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Are Geographical Indications a Worthy Quality Label? A Framework with Endogenous Quality Choice

Marion Desquilbet and Sylvette Monier-Dilhan[1]

Abstract

We analyze the effects of Geographical Indication (GI) labeling on quality choices and welfare with two vertically differentiated goods, one labelable, the other not. We consider two attributes of these goods: gustatory quality and geographical origin. We investigate two extreme cases of the Protected Designation of Origin (PDO) label: a denomination standard, which guarantees only the origin of the product, without any requirement on production specifications; and a minimum quality requirement, which guarantees both the origin and the quality of the product. We find that the PDO good is not necessarily the high-quality good. When it is, the introduction of the denomination standard causes its quality to decrease. Binding production specifications that maintain the quality level of the labeled good adversely affect the PDO firm.

Key words: geographical indication, quality label, endogenous quality choice, product differentiation.

JEL : D21, L15, L13, Q13

Introduction

Third-party standards inform consumers on some quality dimensions of goods, when such information is either costly or inaccessible to consumers due to asymmetric information. Many such standards, both public and private, exist for food products, and cover different types of quality attributes. For example, organic products must comply with production practices defined by public standards. Fair-Trade Labeling Organizations International sets international standards for fair trade covering both trade and production conditions. The Sustainable Agricultural Network (best

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known through the certification trademark Rainforest Alliance) defines social and environmental standards. Mandatory labeling of genetically modified organisms (GMOs) in the European Union ensures consumers that any unlabeled product contains less than 0.9% of GMOs per ingredient.

Our focus in this paper is on a food quality standard, the European Protected Designation of Origin (PDO), which differs from all the aforementioned standards in that it is designed to signal a more immaterial dimension of quality, namely “terroir” - meaning some tradition, authenticity and typicity derived from a combination of natural conditions (soil, climate…) and accumulated know-how in a given place of origin. As defined by EU Regulation 510/2006, the PDO standard designates a product originating from a specific region, and "*the quality or characteristics of which are essentially or exclusively due to a particular geographical environment with its inherent natural and human factors, and the production, processing and preparation of which take place in the defined geographical area*". How this standard should be met in practice is not described in the EU regulation. Details on its implementation are defined in product specifications, which are different for each of the European PDOs (there are currently over 500). In practice, this legal framework allows for a lot of flexibility on production and processing rules. A recurring element of the general debate about geographical indications (GIs) is whether, in short, they are a relevant quality signal or an abusive rent for producers (see notably Josling, 2006).

The preamble to the EU Regulation gives the political view of Europe on this matter, stating that PDO protection is beneficial both for consumers and producers: For consumers, by giving them information regarding the origin of products and by making available high-quality products with guarantees as to the method of production and origin; for producers, by helping to secure higher incomes in return for a genuine effort to improve quality, and by retaining rural population in less-favored or remote areas. In practice, the way the PDO system is applied does not appear to guarantee a link between a geographical name and high quality (Lucatelli, 2000). Benefits for consumers depend on the extent to which natural factors and accumulated know-how in the place of origin actually do confer some specific quality attributes on products; the extent to which the reputation provided by GIs help producers to improve their quality; and the extent to which consumers intrinsically value the fact that production took place in a given area with given methods of production, independent of the quality attained. In the worst-case scenario, where no pre-established link exists between quality and territory and where producers granted with a GI do not undertake genuine efforts to improve quality, consumers may be misled by the label, which could wrongly suggest to them that localization confers special qualities on the product, while it actually just helps producers in the agro-food chain to capture undue rents.

In the theoretical economic literature, GIs are usually modeled as a signal of high quality in a vertical differentiation context. In some papers, the high quality of the GI good is exogenous and its existence precedes that of the label. The GI certification aims at informing consumers on this quality level, which they cannot assess in the absence of this label (Marette, Crespi and Schiavina, 1999; Marette and Crespi, 2003; Zago and Pick, 2004). Alternatively, some authors assume that GI producers have the ability to produce an exogenously high level of quality only if they invest the fixed costs of quality improvement. Given imperfect information, the GI standard gives them the incentive to invest in quality (Lence et al., 2007; Mérel, 2009). In other papers, GI producers face a competitive market of low-quality products and strategically choose the high quality level of the GI product (Moschini, Menapace and Pick, 2008; Bouamra-Mechemache and Chaaban, 2010; Mérel and Sexton, 2012). Finally, Menapace and Moschini (2012) use a dynamic model of reputation with endogenous quality choice in competitive markets. Producers within a region with distinctive “terroir” features may use GI certification and/or private trademarks in order to establish a reputation of high quality. They compete with producers using a standard technology, who may only use private trademarks.

