Agricultural production clubs: Viability and welfare implications

Corinne Langinier* and Bruce A. Babcock†

September 2007

Abstract

Consumers are, in general, less informed than producers about the quality of agricultural goods. To reduce the information gap, consumers can rely on certification that ensures the quality and origin of the goods. Certification can be voluntarily adopted by a group of producers, as is the case for geographical indications. We model such a group as a club, and analyze the certification decision of the club and its welfare implication.

We find that for intermediate values of certification costs, the industry and a club of given size have divergent incentives, and there may be overprovision of certification. If club members can erect barriers to entry, an optimal size of club exists. There may be a conflict between the efficient outcome (that maximizes the aggregate profit of the firms) and the equilibrium, which may be socially undesirable. In the absence of a barrier to entry, it is less likely that a club will emerge.

Keywords: Asymmetric information, certification, clubs, quality

JEL classification: L11 (market structure); L15 (information and product quality); D82 (asymmetric and private information); D71 (clubs).

*Iowa State University, Ames; langinier@econ.iastate.edu
†CARD, Iowa State University, Ames; babcock@iastate.edu
1 Introduction

Consumers are, in general, less informed than producers about the quality of agricultural goods. For some goods, the quality cannot be assessed before they are purchased (experience goods), whereas for other goods, consumers will never be able to assess their quality (credence goods).\footnote{Nelson (1970) and Darbi and Karni (1973) introduced this categorization of goods.}

To reduce the information gap, consumers can rely on standards (labels, geographical indications, certifications) that are granted or regulated by a governmental agency to ensure the quality of goods. However, they generally do not fully reveal information: if high-quality goods are certified, it does not necessarily mean that all non-certified goods are of low quality. This is the case with a geographical indication (GI) that provides consumers with the information that the good has been produced within a certain geographic area, and guarantees a certain quality. However, producers who do not have the GI may produce a good of equal quality.

Our analysis focuses on GIs, and on the formation of a group of producers that obtains a GI. These standards are mostly used in Europe, as many countries (including the U.S.) are reluctant to adopt such protection (Addor and Grazioli, 2002),\footnote{European countries seek to extend GIs to most countries worldwide, as defined in the TRIP agreements. However, the U.S., Canada, and Australia, among other countries, are reluctant to adopt such protection.} and they are generally combined with national labels (e.g., “label rouge” in France) to insure the quality and origin of goods. According to the World Trade Organization definition,\footnote{“Geographical indications are defined, for the purposes of the Agreement, as indications which identify a good as originating in the territory of a Member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin (Article 22.1).”} GIs define who can make a particular product, where the product is to be made, and what ingredients and techniques are to be used to guarantee origin and authenticity. The geographical link must occur in at least one of the stages of production, processing, or preparation. Some well-known examples of GIs are Parmesan cheese, Champagne wine, and Roquefort cheese.

To obtain a GI, a group of producers must first define the product according to precise specifications, and then the GI must be approved by a governmental agency. GIs are not limited to any particular firm: there is no monopoly right in the hands of a single firm, but rather it is a collective right.\footnote{There is no owner of a GI; within the E.U., the indication is owned by the States. Administration and control of GIs are shared by public and private parties.} In general, all producers in a specific geographical area have the right to use
the GI if their products meet the stipulated requirements. Specifically, the protection should be given to any producer who can show the link between his product and the geographical origin. However, in practice, the group of producers that has defined the GI can make it harder for other producers to comply with the requirements. It is not uncommon to find that few producers are able to use a GI (e.g., Roquefort). The group can always claim that the quality of a potential entrant’s product is not good enough or does not meet some of the specifications. For instance, it could be argued that to use the GI an entrant must buy land in the area to be able to claim the geographical link. In economic terms, the group creates a direct barrier to entry with the imposition of an entry cost.

Our contribution is to offer a formal framework to understand and explain the group formation. We investigate whether the equilibrium is an efficient outcome that maximizes the aggregate profit of the firms, and whether it is socially efficient. Our analysis may be helpful to explain the opposition to the adoption of GIs by some countries. It may be that the adoption of a GI is socially undesirable because it is too costly (the benefit from adopting does not offset the cost), or it can also be that consumers are not willing to pay for some of the characteristics of the good. It is also possible that some producers lobby the government when the adoption of a GI is not an efficient outcome. According to Hayes, Lence, and Babcock (2005) a few large U.S. food companies oppose GIs, which may be why the U.S. is reluctant to adopt them.\footnote{The U.S. favors trademarks and argues that GIs are sufficiently protected under existing trademark laws. However, there are major differences between trademarks and GIs. Trademarks are not limited by any territorial link, can be easily transferred or licensed, and are private in nature. Similar comments apply for certification marks or collective marks (e.g., Vidalia onions, Idaho potatoes).}

We consider a model of vertical differentiation in which firms produce goods of given quality.\footnote{Models of vertical differentiation were first developed in the context of a monopoly (Mussa and Rosen, 1978) and a duopoly (Gabszewicz and Thisse, 1979). The focus was on the optimal choice of product qualities.} Consumers are not aware of the quality of the good unless they get more information through certification. At the outset, some high-quality producers can decide to form a group to obtain a GI, and share the associated cost. We explicitly model GIs as club goods (non-rival, congestible, and excludable),\footnote{Rangnekar (2004) also suggests that a GI can be seen as a club good.} where letting one more producer join the club reduces the average certification cost but also reduces the profit for each producer. Producers who seek to join the club must comply with specific quality requirements.
We investigate under what circumstances producers may prefer to rely on GIs - a certification regime that does not fully reveal information - whether it is an efficient outcome and if it can be welfare improving. We then determine the optimal club size and the equilibrium, both in the presence of a direct barrier to entry and in the absence of a barrier.

For intermediate values of GI cost and for a given club size, the group of labelled producers and the entire industry have divergent labeling incentives, and for some constellation of parameters (in particular, if the fraction of high-quality producers is relatively high) there may be overprovision of labels compared to what is socially desirable. In this case, the benefit from the revelation of the quality does not outweigh the cost and the loss incurred by low-quality producers. This can explain the reluctance of some countries to adopt GIs, as the entire industry can lobby the government to prevent the imposition of such a label. For instance, this finding might explain the hesitancy of the U.S. cattle industry to endorse full traceability for cattle.

If the government allows a club of producers to prevent entry, an optimal club size exists and more revelation of information occurs. However, depending on the cost structure, there is a divergence between the incentives of the club and those of the entire industry (the equilibrium outcome and the efficient outcome are divergent), and there may be overprovision of the label.

Asymmetric information between sellers and consumers has been widely studied in the economic literature. Starting with the seminal work of Akerlof (1970), studies have shown how asymmetric information affects the allocation and distribution of resources. When it is more costly to produce high quality than low quality, prices can signal the quality of the good (Bagwell and Riordan, 1991). However, it is not always possible to signal quality through prices, especially when marginal costs of production are identical, as we assume here.

Allowing uninformed consumers to become better informed can also be done through a certification intermediary, which is what we consider in this paper. Biglaiser (1993) and Biglaiser and Friedman (1994) investigate how middlemen can partially mitigate the problem of asymmetric information. What amount of information should be revealed by the certification intermediaries and how this affects surplus has been studied by Lizzeri (1999). In our paper, qualities are given and we do not allow for strategic revelation of information by the certification intermediary. We assume that the information conveyed by the intermediary is accurate and that it completely reveals the quality. Unlike Lizzeri (1999) wherein consumers have identical tastes, we consider that they differ in their tastes and, therefore, those who value the good the most consume the
high-quality good. We do not question whether self-certification or public intervention is better.\footnote{A public agency may benefit from economies of scale when the fixed costs for certification are high (Auriol and Schillizzi, 2003).}

However, labels can be private or public.\footnote{See Bergès-Sennou, Bontems and Réquillart (2004) for a survey on private labels, Crespi and Marette (2003) for a survey on public labels, and Marette (2005) for a survey on common labeling.} Public labeling can be done directly by a public agency that controls the entire labeling process, or through a third-party or middleman (producer association) that certifies the goods according to rules imposed by a regulator. Our paper is concerned with the latter case: a certification intermediary has the power to certify,\footnote{As to who should pay for labeling, Crespi and Marette (2001) show that in most cases a per-unit or an ad valorem fee is preferred.} and we consider that the cost of labeling is shared by all of the producers who acquire the label.

