac{1}{3}(\overline{q}(1+\overline{q}c_z)+k)$
	p_c	$\frac{2}{3}(\overline{q}(1+\overline{q}c_z)+k)$
Firms Profit	$\Pi_{z'u}$	$\frac{(\overline{q}(1+\overline{q}c_z)+k)^2}{9\overline{q}}$
	Π_{zc}	$\frac{(\overline{q}(2-\overline{q}c_z)-k)^2}{9\overline{q}}$
Global Quality	GQ	$\frac{\overline{q}(2-\overline{q}c_z)-k}{3}$

Respective profits of firm z and z' are:

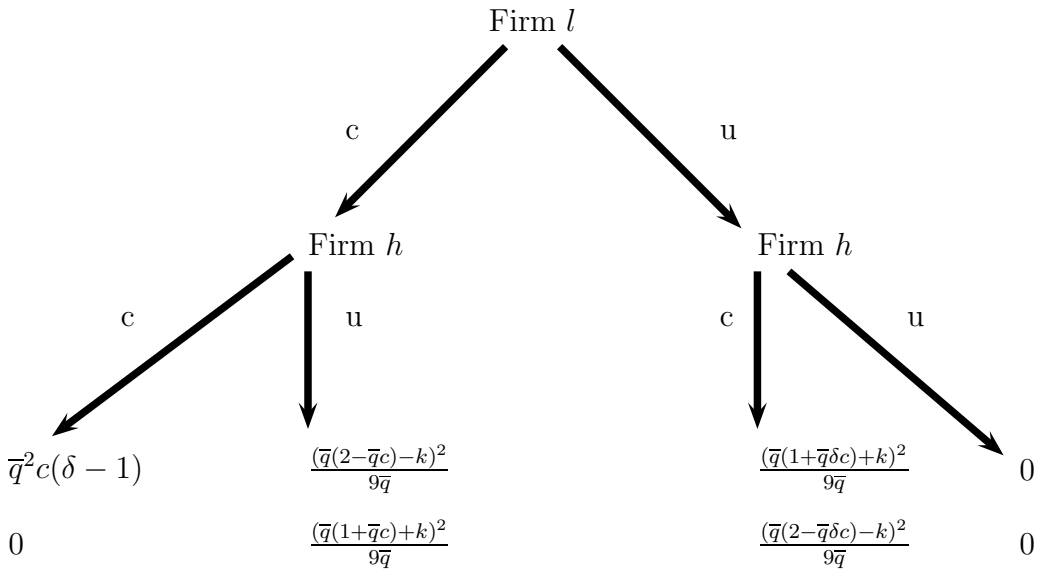
$$\begin{cases} \Pi_{z'u} = \frac{(\overline{q}(1+\overline{q}c_z)+k)^2}{9\overline{q}} \\ \Pi_{zc} = \frac{(\overline{q}(2-\overline{q}c_z)-k)^2}{9\overline{q}} \end{cases} \tag{12}$$

Table 1 gives a summary of the potential outcomes if only one firm z certifies its product (Global market quality is defined as $GQ = \overline{q}D_{zc}$).

2.3. Certifying decision

The choice of labeling is assumed to be sequential. Indeed, real world examples frequently show labeling processes have usually relatively slow-motion patterns, as only few firms adopt labels in the earlier stages of implementation. This statement may be explained by the fact that those processes require firms to adapt their production modes and are often costly to the firm. This implies that observation of ones opponents is essential, which justify the sequential choice. When choosing to certify or not, we consider that the low-cost firm may have a first mover advantage. Indeed, it is straightforward that the first objective of the less efficient firm is to avoid symmetric strategies (see figure 1): the high-cost firm is in a position where it can be excluded out of the market by the low-cost firm. So the objective for the less efficient firm is to get an equilibrium with product differentiation (whatever the product quality). It thus seems natural that this firm has an advantage to wait for its opponent strategy, in order to be sure that an asymmetric outcome will come

Figure 1: **The certification game**



out.[3] Finally, once both firms have chosen to certify or not, they fix prices simultaneously.

Firm h choice: It is trivial to see that firm h always chooses firm l's opposite strategy. Indeed, firm h gets zero profit whenever it imitates firm l's strategy, while its profit is positive when choosing the opposite strategy. Thus, the market always splits, with a firm certifying its production, while the other does not.