This literature addresses the welfare implications of GI labeling in a context of asymmetric information (for a survey, see Teuber, Anders and Langinier, 2011). Some studies investigate GIs as a way of direct or indirect supply control. They find that allowing GI producers to collude may improve general welfare by enabling these producers to cover the fixed costs of quality development and certification (Marette, Crespi and Schiavina, 1999; Marette and Crespi, 2003; Zago and Pick, 2004; Lence et al., 2007; Mérel, 2009). Bouamra-Mechemache and Chaaban (2010) investigate whether producers with a quality advantage should collectively choose a GI certification (modeled as entailing variable certification costs) or a private common label (entailing fixed certification costs). Moschini, Menapace and Pick (2008) differ in their approach, by showing that GI labeling is compatible with a competitive provision of quality with free entry. In this competitive context, they also find that GI labeling may improve welfare. Mérel and Sexton (2012) investigate a situation in which GI producers are able to collude on quality choice, but not on quantities. They find that GI producers may end up supplying a higher level of quality than the welfare-maximizing one. Menapace and Moschini (2012) show that GI certification, acting as a tool for collective reputation, improves welfare compared with a situation where only private trademarks would be available for firms.

In this paper, we aim to provide additional insights on the assumption, on which all the aforementioned models are based, namely that there is a positive link between GIs and high quality. In order to do so, we step back from the sophisticated level on which some issues, such as direct versus indirect supply control or dynamic reputation, have been addressed in this literature. However, rather than assuming a direct positive link between "terroir" and high quality, we bring additional complexity in the link between territory and quality, both in terms of consumer preferences and firm technology.

With this in mind, our paper borrows some insights from that of Crampes and Hollander

(1995a) on denomination or appellation standards. Their paper builds on a stylized fact about the harmonization of the standard for gold in the EU, which has led France to reduce the number of karats that a metal has to contain in order to be called “gold”. The authors examine how relaxing this standard affects producers and consumers. They model the appellation standard as certifying that quality is at least equal to a given threshold. They adopt a vertical differentiation framework where consumers value the intrinsic quality level of the good they consume, as well as the presence of a label on this good, and where a firm that has adopted the standard competes with a low-quality firm that has not. The authors show that relaxing the denomination standard benefits high-quality producers. As in their model, we adopt here some assumptions on how consumers derive utility from both the existence of the PDO label signaling where the product originates from, and the actual taste of the product. Our paper also relates to the analysis of Chambolle and Giraud-Héraud (2005), who model quality choices by two firms, one of which can adopt a label of origin, while the other cannot. Their analysis differs from ours in that they assume that the labeled firm must commit itself to quantity restrictions in order to benefit from the label (we do not model any capacity constraint linked with PDO labeling). More generally, our article builds on the industrial organization literature on endogenous quality choice (notably Cremer and Thisse, 1994; Motta, 1993; Lambertini, 1996).

In our model, drawing from this literature, we derive endogenous quality choice both by a firm that may pretend to PDO labeling and by one which cannot put forward the necessary traditional know-how to benefit from PDO labeling. We compare equilibria with no label and with a PDO label, distinguishing between two extreme cases: either the PDO label only guarantees the origin of the product; or it guarantees both the origin and the final quality of the product. We also analyze an extension of this duopoly model in which producer organizations choose the quality for each good and in which a competitive equilibrium with atomistic producers arises once qualities are chosen.

Do PDO product specifications reflect terroir attributes? The examples of the comté and cantal French cheeses

EU Regulation 510/2006 stipulates that each PDO must comply with a product specification that should include details which bear out the link between the quality or characteristics of the product and the particular geographical environment it originates from, with its inherent natural and human factors. In practice, PDOs are very heterogeneous with respect to the content and the degree of precision of their product specifications. A reason for this heterogeneity is that each product specification reflects a local balance of power, as the decision process for PDO creation or evolution devotes a central place to professional organizations (Ansaloni and Fouilleux, 2008). Below we illustrate this heterogeneity of product specifications, through time and between products, with the example of two French AOC cheeses, comté and cantal.[1] Comté dominates AOC cheese sales in France by far, with 25% of volumes sold on that market in 2010. Cantal is the fourth French AOC cheese with almost 8% in 2010 (INAO/CNAOL, 2011).[2] Both cheeses are regional products with very ancient origins (comté, from the East of France, and cantal, from the center of France). Both were recognized as AOC by courts in the 1950s after their local craft unions respectively initiated lawsuits against grocers selling cheeses, which originated from outside the traditional production area, as “comté” and “cantal”.