Our paper is close to that of Marette and Crespi (2003), where they investigate whether cartels (producer associations that use common labels and trademarks) improve overall welfare. They consider that producers can collude in quantity, and use the concept of sequential formation of a cartel to examine the actions of sellers who join a cartel. They show that if cartels are allowed and there exists a third-party certification, a stable cartel may emerge. Our analysis is different from theirs on several grounds. We do not allow for collusion on quantity; rather, we consider that an association of producers can be formed to get a common label, but they compete in quantity afterwards. The group can, however, reduce competition by not allowing too many producers into the group. Our formation of the group is a club formation. The optimal club size is the result of a trade-off between allowing more producers to join the club, which reduces the average cost, and reducing the number of club members, which increases the profit of each producer.\footnote{On club goods, see for instance Scotchmer (2002).}

The paper is organized as follows. The model is presented in section 2. Section 3 gives the details of the production stage under different scenarios. In section 4 we study the provision of certification for a given club size. Section 5 in concerned with the determination of the optimal size of the club and the existence of an equilibrium. In section 6 we derive the optimal certification choice by producers. Section 7 concludes.
2 The model

We consider an industry where \( m > 2 \) firms produce goods of two different given qualities: high, \( s_h \), and low, \( s_l \), where \( s_h > s_l \). We assume that a fraction \( \alpha \) (respectively, \( 1 - \alpha \)) of the firms produce high-quality goods (respectively, low-quality), and that the marginal cost of production is zero.

Information is asymmetric, as consumers do not know the quality of the good,\(^{12}\) while producers know the quality of their own good. However, the information gap can be reduced if some (or all) of the high-quality producers obtain certification, in which case consumers learn that certified goods are of high quality.

To be more specific on the demand side, we consider \( N \) consumers, each of whom consumes either 0 or 1 unit of the good, and we normalize \( N = 1 \). Each consumer has the following preferences:

\[
U = \begin{cases} 
\theta s - p & \text{if he buys the good of quality } s \text{ and pays } p, \\
0 & \text{otherwise}, 
\end{cases}
\]

where \( \theta \) is a taste parameter, and \( s \) represents the quality of the good. We assume that \( \theta \) is distributed according to a uniform distribution between 0 and 1 and, thus, \( F(\theta) \) is the fraction of consumers with a taste parameter of less than \( \theta \).

If there were only one quality, there would exist a consumer \( \tilde{\theta} \) who is indifferent between buying the good of quality \( s \) or not. His utility is \( \tilde{\theta} s - p = 0 \), and hence \( \tilde{\theta} = p/s \). Consumers with \( \theta > \tilde{\theta} \) buy the good, and the demand function is \( D(p) = (1 - p/s) \). The inverse demand is

\[
p(Q) = [1 - Q]s, \quad (1)
\]

where \( Q \) represents the total quantity.

With two different levels of quality and \( s_h/p_h < s_l/p_l \) (quality-adjusted price is higher for low quality), there exists a consumer \( \tilde{\theta} \) who is indifferent between consuming the high-quality good or the low-quality good, and thus \( \tilde{\theta} s_h - p_h = \tilde{\theta} s_l - p_l \), where \( p_h \) (respectively, \( p_l \)) is the price for the high- (respectively, low-) quality good. Hence, \( \tilde{\theta} = (p_h - p_l)/(s_h - s_l) \). Consumers who choose not to buy the high-quality good, buy either the low quality or nothing. Therefore, there exists an indifferent consumer such that \( \tilde{\theta} s_l - p_l = 0 \). The demands for high quality and

\(^{12}\)It can be either a credence good or an experience good.
We can easily derive the inverse demand functions

\[ ph(Q_h; Q_l) = [1 - Q_h] s_h - Q_l s_l, \]  

\[ pl(Q_h; Q_l) = [1 - (Q_h + Q_l)] s_l, \]

where \( Q_h \) (respectively, \( Q_l \)) represents the total quantity of high- (respectively, low-) quality goods.

At the outset of the game, a trustable governmental agency allows high-quality producers to adopt a label that perfectly reveals quality.\(^{13}\) If none of the producers get the label, there is no revelation of information. On the other hand, if all of them get the label, there is full revelation of information and consumers learn perfectly the quality.\(^{14}\) However, if only a fraction of high-quality producers adopts the label, consumers are only partially informed about the quality. When buying a labeled good, they know that it is of high quality, whereas they do not know the quality of a non-labeled good. Among the non-labeled goods, some are of low quality and some are of high quality. We denote this kind of label, when there is only partial revelation of information, \( \text{label-G} \), as it can be used in the case of GIs. Further, the number of high-quality producers that get the label is endogenously defined.

The endogenous club formation has two stages. In the first stage, firms form a club of optimal size \( n^* \). In the second stage, producers and consumers learn the existence of the club. Contingent on the club size, firms compete as oligopolist in the product market.

We consider the following scenarios: \( (i) \) no certification; \( (ii) \) certification fully reveals the quality of the good; \( (iii) \) certification reveals only high-quality goods when the size of the club

\(^{13}\)In our model we are not concerned with strategic behavior on the part of the certification party, as we assume that consumers trust the agency that delivers the certification.

\(^{14}\)For instance, consider a monopolist that can produce either a high-quality good or a low-quality good. The quality is unknown by consumers, and we assume that with a probability 1/2 the good is of high quality. Thus, if it is not too costly to certify the good, there exits a separating equilibrium in which the high-quality producer will certify his good, whereas the low-quality producer never certifies his good. Thus, consumers learn the quality of the good, as certified goods are of high quality, whereas non-certified goods are of low quality.
is positive but smaller than $\alpha m$. Scenarios (i) and (ii) are benchmark cases against which we compare scenario (iii).

3 Production stage

In this section, we first define the Cournot equilibrium for each possible scenario, and then we compare the results under the different regimes for a given club size.

3.1 No certification regime

As a benchmark, we consider a regime with no certification. Consumer expectation of the quality is

$$s^a = \alpha s_h + (1 - \alpha) s_l.$$ 

There exists a consumer $\theta^a$ who is indifferent between buying the good of expected quality $s^a$ and not buying it, $\theta^a s^a - p = 0$. Hence, the inverse demand function for the good of quality $s^a$ is

$$p(Q) = [1 - Q] s^a,$$

where $Q$ is the total quantity.

Each firm chooses the quantity that maximizes its payoff,

$$Max_{q_i} \{p(q_i, q_{-i})q_i\},$$

where $q_i + q_{-i} = Q$. Firms are symmetric, and thus $q_{-i} = (m - 1)q$. The maximization program of each firm becomes

$$Max_{q_i} \{[1 - q_i - (m - 1)q] s^a q_i\},$$

which gives the best response function of each firm,

$$q_i(q) = \frac{[1 - (m - 1)q] s^a}{2s^a}.$$ 

Because of symmetry, $q_i = q$, and thus, the optimal output level for each firm is $q^* = 1/(1 + m)$
and the price is \( p^* = s^a/(1 + m) \). Each firm gets a gross profit\(^{15}\)

\[
\Pi^* = \frac{s^a}{(1 + m)^2}.
\]

To complete the analysis, we can define the consumer surplus, which is

\[
S^a = \int_{\theta^d}^{1} (\theta s^a - p^*) d\theta = \frac{s^a m^2}{2 (m + 1)^2},
\]

and the total welfare,

\[
W^a = m\Pi^* + S^a = \frac{ms^a}{(1 + m)^2} + \frac{s^a m^2}{2 (1 + m)^2}.
\]

### 3.2 Full revelation certification regime

The other polar case is when all of the high-quality producers obtain certification that fully informs consumers of the quality. This can happen if, for example, there is a mandatory label and all of the high-quality producers must get the label. Consumers then know that certified goods are of high quality, whereas non-certified goods are of low quality. Thus, depending on their willingness to pay, they buy the high-quality good or the low-quality good. Demands are defined by equations (2) and (3).