Proposition 1 : *In the case of a Bertrand duopoly, the existence of a label always splits the market, when the choice of labeling is sequential and the low-cost firm chooses first.*

Proof : firm h's profit is always positive when choosing firm l's opposite strategy: $\frac{(\overline{q}(2-\overline{q}\delta c)-k)^2}{9\overline{q}} > 0$, and $\frac{(\overline{q}(1+\overline{q}c)+k)^2}{9\overline{q}} > 0$.

[3]The case in which firm h is the leader and firm l the follower has also been considered. The main difference results from the threat of the low-cost firm to exclude the leading high-cost firm if it opts for certification. Computations for the high-cost firm leader case are available upon request to the authors.

Indeed, the existence of a label allows firm h to get some market power, and thus to make positive profit. If firm l chooses not to certify its production, firm h can capture consumers with the highest taste for quality. Conversely, if firm l certifies its production, firm h captures low taste for quality consumers.

At this stage, assumption of positive certified demand $p_c \leq p_u + \overline{q}$ imposes some restrictions on k and $\overline{q}$ (see appendix A).

Firm l choice: From proposition 1, firm l knows that firm h always chooses firm l's opposite strategy. Thus, its choice is made between two potential outcomes.

Firm l chooses to certify its production if:

$$\frac{(\overline{q}(2-\overline{q}c)-k)^2}{9\overline{q}} \geq \frac{(\overline{q}(1+\overline{q}\delta c)+k)^2}{9\overline{q}} \tag{13}$$

This condition is met for:

$$\begin{cases} \overline{q} \in [q_1; q_2] \\ q_1 = \frac{1-(1-8(\delta+1)kc)^{1/2}}{2(\delta+1)c} \\ q_2 = \frac{1+(1-8(\delta+1)kc)^{1/2}}{2(\delta+1)c} \end{cases} \tag{14}$$

We can define the interval in which firm l chooses to certify:

$$I = q_2 - q_1 = \frac{(1-8(\delta+1)kc)^{1/2}}{(\delta+1)c} \tag{15}$$

Note that this interval only exists for small labeling prices (or small costs of improving quality for both firms): $k \leq \frac{1}{8(\delta+1)c} \equiv \overline{k}$. Assuming this condition is met, the interval is decreasing in the cost of certifying, the cost of quality, and the cost differential between the two firms: $\frac{\partial I}{\partial k} < 0$, $\frac{\partial I}{\partial c} < 0$ and $\frac{\partial I}{\partial \delta} < 0$. If this condition is not met, that is for high cost of certification, the low-cost firm never certifies its production and the equilibrium is: $[l, h] = [u, c]$.

The leading firm will take the high quality advantage only if it allows to gain higher profits (Shaked and Sutton, 1982). The high quality advantage does not always exist as labeling is costly. The firm that certifies faces both higher production costs as well as labeling costs. Then, if the label program sets the quality standard at a low level, the low-cost firm who has the leader advantage prefers not to certify and thus let the high quality advantage to the high-cost firm. The reason for this behavior can be explained as follows: as the differentiation between products is small, the low-cost firm prefers to accentuate differentiation by inducing the high-cost firm into labeling. By

Table 2: **Certification decision according to certification requirement**

Labeling Cost	k	$\leq \overline{k}$			$> \overline{k}$
Label Quality	$\overline{q}$	$< q_1$	$[q_1; q_2]$	$> q_2$	
Market Outcome	$[l; h]$	$[u; c]$	$[c; u]$	$[u; c]$	

pushing the high-cost firm to certify, obliging the firm to set higher prices as it faces higher costs, the low-cost firm creates space to capture consumers without increasing its production costs.

Conversely, if the labeling scheme sets the quality standard at a high level, the certifying firm will bear a high increase of its production costs. A direct consequence will be a high price for the certified product and a low demand. The low-cost firm might then prefer to sell low quality products. The advantage of obliging the high-cost firm to adopt certification, is an even higher price for certified products and thus a higher demand for uncertified products. In other words, the leading firm will only choose the high quality option (adopt labeling) if the quality level set by the label program is in between q_1 and q_2. In all other cases, the low-cost firm will constraint the rival and less efficient firm to opt for labeling. Potential outcomes can thus be described in table 2.