The 1952 court decision for comté, which put forward evidence of the long tradition of comté production in the region, delimitated the area of authorized production and specified that AOC comté cheese should be produced in accordance with local, loyal and consistent customs; and notably also come from local cow breeds, fed according to customs codified in the statutes of the local cheese dairies. The initial decree of the Comté AOC, published in 1958, imposed only the area of authorized production and the condition that it should be produced “in accordance with local, loyal and consistent customs”. Gradually, other rules have been introduced on milk production and processing, as summarized in the Appendix (Table A1).

The main current rules for milk production are the obligation to use local cow breeds; the prohibition of the use of silage; a limitation on livestock and milk production per hectare; and a limitation on feed concentrate. For processing, the main current rules are the obligation to collect milk near the production point and the duration of cheese ripening.

Colinet et al. (2006) provide a detailed analysis of this product specification. In short, currently the obligations imposed by the comté PDO specification do not appear to be very restrictive for farmers. In fact, on the whole, the levels of compliance observed in the PDO area remain well within the requirements of the regulation, just as much for the producers of comté milk as for local producers of other milks. Thus, the product specification records and sets the rules of production of the existing regional extensive dairy farming model.

The first decree of the cantal AOC was published in 1980, long after a 1956 court decision recognized the AOC. This decree only instituted a minimum of 45 days of cheese ripening (decreased to 30 days in 1986) and a few details concerning the temperature and length of certain manufacturing stages (INAO, 1980 and 1986). Yet, the 1956 court decision that ruled in favor of the cantal AOC insisted on the significance of every constitutive detail of the cantal terroir, notably the volcanic ground, the special local flora, the rustic cow breeds, the transhumance and estive, and the traditional manufacturing (see the appendix Table A2). A new specification, adopted in 2007 after a lengthy process and under pressure from the French institute for AOCs, instituted a series of precise rules at the production, processing and ripening stages. The specifications are not completely in line with the initial description of the cantal terroir in the 1956 court ruling. Dairy and cheese production practices in the area have actually evolved a lot in the meantime, and no longer match the initial description of the cantal terroir. Cantal milk production, initially limited to the mountain area during estive, has developed in a peneplain area contained in the AOC area, with more intensive milk production methods based on corn silage; intensive Holstein cattle has partly replaced the initial Salers and Aubrac rustic breeds; while processing has industrialized (Colinet et al., 2007).

A detailed evaluation of the extent to which the comté and cantal decrees have been and are currently binding for local farms, and the extent to which required specifications confer special characteristics on the final product, is beyond the scope of this paper. For the purpose of our analysis, it is of interest to point out two elements shown by that these examples. First, the restrictiveness of production/processing specifications varies among PDOs and across time for a given PDO. Second, while the EU PDO Regulation requires that the quality or characteristics of the PDO product are *"essentially or exclusively due to a particular geographical environment with its inherent natural and human factors*", our examples show that the extent to which actual PDO specifications convey a specific terroir varies in practice.

Theoretical framework and benchmark equilibrium with no labeling

We adopt a model that draws on standard features of the vertical differentiation literature. We consider two goods: a "labelable" good, denoted *a*, which may pretend to PDO labeling; and a "non-labelable" good, denoted *b*, for which no PDO labeling is possible. The economic literature assumes either that both the high and low quality levels are exogenous (Marette, Crespi and Schiavina, 1999; Zago and Pick, 2004), or that only the high quality (enjoying a GI) is endogenous (Moschini, Menapace and Pick, 2008; Menapace and Moschini, 2012; Mérel and Sexton, 2012). In our framework we assume that the quality levels of both labelable and non-labelable goods are endogenous. For our purpose, we consider two extreme alternative implementations of the PDO label. We call the PDO label a "denomination standard" (DS) if PDO specifications require that every production step takes place within a given area, but do not induce any effective quality constraint. Therefore, the labelable good may be granted a denomination standard label whatever its quality level, departing from the usual assumption that the PDO label signals a high level of quality. Alternatively, we call the PDO label a "minimum quality requirement" (MQR) when PDO specifications impose both local production and binding quality requirements, so that the final product meets at least some given quality level.

In models on geographical indications, typically the quality level is one-dimensional and the high-quality good is a credence good.[3] We distinguish two attributes of goods: gustatory quality and geographic origin. Gustatory quality of good *i* is a one-dimensional continuous vertical attribute labeled by q_i (the higher q_i, the better the taste of good *i*). In the usual classification of search, experience or credence attributes (Nelson 1970, Darby and Karni 1973), taste is typically an experience attribute, known only after purchase. However, for a product purchased repeatedly, which is the usual case with food products, consumers have an idea of its taste before purchase (as long as the product is identifiable, for example by trademark, and its taste is stable enough over time). In our one-period model, we handle this gustatory quality as a search attribute (detected before purchase). We leave out any informational problems related to this gustatory quality, assuming, as in Menapace and Moschini (2012), that firms can identify their products by trademarks at no cost. By contrast, we assume that consumers are not able to discern whether the good originates from a particular area and, therefore, the attribute of geographic origin is a credence attribute, which can be revealed only by public labeling.