We assume that the certification cost is a fixed cost \( C \) that is borne by the entire group of certified producers: for instance, this may be the administrative cost associated with the label. In our analysis we abstract from other kinds of costs, such as implementation costs to insure that each producer complies with the rules (that actually should be borne by the regulatory agency), or the cost of insuring a certain quality (for instance, cost per unit of production). In a more general setting, the labeling cost could also depend on the total number of high quality producers and / or on the quantity produced by high quality firms. However, to keep our model simple and because we also believe that the fixed part of the cost is the most significant one, we just consider the fixed part of the cost. We further make the simplifying assumption that marginal costs are identical and normalized to zero in order to have a tractable model.

\(^{15}\)In this simple setting, because marginal costs are identical, if firms had to choose their quality they would all produce a low-quality good. Consumers anticipate this correctly and, thus, they are only willing to pay \( s_i/(1 + m) \). This leads to a market failure. But here, qualities are given.
We relegate to the appendix the maximization programs and their resolutions. The quantities offered respectively by each high-quality producer and low-quality producer are

\[ q_h^* = \frac{s_h + (1-\alpha)m(s_h - s_l)}{(1+m)s_h + (1-\alpha)am^2(s_h - s_l)}, \]

\[ q_l^* = \frac{s_h}{(1+m)s_h + (1-\alpha)am^2(s_h - s_l)}. \]

The prices are \( p_h^* = s_h q_h^* \), and \( p_l^* = s_l q_l^* \), and the gross profits are

\[ \Pi_h^* = s_h (q_h^*)^2, \]

\[ \Pi_l^* = s_l (q_l^*)^2. \]

Each high-quality producer gets the net profit

\[ \Pi_h^* - C_{am} \geq 0. \]

Consumer surplus \( S \) is defined in the appendix, and the total welfare is

\[ W = \alpha m \Pi_h^* + (1-\alpha) m \Pi_l^* - C + S. \]

### 3.3 Label-G regime

Consider now that \( n > 0 \) high-quality producers decide to form a group and obtain a label-G at a cost \( C_g \). Because the label is granted by a trustable agency, consumers have no doubt about the veracity of the information provided. However, as is the case with GIs, the group of producers has to precisely define a set of specific rules that include geographic area (for instance, to make a labeled cheese, the rules must specify the location where the milk originates). Therefore, the cost associated with the label-G, \( C_g \), can be different from \( C \). Besides the administrative cost of the label, it can also include the coordination cost associated with having all of the producers agree on a specific set of rules and, therefore, \( C_g > C \). However, it can be the converse, also, \( C_g < C \), as the mandatory labelling can be more costly to implement.

Because only high-quality producers can be part of the group, \( n \leq \alpha m \) and consumers who buy the label-G good know that it is a high-quality good. There is no collusion, no cartel formation, just a club that is formed by a group of producers to obtain the benefit of revealing their type. For now, we consider that with a given club size entry is prevented, as no more
high-quality producers can get into the club. In the next section we discuss whether there exists such an equilibrium and, if so, under what conditions.

The remaining \((m - n)\) producers do not belong to the group and whenever consumers buy from them, they do not know the quality. Among these producers, \((1 - \alpha)m\) produce low quality, whereas \((\alpha m - n)\) produce high quality. Hence, some consumers choose to buy the certified (known high-quality) good, and others choose not to and buy a good of expected quality

\[
s_g^a = \frac{(1 - \alpha)ms_l + (\alpha m - n)s_h}{m - n} = \frac{ms^a - n s_h}{m - n} < s^a < s_h.
\]

There exists an indifferent consumer \(\bar{\theta}_g\) such that \(\bar{\theta}_g s_h - p_g = \bar{\theta}_g s^a_g - p\), where \(p_g\) is the price of the label-G good and \(p\) is the price of the non-label-G good. Demands and maximization programs are also defined in the appendix. The quantities offered respectively by each label-G producer and non-label-G producer are

\[
q_g^* = \frac{s_h + (1 - \alpha)m(s_h - s_l)}{(1 + m)s_h + m(1 - \alpha)s_h s_l}, \tag{6}
\]
\[
q_a^* = \frac{s_h}{(1 + m)s_h + m(1 - \alpha)s_h s_l}. \tag{7}
\]

These optimal quantities are decreasing in \(n\). The optimal prices are \(p_g^* = s_h q_g^*\) and \(p_a^* = s^a_g q_a^*\). A label-G producer produces more than a non-label-G producer (i.e., \(q_g^* > q_a^*\)), and therefore the price charged by the label-G producers is higher than the non-label-G price (i.e., \(p_g^* > p_a^*\)). Because there is complete resolution of uncertainty concerning the quality of the good in the case of label-G, demand is higher and, thus, producers produce more.

The gross payoffs of each label-G producer and each non-label-G producer are

\[
\Pi_g^* = s_h (q_g^*)^2, \tag{8}
\]
\[
\Pi_a^* = s^a (q_a^*)^2.
\]

The net payoff of each label-G producer is

\[
\Pi_g^* - \frac{C_g}{n} \geq 0, \tag{9}
\]

and each non-label-G high-quality producer gets \(\Pi_a^* \geq 0\).

Consumer surplus \(S^g(n)\) is defined in the appendix and is increasing with \(n\). For a given \(n\) the social welfare is

\[
W^g = n \Pi_g^* + (m - n) \Pi_a^* - C_g + S^g(n).
\]
The label-G regime is an intermediate case between the two extreme regimes: the non-certification regime \((n = 0)\) and the full-revelation regime \((n = \alpha m)\).

4 Provision of certification for a given club size

To have a better understanding of how a club of a given size can impact on the labeling decision, let us first assume that the club size is exogenously given, and compare the different regimes.

Not everyone will benefit from revelation of information. For instance, low-quality producers prefer that consumers stay uninformed, as they benefit from unknown quality. Hence, producers and consumers can be separated into two groups: those who benefit from revelation of information and those who do not. In the former group are the certified high-quality producers, some of the consumers with a low willingness to pay who did not buy the good of unknown quality but can now buy the less expensive non-labeled good, and the consumers with high willingness to pay who are willing to pay a premium for the high-quality good. On the other hand, those who lose from revelation of information are high-quality producers who do not get the label, low-quality producers, and consumers with middle willingness to pay who before had a probability \(\alpha\) of getting a high-quality good but now have a lower probability. Therefore, who decides to get the label and who opposes it will affect the labeling decision.

As we are mainly interested in determining who benefits from the label-G regime, we focus our analysis on three different groups of agents: (i) the label-G high-quality producers, (ii) the whole industry, and (iii) society.

A club of high-quality producers of given size \(n\) gets the label as long as the label-G cost is not too high, i.e., \(C_g < \Gamma_g\) (\(\Gamma_g\) is defined in the appendix). On the other hand, if the labeling decision is made by the entire industry, it will occur less often, as a label would be adopted only if \(C_g < \Gamma_2 < \Gamma_g\).

We can therefore posit the first proposition:

**Proposition 1**: For intermediate values of both certification costs \(C_g\) and \(C\), label-G producers are better off under the label-G regime, whereas the entire industry is worse off.

All of the proofs are given in the appendix.

The certification incentives for a club of a given size and the industry are divergent. If
the loss incurred by all of the producers who cannot get the label exceeds the benefit to the certified producers, the entire industry is worse off. Therefore, if the entire industry can lobby the government and prevent the adoption of a label, no label will be adopted. In the case of the refusal to adopt GIs in the U.S., it seems that some companies are trying to convince the government to reject GIs altogether (Hayes, Lence, and Babcock, 2005).

To determine whether the adoption of a label is socially efficient, we also need to consider the consumer surplus and compare total welfare under all scenarios.