Proposition 2 : *In the case of a Bertrand duopoly, if the choice of certifying is sequential, the most efficient firm tends to certify its production when the label standard takes intermediate values and the labeling cost is not too high. Conversely, the most efficient firm will let the less efficient firm certify its production when the label standards takes extreme values.*

Proof: firm l chooses to certify its production if $\frac{(\overline{q}(2-\overline{q}c)-k)^2}{9\overline{q}} \geq \frac{(\overline{q}(1+\overline{q}\delta c)+k)^2}{9\overline{q}} \Longleftrightarrow \overline{q}\left(3+\overline{q}c\left(\delta-1\right)\right)\left(\overline{q}\left(1-\overline{q}c\left(1+\delta\right)\right)-2k\right) \geq 0$. As $\delta > 1$, this condition is satisfied whenever $\overline{q}\left(1-\overline{q}c\left(1+\delta\right)\right)-2k \geq 0$. This is only true when $k \leq \overline{k}$ and $\overline{q} \in [q_1; q_2]$

Now that we have defined the different equilibrium patterns, we can focus on the certifier's objective and its consequences.

3. Certification policies and quality standard

Certifiers may have different objectives when choosing the required quality standard, which are related to potentially different outcomes. We consider in this section that the certifier may either maximize certified demand or global market quality. We implicitly assume here that the certifier has a zero profit condition. It will thus fix the labeling price k in order to meet its own costs.

Note here that the certifier has a perfect knowledge of the market. This means that for any label standard it decides to implement, the certifier perfectly infers what will be the market outcome: which firm certifies, what are the equilibrium prices and quantities, what is the global market quality.

3.1. Wide public policy

The certifying organization may first choose to set the label standards in order to maximize the certified demand, taking the certifying firm $z = l, h$ as given:

$$\max_{\overline{q}} D_c(\overline{q}) \quad = \quad \frac{\overline{q}(2 - \overline{q}c_z) - k}{3\overline{q}} \tag{16}$$

The first-order condition gives:[4]

$$\overline{q}_{wz} = (\frac{k}{c_z})^{1/2} \tag{17}$$

The certifier knows that the wide public policy may lead to different outcomes, depending on the chosen label standard. First, if $\overline{q}_{wl} = (\frac{k}{c})^{1/2}$ lies on the interval $[q_1; q_2]$, that is if the unit cost of certification is small enough compared to the cost of improving quality of both firms, the first order condition induces an equilibrium of the type $[l, h] = [c, u]$. This condition is met for:

$$k \leq \frac{1}{(3+\delta)^2 c} \equiv k_1 \tag{18}$$

Second, if this condition is not met, it is important to check if q_1 and q_2 generate greater certified demand than $\overline{q}_{wh} = (\frac{k}{\delta c})^{1/2}$. [5] In this case, the market outcome is of the type: $[l, h] = [c, u]$. Finally, for otherwise, the equilibrium wide public policy leads to an outcome of the type $[l, h] = [u, c]$.

[4]Note that this value of the label standard does not violate the positive certified demand assumption. See appendix A.

[5]See appendix B.

Table 3: **Certification outcome in the case of a Wide Public Policy**

Certification Cost	k	$< k_1$	$[k_1, \overline{k}]$				$> \overline{k}$
	q_1	$< \underline{q_w}$			$[\underline{q_w}, \overline{q_w}]$	$> \overline{q_w}$	
	q_2	$< \underline{q_w}$		$[\underline{q_w}, \overline{q_w}]$		$> \overline{q_w}$	
Label Quality	$\overline{q}$	$\overline{q_{wl}}$	$\overline{q_{wh}}$	q_2	q_y	q_1	$\overline{q_{wh}}$
Market Outcome	$[l, h]$	$[c, u]$	$[u, c]$	$[c, u]$			$[u, c]$

Proposition 3 : *In the case of a Bertrand duopoly with sequential certification choice:*

- *if the cost of labeling is low enough:* $k \leq k_1$*, then the wide public policy always leads to a market equilibrium where the most efficient firm produces and sells the labeled product:* $[l, h] = [c, u]$ *and* $\overline{q}_{wl} = (\frac{k}{c})^{1/2}$.
- *if the cost of labeling is higher, the wide public policy leads to a market equilibrium where the less efficient firm produces the labeled good, only if both* q_1 *and* q_2 *do not represent corner solutions:* $[l, h] = [u, c]$ *and* $\overline{q}_{wh} = (\frac{k}{\delta c})^{1/2}$*, if* $[q_1; q_2] \nsubseteq [\underline{q_w}; \overline{q_w}]$.