Consumers purchase a single unit of one of the two goods, or nothing. Their utility is additive in the two attributes of the good. They differ in the intensity of their preference for gustatory quality, measured by a parameter θ distributed uniformly on the interval $[\underline{\theta}, \bar{\theta}]$, with $\bar{\theta} = \underline{\theta} + 1$.

They have identical preferences for geographical origin, measured by a same parameter g for all consumers. The utility derived from a positive consumption of one of the two goods is given by:

(1) $U_\theta(q_i, p_i, L) = \theta q_i + g\, L - p_i$,

where L is a dummy variable defined as:

$$L = \begin{cases} 1 & \text{for the labelable good if it is labeled as PDO,} \\ 0 & \text{otherwise.} \end{cases}$$

This formulation assumes that consumers value the origin of the labelable good only if the origin is certain, that is, if this good is actually labeled. Analogously to Crampes and Hollander (1995a), we assume that all consumers derive the same utility from the origin; but contrary to these authors, in order to simplify matters, we do not assume that the utility attached to the origin depends on the gustatory quality of the good. Contrary to the usual assumption of the literature on geographical indications, we assume here that consumers attach an intrinsic utility to the origin of the good. This assumption conveys the idea that the PDO label has acquired a collective reputation through time, which may confer some "status" characteristic on a good bearing this label.[4] Alternatively, it may be viewed as consumers being altruistic and considering PDO purchase as contributing to a public good, such as the maintenance of rural activity and traditional production (although we do not model such a public good in our welfare function).

For tractability reasons, we adopt the usual assumption of the literature on endogenous quality choices, namely that there exists only one producer of each good, with both firms playing a two-stage game, choosing quality levels first, and then prices. Besides, we make no a priori assumption on which firm produces the low or the high quality good. In models on geographical indications, the considered producers are usually farmers who behave competitively. In this literature, PDO producers are capable of collectively choosing the quality level of the PDO product. They do not have the power to set prices, but they may have the power to control supply, either directly or indirectly, by controlling the amount of farmland or by introducing production practices that reduce output (such as stipulating maximum yields, or the maximum stocking rate of cows per hectare…). Our assumption of one firm per product, with strategic behavior both with and without labeling, applies to the processing stage of PDOs, where there is often market power, rather than to the farm stage. In that sense, our model can be viewed as an extreme case, in which processors have integrated farmers vertically. We relax our duopoly assumption in the last section, in which we simulate a game with competition at the second stage.

To be able to reach analytical solutions in our model, we first study the case in which the market is covered and in which both firms have identical cost functions.[5] We assume that fixed costs of production are zero, while variable costs of production are constant in quantity (x_i) and quadratic in quality (q_i):

(2) $C_i(x_i, q_i) = c\, q_i^2\, x_i$

where c is the cost parameter.[6]

In order to assess the robustness of our findings, we then use simulations to analyze the case of an uncovered market, possibly with a cost disadvantage for the firm producing the non-labelable good. When it exists, we assume that this cost disadvantage occurs through a fixed cost born by firm b only. This fixed cost (f) may be thought of as an investment cost to acquire knowledge about how to produce the high-quality good or dedicated infrastructures.[7] In this extension, the total cost function for firm b is written as:

(3) $C_b(x_b, q_b) = (c\, x_b + f)\, q_b^2$.

We now analyze the benchmark equilibrium in which the labelable good is not labeled, with a covered market and symmetric cost functions. In the absence of labeling, consumers get no utility from the origin attribute. Results of this benchmark case are identical to those derived by Cremer and Thisse (1994) and Lambertini (1996).

Consumer θ gets a utility θq_i - p_i when consuming good i = {l, h}, where indexes l and h denote respectively the low and the high qualities. The consumer that is indifferent between the low-quality or the high-quality product is characterized by $\tilde{\theta} = \frac{p_h - p_l}{q_h - q_l}$. When the market is covered, the demand for the low-quality product is $\tilde{\theta} - \underline{\theta}$ while the demand for the high-quality product is $\bar{\theta} - \tilde{\theta}$. There exist two duopoly equilibria with a covered market generated by switching the role of both firms (depending on whether the labelable good is the high-quality or the low-quality good). In equilibrium, we obtain the standard results of the literature (Cremer and Thisse, 1994; Lambertini, 1996), stating that the market is differentiated, and that both firms sell the same quantities and obtain the same profit (Table 1). These results hold as long as $\underline{\theta} > \frac{p_l^0}{q_l^0}$, or equivalently, $\underline{\theta} > \frac{5}{4}$ (covered market condition).