First, if we assume that the cost of full certification is higher than the label-G certification cost \( C > C_g \), for intermediate values of \( C_g \) and for a relatively high fraction of high-quality producers \( \alpha (\alpha > \bar{\alpha}) \) there is overprovision of label-G. To see this, we compare the losses of the producers who did not get the label and the benefit to consumers from being more informed. If the full certification cost is too high, it is socially too costly to adopt full certification, and the choice is between label-G and no certification. If the fraction of high-quality producers is relatively high, the loss incurred by non-labeled producers is borne by more high-quality producers. Therefore, for some values of the label-G cost, the benefit in the consumer surplus does not outweigh the losses of the non-labeled producers. From a society viewpoint, it is thus too costly to inform consumers of the quality of the good.

For intermediate values of both certification costs that are relatively close, there may still be overprovision of the label for a relatively high fraction of high-quality producers \( \alpha \) when the club size not too small \( (n > \bar{n}_1) \).

If we now consider that the cost of full certification is lower than the label-G certification cost, \( C < C_g \), not surprisingly, full revelation of information may be preferred by all of the producers, as well as by society. If not, there may be underprovision of the label: society would prefer more revelation of information, but if it is the club’s decision, not all of the high-quality producers will get the label.

We summarize these findings in the following proposition.

**Proposition 2:** For a relatively high fraction of high quality producers \( \alpha \), there is overprovision of label-G,

- if \( C > C_g \), and for intermediate values of the label-G cost, \( C_g \in (\phi_3, \phi_g) \),
• for intermediate values of the cost \( C \) close enough to \( C_g \), and for a club size that is not too small \((n > \pi_1)\).

Further, whenever there is overprovision of the label, the incentives of the industry and of the club are divergent.

For all of the other configurations of parameters (i.e., for any size smaller than \( \pi_1 \), or for any \( \alpha \)) and costs, society may prefer more revelation of information, whereas no high-quality producers may want to get a label, or the incentives may coincide.

5 Optimal club size and provision of certification

So far we have considered that the club size is exogenously given. In fact, it is endogenously defined and, therefore, we now turn to the determination of the optimal club size.

The rationale for a club is that GIs can be seen as club goods that are non-rival but congestible (many firms can have access to this kind of protection, but if too many of them have access to it, it will decrease the profit of each) and excludable (those who do not have the label are excluded to benefit from it). Hence, each producer derives benefit from joining the club, but the arrival of new members will reduce the benefit. A club is formed if and only if all the potential members agree to its formation.

We first define the optimal size of the club. The net benefit to each member of the club is defined by equation (9). The optimal size is the solution to the following maximization program:

\[
\begin{align*}
\max_n \{ \Pi_g^*(n) - \frac{C_g}{n} \}, \\
\text{with } n \leq \alpha m.
\end{align*}
\]

Because \( \Pi_g^*(n) \) is decreasing and convex in \( n \), we may have several solutions. If we assume a positive interior solution,\(^{16} \) \( n \) must satisfy

\[
\frac{d\Pi_g^*(n)}{dn} + \frac{C_g}{n} = 0,
\]

which we re-write as

\[
n \left| \frac{d\Pi_g^*(n)}{dn} \right| = \frac{C_g}{n}. \tag{10}
\]

\(^{16}\)We also make sure that the second order condition is satisfied (see appendix).
With $n$ producers in the club, if a new member enters, the total costs imposed on the existing members is represented by the term on the left-hand side of equation (10). On the right-hand side, the benefit from a new member is the amount received in additional membership. At the optimum, the total cost imposed on existing members must be equal to the benefit from a new member. Let $n^*$ be the optimal size of the label-G group.

Which firms join the club cannot be determined without more specification about firms. In our setting, because firms are identical it does not matter which one will be part of the club. In a different setting where firms are heterogeneous, for instance, if they are heterogeneous with respect to their “eagerness” to join the club, the most eager producers join the club, and the rest of the high-quality producers have no opportunity to signal their quality. In the case of GIs, the group of high quality producers that precisely defines the quality and location requirements needed to obtain a GI will be the club. Therefore, it is likely that producers within the club are those who originated the GI.

Using equation (8), the first-order condition becomes

$$2s_h q^*(n) \frac{dq^*(n)}{dn} + \frac{C_g}{n^2} = 0.$$ 

Consider now that the entire industry can decide the club size. The efficient outcome is such that it maximizes aggregate profits of the firms in the entire industry. Therefore, the optimization problem becomes

$$\begin{cases} 
\max_n \{n g^*(n) - C_g + (m - n) g^*_a(n), \\
\text{with } n \leq \alpha m.
\end{cases}$$

The optimal size $n^{**}$ is solution of

$$g^*(n) - g^*_a(n) + n \frac{dg^*_a(n)}{dn} + (m - n) \frac{d\Pi^*_a(n)}{dn} = 0.$$ 

By comparing the first-order conditions, we obtain $n^{**} > n^*$. The club size is suboptimal, as from the industry viewpoint, too few high-quality producers are part of the club. The optimal size of the club is not the efficient outcome.

**Lemma 1**: *If a club can be formed, its size is suboptimal from the industry viewpoint.*

If the label-G cost is small enough compared to the full-certification cost, at the optimal level of the industry, $n^{**}$, the label-G regime gives a higher welfare than the full-certification regime. However, at the club level, $n^*$, the welfare is lower under the label-G regime.
So far, we have only defined the optimal size of the club that some producers of high-quality will join. But is this a Nash equilibrium? A club of size $n^*$ is an equilibrium if and only if there is neither a member who wishes to deviate and leave the club, nor a firm outside of the club that wants to get in.

We need to make sure that no deviation occurs, and therefore that each high-quality producer inside and outside of the club has no incentive to deviate. To see this, even though all of our discussion is in terms of continuous values for the club’s size, we provide our rationale in discrete terms. A high-quality producer in the club does not deviate if

$$
\Pi^*_g(n^*) - \frac{C_g}{n^*} \geq \Pi^*_a(n^* - 1),
$$

and a high-quality producer outside of the club chooses not to get into the club if

$$
\Pi^*_a(n^*) \geq \Pi^*_g(n^* + 1) - \frac{C_g}{n^* + 1}.
$$

These two inequalities cannot hold simultaneously, and thus $n^*$ cannot be an equilibrium. Indeed, a high-quality producer inside the club has no incentive to deviate as long as $C_g$ is small enough, whereas a producer outside of the club has an incentive to get into the club.

However, an equilibrium $(\bar{n} - 1)$ exists such that none of the producers deviate:

$$
\Pi^*_g(\bar{n}) - \frac{C_g}{\bar{n}} = \Pi^*_a(\bar{n}).
$$

At $\bar{n}$, a producer outside of the club prefers not to join, whereas a producer inside prefers to leave the club. At $\bar{n} - 1$, a producer outside of the club gets less from joining the club, and a producer inside the club has no incentive to exit. This is an equilibrium. Furthermore, this equilibrium exists only if $C_g > \alpha m(\Pi^*_n - \Pi^*_l) = \kappa_1$ (see appendix). However, if $C_g < \kappa_1$, the equilibrium is the entire group of high-quality producers, $am$.

**Proposition 3:** Under a free-entry condition, there is no equilibrium with a club of optimal size. However, under certain cost conditions, a club of larger size may exist.

If the government lets the club set a barrier to entry, the optimal club size can be reached. The barrier can be such that any producer who wants to join the club after the optimal size has been reached needs to pay an extra fixed cost. This fee can be set at exactly $\Pi^*_g(n^*) - \frac{C_g}{\bar{n}}$. For instance, because of geographical restraint, if one more producer decides to be certified, he
has to buy some land inside the geographical area. In fact, OECD (2000) points out that “the conditions of entry to producer groups with a geographical name are often set out in the group’s own statutes; this leaves it free to set conditions that may not be consistent with the free play of competition.” However, this behavior may be prohibited by law, and some anticompetitive cases have been observed.

We now consider the adoption decision under both the free entry condition and the no free-entry condition.