If the labeling cost is sufficiently low, the efficient firm will gain from being the high quality producer. This is not necessarily true if labeling costs are high. Whether the efficient firm chooses to be the high quality producer will then depend on c (production costs) and δ (possibility for the efficient firm to increase product differentiation). Table 3 summarizes the market outcome and the equilibrium wide public policy.

3.2. Global quality policy

Another of the certifier's potential objective is to maximize global quality on the market. This objective makes sense when a non-profit organization aims for example at providing environmental quality. The programme of the certifier is, considering the certifying firm $z = h, l$ as given:

$$\max_{\overline{q}} GQ(\overline{q}) \quad = \quad \frac{\overline{q}(2 - \overline{q}c_z) - k}{3} \tag{19}$$

The first-order condition gives:[6]

[6]Which also respect the positive certified demand assumption. See appendix A.

Table 4: **Certification outcome in the case of a Global Quality Policy**

	q_2	$< \underline{q_g}$	$[\underline{q_g}, \overline{q_g}]$	$> \overline{q_g}$
Label Quality	$\overline{q}$	$\overline{q_{gh}}$	q_2	$\overline{q_{gh}}$
Market Outcome	$[l, h]$	$[u, c]$	$[c, u]$	$[u, c]$

$$\overline{q}_{gz} = \frac{1}{c_z} \tag{20}$$

For this label policy to represent an equilibrium of the type $[l, h] = [c, u]$, condition described in equation (14) must be respected, implying: $-\delta \geq 2kc$. The three parameters being strictly positive, this condition cannot be met. Note however that $\overline{q} = q_2$ may generate greater global quality than $\overline{q}_{gh}$: $GQ(q_2) > GQ(\overline{q}_{gh})$ if $q_2 \in [\underline{q_g}; \overline{q_g}]$. [7]

Proposition 4 : *In the case of a Bertrand duopoly with sequential certification choice, a global quality policy implies that:*

- *the global quality policy leads to an outcome in which the less efficient firm is pushed to label its product by the most efficient firm:* $[l, h] = [u, c]$, $\overline{q} = q_{gh}$.
- *the global quality policy may however imply a corner solution for some particular cases:* $[l, h] = [u, c]$, $\overline{q} = q_{gh}$, *if* $q_2 \in [\underline{q_g}; \overline{q_g}]$.

The certifier chooses a high quality for the label. As quality is increasingly costly, the most efficient firm prefers to push the high-cost firm into the labeling process. This will increase the product differentiation. So the low-cost firm can benefit from higher demand (for non-labeled products) without bearing any extra cost. Table 4 summarizes the two types of equilibrium.

3.3. Numerical illustration

To illustrate our qualitative results, we provide a numerical example for both policies. Figures 2 and 3 show the equilibria for the two defined policies, and for the following parameters: $m = 20$, $c = 0.05$, $k = 0.8$ and $\delta = 1.4$.