5.1 No barrier to entry

First, consider that it is prohibited by law to prevent entry. Entry into the club is only restricted by the certification costs. The only equilibrium in this case is \((n - 1)\) if \(C_g > \alpha m(\Pi^*_h - \Pi^*_l)\). If \(C_g < \kappa_1\), the equilibrium is the total number of high-quality producers, \(\alpha m\).

If \(\pi\) exists, because \(\Pi^*_a\) is strictly decreasing in \(n\) and the inequality \(\Pi^* > \Pi^*_g(\pi) - \frac{C_g}{\pi}\) is always satisfied, the high-quality producers prefer not to choose a certification, and thus \(n = 0\). On the other hand, if \(C_g < \kappa_1\), the only optimal size is the entire group of high-quality producers, \(\alpha m\).

Then, for values of \(C_g \in [\kappa_1, \alpha m(\Pi^*_h - \Pi^*_l)]\), high-quality producers choose not to label.

**Proposition 4:** A club with free entry with a size strictly higher than 0 and strictly smaller than \(\alpha m\) is not viable.

This is actually consistent with the literature on club goods, where there is a problem of stability of the equilibrium (see Scotchmer, 2002).

For any certification cost \(C_g \leq \overline{C}\), all the high-quality producers join the club. For \(C_g > \kappa_1\), no high-quality producers join the club. We can thus posit the following proposition:

**Proposition 5:** If the club cannot create a barrier to entry,

- for low enough certification costs, all of the high-quality producers join the club;
- for high certification costs, there is no club and there may be underprovision of the label.
5.2 Barrier to Entry

Let now consider that a barrier to entry can be created. We assume that \textit{ex ante} the optimal club size is defined, and that any extra producer who wants to get into the club has to pay an extra fee, corresponding to the profit earned by each member of the club (or it could be less than that). We can now define the optimal choice of certification.

As before, we need to determine the areas where label-G producers are better off if they get a label. However, here we need to account for the fact that the optimal club size is endogenous and, thus, \( n^* \) depends on \( C_g \). Label-G producers are better off under the label-G regime if \( C_g < \Gamma_g(C_g) \), where \( \Gamma_g \) is now a function of \( C_g \) (see appendix). We show that there exists a value of \( C_g \) such that \( C_g = \Gamma_g(C_g) \). Let \( \overline{C}_g(C) \) denote this value. It first increases with \( C \) and then is a constant. Therefore, for any certification cost \( C_g \leq \overline{C}_g(C) \), \( n^* \) high-quality producers join the club. However, for \( C_g > \overline{C}_g(C) \), no high-quality producers join the club. We can thus posit the following proposition:

**Proposition 6:** If the club can create a barrier to entry,

- for intermediate values of certification costs, a positive optimal club size exists, i.e., \( n^* \in (0, \alpha m) \),
  
  - and for a relatively high fraction of high-quality producers there is overprovision of the label;
  
  - otherwise there is underprovision.

- for higher certification costs, there is no club.

Allowing producers to restrict entry permits some revelation of information. However, it is not always socially optimal, as it may lead to too much labeling.

Furthermore, \( \kappa_1 < \overline{C}_g \) where \( \overline{C}_g \) corresponds to the constant value of \( \overline{C}_g(C) \). For values of \( C_g \in (\kappa_1, \overline{C}_g) \), by letting the club create a barrier to entry, the government allows for more revelation of information. Indeed, in the absence of a barrier to entry, for these values of the certification costs no club will be formed. However, if entry is prevented there will be some
revelation of information, and a club with less than all of the high-quality producers will be formed.

From an antitrust perspective, the creation of barrier to entry can be challenged in court. However, in general those practices that have been observed by competitive authorities were also linked to other practices aimed at restricting production (e.g., in 1998, French competitive authorities denounced abusive practices in the sector of comté cheese, 98-D-54).

6 Conclusion

Advances in information technologies and logistics continue to lower the costs of providing new food products to consumers. These advances have increased the incentive for some growers and processors to implement new certification programs to help them differentiate their output. We analyze the welfare consequences of such certification programs on heterogeneous producers, consumers, and society. Certification costs play a key role in determining the distributional benefits. Relative to the baseline case of no certification program, we find that under a certification program that fully reveals quality, producers of high-quality output will benefit and producers of low-quality output will lose from certification programs. The level of certification costs determines whether the gains to high-quality producers offset the losses to low-quality producers. Both consumers with high willingness to pay and with low willingness to pay gain from certification. Those with high willingness to pay benefit by being able to buy a high-quality product with certainty. Those with low willingness to pay benefit from lower prices for low-quality production. Those with moderate willingness to pay may lose from certification because they now have to pay a high price for a high-quality product, whereas without certification they had a chance at obtaining a high-quality product at a moderate price. We also model a certification program that fully reveals the high-quality product but not the low-quality product with similar welfare consequences, and with certification costs again playing a key role in determining the distributional benefits.

Our findings provide insight into why producer groups often cannot agree on new certification programs that provide consumers with more information. For example, U.S. cattle producers continue to resist implementation of a full traceability system that would provide consumers with knowledge about an animal’s age, breed, and where it was bred, fed, and processed. We show that
the current system that allows mixing of heterogeneous product into a common commodity pool benefits low-quality producers and perhaps the industry as a whole. Even if certification costs are low enough so that the entire industry will benefit from de-commoditization, producers of low-quality cattle could form a blocking coalition, preventing implementation of welfare-increasing certification rules.
References


Appendix

A.1. Production stage

Full-revelation certification regime

Each high-quality firm $i$ chooses $q_{ih}$ that solves

$$\max_{q_{ih}} \{ [1 - q_{ih} - (\alpha m - 1)q_h]s_h - s_l m(1 - \alpha)q_l q_{ih} - \frac{C}{\alpha m} \},$$

where $q_h$ (respectively, $q_l$) is the quantity sold by each other high-quality (respectively, low-quality) producer.

Each low-quality firm $j$ chooses $q_{jl}$ that solves

$$\max_{q_{jl}} \{ [1 - q_{jl} - ((1 - \alpha)m - 1)q_l - \alpha mq_h]s_l q_{jl} \}. $$

The best-response function of each high-quality firm is

$$q_{ih}(q_h, q_l) = \frac{[1 - (1 - \alpha)m q_l]s_h - s_l (1 - \alpha)m q_l}{2s_h},$$

and of each low-quality firm is

$$q_{jl}(q_h, q_l) = \frac{[1 - ((1 - \alpha)m - 1)q_l - \alpha mq_h]}{2}.$$

Because high- (respectively, low-) quality firms are identical, $q_{ih} = q_h$ and $q_{jl} = q_l$, and the best response functions of each high- (respectively, low-) firm, $q_h$ (respectively, $q_l$) to the quantity offered by each low- (respectively, high-) quality firm $q_l$ (respectively, $q_h$) are

$$q_h(q_l) = \frac{s_h - s_l (1 - \alpha)m q_l}{(1 + \alpha m)s_h},$$

$$q_l(q_h) = \frac{1 - \alpha mq_h}{(1 + (1 - \alpha)m)}.$$

Thus, solving for these two equations, we find (4) and (5).

Consumer surplus is given by

$$S = \int_{0}^{\hat{\theta}} (\theta s_l - p_l^*) d\theta + \int_{0}^{1} (\theta s_h - p_h^*) d\theta = m s_h \frac{N}{2D^2},$$

where $N = \alpha^4m^3(s_h - s_l)^2 - 2\alpha^3(s_h - s_l)^2(1 + m)m^2 + \alpha^2(s_h - s_l)m(s_h + m^2(s_h - s_l) + 2m(s_h - 2s_l)) + 2\alpha s_l (-s_h(1 - s_l) + m^2(s_h - s_l)) + s_h s_l (2 - 2s_l + m)$ and $D = (1 + m)s_h + (1 - \alpha)m s_l - (s_h - s_l).$
To compare $S$ and $S^a$, where $S^a = (\alpha s_h + (1 - \alpha) s_l) m^2 / 2 (m + 1)^2$, we calculate

$$S - S^a = -\frac{(1 - \alpha)m}{2D^2 (m+1)^2} \Phi(\alpha),$$

where $\Phi(\alpha) = -\alpha^4 m^5 (s_h - s_l)^3 + \alpha^3 m^2 (s_h - s_l)^2 (s_h (2m + 1) + 2m^2 (s_h - s_l))$

$$- \alpha^2 m^2 (s_h - s_l)^2 (m^3 (s_h - s_l) + s_h (3m + 2m^2 + 2)) + \alpha s_h m (s_h - s_l) (m + 1) (2ms_l - ms_h - s_h) - 2s_l s_h^2 (m + 1)^2 (1 - s_l).$$

In order to show that $S - S^a > 0$, $\Phi(\alpha) < 0$ for $\alpha \in [0, 1]$. For $\alpha = 0$, $\Phi(0) < 0$, $\Phi'(0) < 0$, and $\Phi''(0) < 0$. Further because $\Phi'(\alpha)$ has no real roots between $[0, 1]$, $\Phi(\alpha)$ has no real roots between $[0, 1]$ either, and is negative on $[0, 1]$. Hence, if $\Phi(\alpha) < 0$ for $\alpha \in [0, 1]$, $S > S^a$.

**Label-G regime**

The inverse demand functions for the label-G good and the non-label-G good are

$$p_g(Q_g, Q_a) = [1 - Q_g] s_h - s^g Q_a,$$

$$p_a(Q_g, Q_a) = [1 - Q_g - Q_a] s^a_g,$$

where $Q_g$ represents the total quantity of label-G good produced, and $Q_a$ is the total quantity of good of unknown value.

Let firm $i$ denote one of the label-G good producers, with $i = 1, ..., n$, and firm $j$ being one of the non-label-G producers, with $j = 1, ..., m - n$. The maximization program of each firm $i$ is

$$Max_{q_i} \{ ([1 - q_i - (n - 1)q_g] s_h - s^g (m - n)q_a)q_i - \frac{C_a}{n} \},$$

and of each firm $j$ is

$$Max_{q_j} \{ ([1 - q_j - (m - n - 1)q - nq_g] s^a_g)q_j \}.$$  

The best-response function of each firm within the label-G group is

$$q_i(q_g, q_a) = \frac{[1 - (n - 1)q_g] s_h - s^g (m - n)q_a}{2 s_h},$$

and outside of the group is

$$q_j(q_g, q_a) = \frac{1 - (m - n - 1)q - nq_g}{2}.$$

As firms are identical within the group or outside of the group, $q_i = q_g$ and $q_j = q_a$. The best-response functions of each firm inside (respectively, outside) the group, $q_g$ (respectively, $q_a$)
to the quantity offered by each firm outside (respectively, inside) the group $q_a$ (respectively, $q_g$) are

$$q_g(q_a) = \frac{s_h - s_h^*(m-n)q_a}{(1+m)s_h},$$

$$q_a(q_g) = \frac{1-nq_g}{1+m-n}.$$

Thus, solving for these two equations, we find (6) and (7).

The total consumer’s surplus is

$$S^g(n) = \int_{\theta_a}^{\theta_g} (\theta s^g - p^*_a)d\theta + \int_{\theta_g}^{1} (\theta s_h - p^*_g)d\theta = \frac{N_a}{2D^*_n} m s_h.$$

where $N_a = 2mn(s_h - s_l)(1-\alpha)(a s_h + (1-\alpha)s_l) + mn^2(s_h - s_l)^2(1-\alpha)^2 + s_h(m(a s_h + (1-\alpha)s_l) - n(1-\alpha)(s_h - s_l))$ and $D_a = s_h(1 + m) + mn(1-\alpha)(s_h - s_l)$. The derivative of the surplus is strictly positive. Furthermore, when $n = 0$, the consumer’s surplus is the surplus in case of no certification (i.e., $S^g(0) = S^a$), whereas when $n = \alpha m$, it is the case when the quality is perfectly known (i.e., $S^g(\alpha m) = S$).

A.2. Comparison of the different regimes

Quantities, prices, and gross profits

In terms of output, in a full-revelation regime, a certified high- (non-certified low-) quality producer produces more (less) than any producer in a non-certification regime. In the non-certification regime, the production is based on the average quality, which is the only quality consumers are aware of. Whereas in a certification regime, production is based on the true value of the quality. A label-G (non-label-G) producer produces more (less) than a producer in a non-certification regime and a label-G (non-label-G) producer produces more (more) than a high- (low-) quality producer in the full-revelation regime (i.e., $q_g^* > q_h^* > q_a^* > q_l^*$).

In terms of prices, the price charged by high- (low-) quality producers is higher (lower) than the price charged under the non-certification regime because high-quality producers can charge a higher price for their high-quality goods. The price charged for the label-G (non-label-G) product is higher (lower) than the price charged in a non-certification regime, and the price charged for the label-G (non-label-G) product is higher (higher) than the price charged for the high- (low-) quality product in a full-revelation regime (i.e., $p_g^* > p_h^* > p^* > p^*_a > p^*_l$).

In terms of gross profits, a label-G (non-label-G) producer gets a higher (lower) profit than a producer in a non-certification regime, and a label-G (non-label-G) producer obtains a higher
(higher) profit than a high- (low-) quality producer in a non-certification regime (i.e., $\Pi^*_g \geq \Pi^*_h > \Pi^*_a \geq \Pi^*_l$).

**Non-certification, full-revelation, and label-G regimes**

For a given club size, we study under what conditions a label-G regime will be adopted, and whether the industry and society are better off. Our discussion depends on both the label-G and the full-certification costs, $C_g$ and $C$.

Label-G producers are better off under the full-revelation regime versus the non-certification regime if $\alpha m \Pi^*_h - C > \alpha m \Pi^*$, or equivalently $C < \kappa_1 \equiv \alpha m (\Pi^*_h - \Pi^*)$ (this is actually the same for all of the high-quality producers). Thus, as long as $C > \kappa_1$, we need only to compare the label-G regime and the non-certification regime. Label-G producers are better off under the label-G regime as long as $n \Pi^*_g - C_g > n \Pi^*$, which is equivalent to $C_g < \phi_g \equiv n (\Pi^*_g - \Pi^*)$. For $C < \kappa_1$, they are better off under label-G versus full certification if $n \Pi^*_g - C_g > n \Pi^*_h - \frac{n}{\alpha m} C$ or equivalently $C_g < \varphi_g + \frac{n}{\alpha m} C$ where $\varphi_g \equiv n (\Pi^*_g - \Pi^*_h)$. Hence, overall, label-G makes them better off as long as $C_g < \Gamma_g = \min \{ \phi_g, \varphi_g + \frac{n}{\alpha m} C \}$.

At the level of the entire group of high-quality producers, the label-G regime is appealing less often, as not all of the high-quality producers get in the club, and therefore some of them cannot enjoy the benefit of the label-G regime. If $C > \kappa_1$ high-quality producers are better off under the non-certification regime (compared to the full-revelation regime). Furthermore, they are better off under the label-G regime if $n \Pi^*_g + (am - n) \Pi^*_a - C_g > am \Pi^*$ or $C_g < \phi_1$ where $\phi_1 \equiv \phi_g - (am - n)(\Pi^* - \Pi^*_a)$. However, if $C < \kappa_1$, they are better off under label-G (versus full certification) if $n \Pi^*_g + (am - n) \Pi^*_a - C_g > am \Pi^*_h - C$ or $C_g < \varphi_1 + C$ where $\varphi_1 \equiv \varphi_g - (am - n)(\Pi^*_g - \Pi^*_h)$. Thus, high-quality producers prefer the label-G regime as long as $C_g < \Gamma_1 = \min \{ \phi_1, \varphi_1 + C \}$. As $\phi_1 < \phi_g$ and $\varphi_1 < \varphi_g$, the set of parameters is smaller. Therefore, $\Gamma_1 < \Gamma_g$.