[7] See appendix B

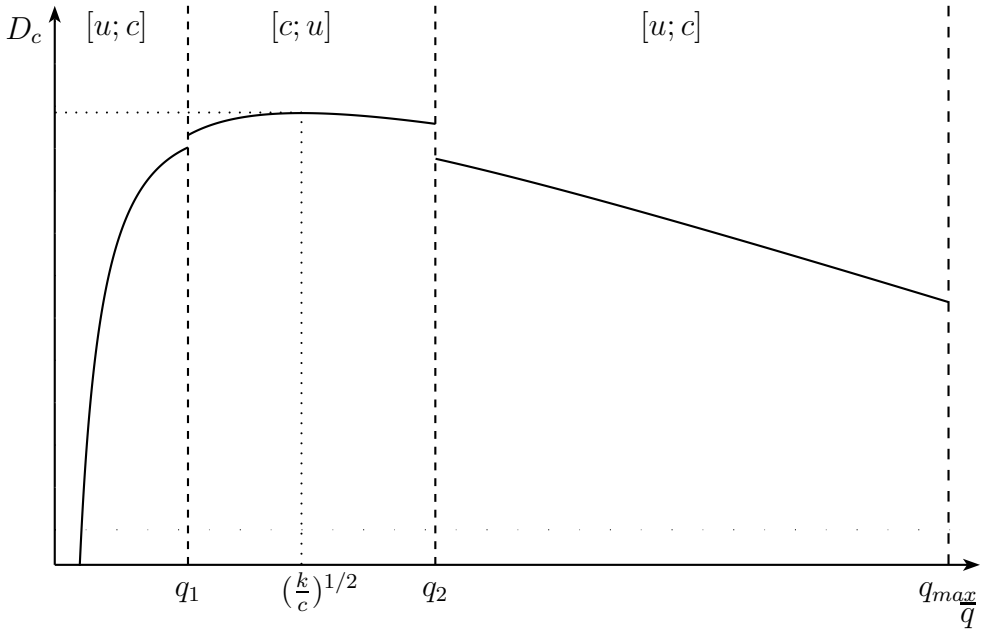


Figure 2: **Wide Public Policy: the efficient firm certifies**

Parameters are chosen so that the wide public policy result in a $[l,h] = [c,u]$ equilibrium (hence $k < k_1$). Numerical results can be found in appendix C.

4. Conclusion

This paper shows that the objective of a third-party certifier when choosing the quality level of a label has an impact on market outcome and on firm's decision to adopt or not the label. The high-cost firm may be the one to certify even if it is the less efficient to do so. Such a situation appears in the context of a global quality policy. Our results point out an important consideration: the objective of the certifier matters and label quality standard differs when the certifier policy aims at expanding the demand for the certified product or improving global quality of the products available on the market. Moreover, those results give some evidence of the potential inefficiency of voluntarily schemes, which may result from strategic behaviors by most efficient firms.

Many avenues can be considered for future research. We have only considered two certifiers objectives. However, certifiers may take very diverse forms (for-profit private certifiers, NGOs...). Private certifiers may choose to maximize certifying firm's profit (for instance firm's autolabel) or their

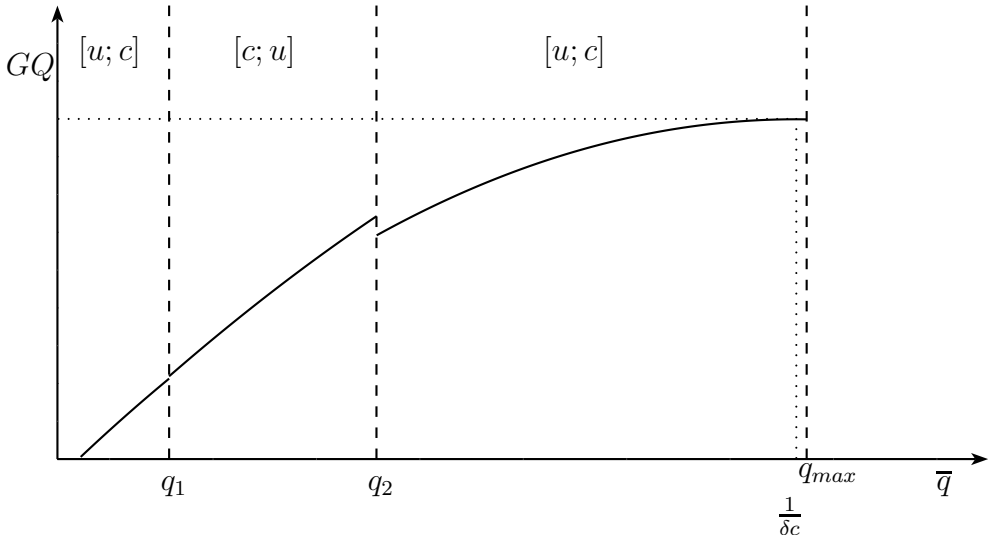


Figure 3: **Global Quality Policy: the inefficient firm certifies**

own profit. This may help to understand the profusion of labels and the sometimes important differences in the required quality for obtaining the label.