The label-G regime can only be appealing if $\varphi_1 > 0$. If not, the label-G regime is never preferred by high-quality producers. Furthermore, $\varphi_1$ is an increasing and then decreasing function of $n$, with $\varphi_1(0) < 0$ and $\varphi_1(am) = 0$. Thus, there exists a value $n_1 < am$ such that $\varphi_1(n_1) = 0$. Thus $\varphi_1 > 0$ implies that $n > n_1$.

At the level of the industry, all the producers prefer the full-certification regime over the non-certification regime as long as $am \Pi^*_h - C + (1 - \alpha) m \Pi^*_l > m \Pi^*$ or $C < \kappa_2$ where $\kappa_2 \equiv$
\(\kappa_1 - (1-\alpha) m (\Pi^* - \Pi^*_a) < \kappa_1\). For \(C > \kappa_2\), the entire industry is better off with label-G as long as \(n\Pi^*_g + (m-n)\Pi^*_a - C_g > m\Pi^* \) or \(C_g < \phi_2\) where \(\phi_2 = \phi_1 - (1-\alpha) m (\Pi^* - \Pi^*_a) < \phi_1\). On the other hand, for \(C < \kappa_2\), the entire industry is better off under label-G if \(n\Pi^*_g + (m-n)\Pi^*_a - C_g > \alpha m \Pi^*_b - C + (1-\alpha) m \Pi^*_1\) or \(C_g < \varphi_2 + C\) where \(\varphi_2 = \varphi_1 + (1-\alpha) m (\Pi^*_a - \Pi^*_1)\). The function \(\varphi_2\) is first increasing and then decreasing with \(n\) with \(\varphi_2(0) < 0\) and \(\varphi_2(\alpha m) = 0\). There exists a value \(n_2 < \alpha m\) such that \(\varphi_2(n_2) = 0\) with \(n_2 < n_1\). Thus, as long as \(C_g < \Gamma_2 = \min\{\phi_2, \varphi_2 + C\}\) the entire industry is better off. Further, \(\Gamma_2 < \Gamma_g\).

Because consumers’ surplus is increasing with \(n\) and \(n = 0\) (respectively, \(n = \alpha m\)) corresponds to the non-certification (respectively, full-revelation) regime, consumers are worse (respectively, better) off in the case of label-G compared to the full-revelation (respectively, non-certification) regime (i.e., \(S^a < S^g < S\)). The entire society is better off under full revelation versus non-revelation for \(\alpha m \Pi^*_b - C + (1-\alpha) m \Pi^*_1 + S > m \Pi^* + S^a\) or \(C < \kappa_3\) where \(\kappa_3 = \kappa_2 + S - S^a > \kappa_2\). For values of \(C > \kappa_3\), society can benefit from the label-G regime if \(n\Pi^*_g + (m-n)\Pi^*_a - C_g + S^g > m \Pi^* + S^a\) or \(C_g < \phi_3\) where \(\phi_3 = \phi_2 + S^g - S^a\). For \(C < \kappa_3\), society is better off under label-G if \(n\Pi^*_g + (m-n)\Pi^*_a - C_g + S^g > \alpha m \Pi^*_b - C + (1-\alpha) m \Pi^*_1 + S\) or \(C_g < \varphi_3 + C\) where \(\varphi_3 \equiv \varphi_2 + S^g - S\). Thus label-G is preferred for \(C_g < \Gamma_3 = \min\{\phi_3, \varphi_3 + C\}\).

Further, we show that \(\kappa_3 > \phi_3\) which implies that \(\varphi_3 < 0\). To prove that the \(\kappa_3 > \phi_3\), we calculate

\[
\kappa_3 - \phi_3 = -(\alpha m - n)(1-\alpha)(s_h - s_i) m s_h^2 \Psi / (2D^2 D_h^2)\text{ where }\Psi(\alpha) = \alpha^3 m^3 (s_h - s_i)^2 (n - m - 2) + \alpha^2 m^2 (s_h - s_i) (s_h (2n - 4m + 2m^2 + 3mn) + s_h (4m - 2n + 2m^2 - 3mn + 1)) - \alpha m (s_h - s_i) (s_h m (4n - 2m + 3mn - m^2) - s_h (m + 1) (m + n + 3mn - m^2 - 4)) + s_h s_l m (6m + n + 4mn + 2m^2 + 2m^2 n + 4) - s_h^2 m^2 (m + 2) - s_l^2 (m + 1)^2 (2m + mn + 3).
\]

The difference \(\kappa_3 - \phi_3\) is positive if \(\Psi(\alpha) < 0\), and therefore we need to study the function \(\Psi(\alpha)\).

First, note that \(\Psi(0) < 0\), \(\Psi(1) < 0\), and \(\Psi'(\alpha) > 0\) for \(\alpha \in [0, 1]\). Hence, the function \(\Psi(\alpha) < 0\) which proves that \(\kappa_3 > \phi_3\). Hence, as long as \(C < C_g\), the label-G is never preferred by the entire society.

We now show that \(\kappa_2 > 0\). Recall that \(\kappa_2 \equiv \alpha m (\Pi^*_b - \Pi^*_a) - (1-\alpha) m (\Pi^* - \Pi^*_b) > 0\) that can be re-written as \(\kappa_2 = (s_h - s_l) (1-\alpha) m a \Psi_2/[(D (m + 1)]^2\text{ where }\Psi_2(\alpha) = \alpha^3 m^3 (s_h - s_i)^2 - \alpha^2 m^2 (s_h - s_i) (s_h - 2s_l) - \alpha m (s_h - s_l) (3s_h + 4ms_h + 2m^2 s_h + m^2 s_l) + s_h (m + 1) (2s_h + m(3 + m)(s_h - s_l))\).

We can easily calculate that \(\kappa_2(0) = 0 = \kappa_2(1)\). We now need to study \(\kappa_2\) for \(\alpha \in [0, 1]\). To do so, we study the function \(\Psi_2(\alpha)\). Indeed if we show that \(\Psi_2(\alpha) > 0\), then \(\kappa_2 > 0\). First, for the extreme values of \(\alpha\), \(\Psi_2(0) > 0\) and \(\Psi_2(1) = 2s_h^2 (1 + m) > 0\). The derivative of \(\Psi_2(\alpha)\) is such
that $\Psi_2'(\alpha)|_{\alpha=0} < 0$ and $\Psi_2'(\alpha)|_{\alpha=1} < 0$, and furthermore the values of $\alpha$ such that $\Psi_2'(\alpha) = 0$ are outside of $[0, 1]$, that gives $\Psi_2'(\alpha) < 0$ for $\alpha \in (0, 1)$. Hence, the function $\Psi_2(\alpha)$ is strictly decreasing but positive for $\alpha \in (0, 1)$ and we can conclude that $\kappa_2 > 0$.

Using the same kind of reasoning we can also prove that $\kappa_3 > \kappa_1$. Indeed,

$$\kappa_3 - \kappa_1 = -\frac{1 - \alpha}{2(m + 1)D_m^2} \Psi_4$$

where $\Psi_4 = \alpha^4 m^4 (s_h - s_l)^2 - \alpha^3 m^4 (s_h - s_l) ((m + 4)(s_h - s_l) - 2s_l) + \alpha^2 (-m^2 (s_h - s_l) (s_h (4 + 3m) + 2m^2 s_l - 2m^2 (s_h - s_l) (2 + m)) - \alpha m^2 (m^2 s_h^2 (2 + m) + s_h^2 (2m^2 - m + m^3 - 2) + s_h s_l (6 + 5m - 4m^2 - 2m^3)) + s_h (m + 1) (2s_h + 3ms_h + m^2 s_h + 2m^2 s_l)$. We study the function $\Psi_4$, and show that it is negative over $\alpha \in [0, 1]$.

We need to show that $\kappa_1 < \phi_g$ or equivalently that $n(\Pi_g^*(n) - \Pi^*) > \alpha m (\Pi_h^* - \Pi^*)$. The function $n(\Pi_g^*(n) - \Pi^*)$ is increasing and concave on the interval $(0, \alpha m)$. It is strictly increasing and negative at 0, and it is decreasing and equal to $\alpha m (\Pi_h^* - \Pi^*)$ for $n = \alpha m$. Therefore, there exists a unique $n < \alpha m$ such that $n(\Pi_g^*(n) - \Pi^*) = \alpha m (\Pi_h^* - \Pi^*)$, that we denote $\pi_1$. Hence, for any $n > \pi_1$, $\kappa_1 < \phi_g$.

We also need to show that $\phi_3 < \phi_g$, which is equivalent to show that $(m - n)(\Pi^* - \Pi_h^*) - (S^g - S^a) > 0 \iff -\frac{1}{2} H(1 - \alpha)(s_h - s_l)n/(D^2(1 + m)^2) > 0$. This is positive if $H < 0$. $H$ is a quadratic function of $\alpha$, $H = A\alpha^2 + B\alpha + C$ where $A > 0$ and $B - C - A > 0$ for any $n$ as long as the size of the entire industry is not too small or the difference between the qualities is large enough. Therefore, there exists a value $\overline{\alpha} \in (0, 1)$ such that for $\alpha > \overline{\alpha}$, $H < 0$.

To complete our analysis we need to insure that certified firms are making positive payoffs in case of full certification, i.e., $C \leq \alpha m \Pi_h^*$ and in case of label-G regime, i.e., $C_g \leq n \Pi_g^*(n)$. This is equivalent to show that $\kappa_3 \leq \alpha m \Pi_h^*$ and $\varphi_g \leq n \Pi_g^*(n)$. It is immediate to show that the latter inequality is satisfied as $\varphi_g = n(\Pi_g^* - \Pi_h^*)$. Showing that the former inequality is satisfied is equivalent to show that $S - S^a < m \Pi^* - (1 - \alpha)m \Pi^*$, which is in fact satisfied for any $\alpha > \overline{\alpha}$.

We represent the different choices in a graph $(C, C_g)$.
For values of $C_g$ smaller than $\Gamma_i$, $i = g$ for label-G high-quality producers, $i = 1$ for all the high-quality producers, $i = 2$ for the industry, and $i = 3$ for society, the label-G regime is preferred. For values of $C_g$ bigger than $\Gamma_i$ and bigger than $\kappa_i$, no certification is preferred, whereas full revelation is preferred for values of $C_g < \kappa_i$. Thus, we can isolate three areas of interest. Area 1 is where high-quality producers and the industry prefer no certification at all, whereas label-G producers and society would be better off under the label-G regime and full-revelation certification, respectively. This arises for relatively high $C_g$. In area 2, high-quality producers and society would prefer no certification at all, but label-G producers still benefit from the label-G regime. Then, area 3 corresponds to the area where label-G high-quality producers, other high-quality producers, and the entire industry are better off with a label-G regime, whereas society would be better off with a full-revelation certification. If both certifications costs were identical, for low costs, there is under-provision of information. Indeed, high-quality producers are better off with a label-G regime, whereas society would prefer full...
revelation.

Proof of Propositions 1 and 2

Intermediate values of the full-certification cost corresponds to $C \in (\kappa_2, \kappa_1)$. Very high values of the label-G costs correspond to $C_g > \phi_g$, intermediate corresponds to $C_g \in (\phi_2, \phi_g + \frac{n}{m}C)$, whereas low values correspond to $C_g < \phi_2$.

For intermediate values of $C_g$, high-quality producers are better (worse) off if $C_g < \Gamma_1$ ($C_g > \Gamma_1$). For low values of $C_g$, high-quality producers are better (worse) off under the label-G regime only if $C_g < \Gamma_1$ ($C_g > \Gamma_1$). For high full-revelation certification cost, i.e., $C > \kappa_3$, and for intermediate values of the label-G cost, $C_g \in [\phi_3, \phi_g]$, there is over-provision of label-G. Label-G high-quality producers are better off under label-G whereas society and the entire industry are worse off. For intermediate values of label-G costs, i.e., $\Gamma_g > C_g \geq C$, there is under-provision of certification from the society viewpoint.

Club size and equilibrium (Proposition 3)

An equilibrium $\pi_g - 1$ exists only if $C_g > \alpha m(\Pi_h^* - \Pi_l^*)$. Indeed, the function $\Pi_g^*(n) - \frac{C_g}{n} = F(n)$ is first increasing and then decreasing with $n$, reaching an optimal value at $n^*$ and $F(\alpha m) = \Pi_h^* - \frac{C_g}{\alpha m}$. We also need to ensure that the function is convex i.e., $F''(n) < 0$ for $n \leq \alpha m$. This is equivalent to assume that $C_g > n^3d^2\Pi_g^*(n)/dn^2$. The function $\Pi_g^*(n)$ is strictly decreasing with $\Pi_g^*(0) = \Pi^*$ and $\Pi_g^*(\alpha m) = \Pi_l^*$. Thus, either $F(n)$ and $\Pi_g^*(n)$ never cross, cross once, or cross twice. If $\Pi_l^* > \Pi_g^*(n) - \frac{C_g}{\alpha m}$ for any $n$, the two functions never cross and thus there is no equilibrium. On the other hand, if $\Pi_l^* - \frac{C_g}{\alpha m} > \Pi^*$, they cross once, but this is in the increasing part of $F(n)$ and this is not an equilibrium either. Indeed, denote $n$ the value of $n$ such that $F(n) = \Pi_g^*(n)$. If one more producer enters the club, his payoff increases to $F(n + 1)$, and this is enough to show it is not an equilibrium. If $\Pi_l^* > \Pi_h^* - \frac{C_g}{\alpha m}$ or equivalently $C_g > \alpha m(\Pi_h^* - \Pi_l^*)$, the two functions cross twice: once in the increasing part of $F(n)$ and another time in its decreasing part at $\pi_g$. Therefore $\pi_g - 1$ is the equilibrium, as none of the producers have an incentive to deviate from this point.

Label-G choice in the absence of barrier to entry (Propositions 4 and 5)

As long as $C_g > \alpha m(\Pi_h^* - \Pi_l^*)$, the only equilibrium is a club of size $(\bar{\pi} - 1)$. However, this size is not chosen, as high-quality producers can get a higher payoff if they do not get a label, as
\( \Pi^* > \Pi^*_g(\pi) - \frac{C_g}{\pi} \) is always satisfied. Therefore, for \( C_g > \alpha m(\Pi^*_h - \Pi^*) = \kappa_1 \), there is no club, whereas for \( C_g < \kappa_1 \), all of the high-quality producers join the club.

The value of \( C_g \) such that \( C_g = \phi_g(C_g) \) (denoted \( \overline{C}_g \)) is necessarily higher than \( \kappa_1 \). Therefore, there exist values of \( C_g \), i.e., \( C_g \in [\kappa_1, \overline{C}_g] \), for which allowing the club to create a barrier to entry allows for some revelation of information.

**Label-G choice in the presence of barrier to entry (Proposition 6)**

A group of high-quality producers will decide to form a club of size \( n^* \) if it is worthwhile to do it, in other words, as long as \( C_g < \Gamma_g(C_g) \) where \( \Gamma_g(C_g) = \min\{\phi_g(C_g), \varphi_g(C_g) + \frac{n^*(C_g)}{\alpha m} C\} \) with \( \phi_g(C_g) = n^*(C_g)(\Pi^*_g(C_g) - \Pi^*) \) and \( \varphi_g(C_g) = n^*(C_g)(\Pi^*_g(C_g) - \Pi^*_h) \). There exists a value of \( C_g \), denoted \( \overline{C}_g \), for which \( C_g = \phi_g(C_g) \). There exists also a value of \( C_g \) for which \( C_g = \varphi_g(C_g) + Cn^*(C_g)/\alpha m \) that we denote \( \overline{C}_g(C) \). As long as \( C_g < \overline{C}_g(C) \), a club will be formed of size \( n^* \). For higher values, none of the high-quality producers decide to form a club.