Appendix A: implications of the full market coverage and positive certified demand

We have assumed that $p_u \leq m$ and $p_c \leq p_u + \overline{q}$, so that the market is fully covered and certified demand is strictly positive. This assumption implies restrictions on the label standard and the cost of labeling:

$$\begin{cases} \overline{q} \in [q_{\min}, q_{\max}] \\ q_{\min} = \frac{1-\sqrt{1-c_z k}}{c_z} \\ q_{\max} = \frac{1+\sqrt{1-c_z k}}{c_z} \\ k \leq \frac{1}{c_z} \end{cases}$$

Note here that the label standard related to the wide public policy $\overline{q} = (k/c_z)^{1/2}$ and the global quality policy $\overline{q} = 1/c_z$ both unambiguously hold in this interval. Considering the numerical example, we assume: $m = 20$, $c = 0.05$, $\delta = 1.4$ and $k = 0.8$.

Market Outcome	$[l;h]$	$[c;c]$	$[u;c]$	$[c;u]$
Label Standard	$q_{covered}$	$(\frac{m-k}{\delta c})^{1/2}$	$\frac{(1-4\delta c(k-\frac{3k}{2}))^{1/2}-1}{2\delta c}$	$\frac{(1-4c(k-\frac{3k}{2}))^{1/2}-1}{2c}$
Value		≤ 16.56	≤ 14.49	≤ 16.15

Appendix B: q_1 and q_2 that generate corner solutions

We have to check in this appendix the conditions for which q_1 and q_2 can represent corner solutions to the considered policies.

Wide public policy: Provided that q_{wl} does not lay on the interval $[q_1, q_2]$, the certifier tends to set a wide public policy of the type: $\overline{q} = q_{wh}$. However, the certifier has to check that q_y, $y = 1, 2$, do not involve larger certified demand. We have $D_c(q_y) > D_c(\overline{q}_{wh})$, if:

$$\begin{cases} q_y \in [\underline{q_w}, \overline{q_w}] \\ \underline{q_w} = \frac{1-(1-(k+2(1-(k\delta c)^{1/2})c)^{1/2}}{c} \\ \overline{q_w} = \frac{1+(1-(k+2(1-(k\delta c)^{1/2})c)^{1/2}}{c} \end{cases}$$

It follows that, in the case of a wide public policy, the certifier sets:

- if $q_1 \in [\underline{q_w}, \overline{q_w}]$ and $q_2 \notin [\underline{q_w}, \overline{q_w}]$, $\overline{q} = q_1$.
- if $q_1 \notin [\underline{q_w}, \overline{q_w}]$ and $q_2 \in [\underline{q_w}, \overline{q_w}]$, $\overline{q} = q_2$.
- if $q_1 \in [\underline{q_w}, \overline{q_w}]$ and $q_2 \in [\underline{q_w}, \overline{q_w}]$, $\overline{q} = q_1$ if $D_c(q_1) > D_c(q_2)$; $\overline{q} = q_2$ if $D_c(q_1) < D_c(q_2)$.
- if $q_1 \notin [\underline{q_w}, \overline{q_w}]$ and $q_2 \notin [\underline{q_w}, \overline{q_w}]$, $\overline{q} = q_{wh}$.

Global quality policy: We know that $\overline{q} = q_{gl}$ does not lay on the interval $[q_1, q_2]$. Thus the certifier tends to set a global quality policy of the type: $\overline{q} = q_{gh}$. However, the certifier has to check that q_y, $y = 1, 2$, do not involve larger global market quality. First, note that $GQ(q_2) > GQ(q_1)$, $\forall q_1, q_2$. Thus q_1 has not to be considered as a potential equilibrium. Second $GQ(q_2) > GQ(\overline{q}_{wh})$, if:

$$\begin{cases} q_2 \in [\underline{q_g}, \overline{q_g}] \\ \underline{q_g} = \frac{1-(\frac{\delta-1}{\delta})^{1/2}}{c} \\ \overline{q_g} = \frac{1+(\frac{\delta-1}{\delta})^{1/2}}{c} \end{cases}$$

The certifier global quality policy is then:

- $\overline{q} = q_{gh}$ if $q_2 \notin [\underline{q_g}, \overline{q_g}]$.
- $\overline{q} = q_2$ if $q_2 \in [\underline{q_g}, \overline{q_g}]$.

Appendix C: results of the numerical illustration

Parameter	Value
m	20
c	0.05
δ	1.4
k	0.8

Critical value	
q_1	2.16
q_2	6.17
q_{max}	14.49

Policy	Outcome	$\overline{q}$
WPP	[c;u]	4
GQP	[u;c]	14.29

k_1	1.03305785
$\overline{k}$	1.04166667

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