Insert Table 1.

This symmetry in equilibrium quantities and profits follows from the covered market assumption and is lost when we simulate the case of an uncovered market. In these simulations, we assume that $\underline{\theta} = 0$ and $c = \frac{1}{2}$, and we make three alternative assumptions on the cost disadvantage for firm b: the firm producing the non-labelable good has no cost disadvantage (f = 0, table A3 in the Appendix), a small cost disadvantage ($f = \frac{1}{50}$, table A4) or a high cost disadvantage ($f = \frac{1}{10}$, table A5). In these simulations, we obtain the intuitive result that when this cost disadvantage is absent or low, two duopoly equilibria exist, with the labelable good being either the high-quality or the low-quality good; while there is only one equilibrium, in which the labelable good is the high-quality good, when its rival incurs a high cost disadvantage.

PDO Labeling by a Denomination Standard

We now turn to the equilibrium with labeling by first examining the case of the denomination standard, where the PDO label only indicates the geographical origin, while product specifications stating how the PDO good must be produced do not impose any effective production constraint. We assume that when choosing to certify its product, the firm producing the labelable good incurs a fixed cost of certification F^{DS}, which we model as independent of the quality level.[8]

From equation (1), the utility from consuming the labeled good is $\theta\, q_a + g$, while the utility from consuming the non-labeled good is $\theta\, q_b$. The marginal consumer who is indifferent between the two goods, is characterized by $\tilde{\theta}^{DS} = \frac{p_a - p_b - g}{q_a - q_b}$. Proposition 1 below describes the effects of labeling (proof is given in the Appendix and equilibrium values are described in table 2).

Proposition 1. Denomination standard versus no labeling

- *Assume that the following conditions hold:*
    - *It is profitable for firm a to label its good:* $F^{DS} < \frac{g(16c\,g+18)}{27}$,
    - *The market is covered:* $\theta^2 > 1 + (\frac{9-16cg}{12})^2$,
    - *At equilibrium both firms operate on the market:* $16\,c\,g < 9$.

Then,

1.A. Two alternative duopoly equilibria with labeling may emerge, depending on whether the labeled good is the high-quality good or the low-quality good. If the labelable good is the high-quality good, the introduction of a denomination standard lowers quality levels and prices. Opposite effects are obtained if the labelable good is the low-quality good.

1.B. The introduction of a denomination standard causes the profit of the non-PDO firm to decrease whereas the profit of the PDO firm increases. Consumers' surplus increases. Total welfare increases.

- *The results 1.A and 1.B hold when the market is non-covered with* $\underline{\theta} = 0$, $c = \frac{1}{2}$, $g = \frac{1}{50}$ *and* $f \in \left[0, \frac{1}{50}, \frac{1}{10}\right]$, *except that if the cost disadvantage is high* ($f = \frac{1}{10}$), *only the duopoly equilibrium with the high quality labeled good emerges.*

Insert Table 2.

Labeling increases the utility provided by the labelable good without changing its production cost function. The first effect is to shift out the demand curve for the labelable good while shifting in the demand curve for the non-labelable good. Therefore, we obtain the intuitive result that the profit of the PDO firm increases while the profit of the non-PDO firm decreases with the introduction of the PDO label, with an increase in total profit. With the assumption that prior to labeling, consumers derive no utility to the origin of the labelable good, logically their surplus increases with labeling introduction, and total welfare increases too.

The denomination standard is a signal of origin, but does not impose a quality standard. In this setting, we find that there is a priori no reason for the labeled good to be of a higher or a lower gustatory quality than the non-labeled good, except if the firm producing the non-labelable good bears a high disadvantage cost ($f = \frac{1}{10}$). This is in contrast with usual assumption of the literature that the PDO good is necessarily a high-quality good. This is also in contrast with the Preamble of the European PDO regulation, which, as mentioned in the introduction, associates a notion of high quality with the PDO. Besides, we obtain that gustatory qualities are lowered by the label introduction when the PDO good is the high-quality good. This result once again contradicts the preamble of the European PDO regulation, which views the PDO as encouraging quality improvement for producers.

The intuition for gustatory quality effects in Proposition 1 is as follows: As labeling is introduced, consumers derive utility from the geographical origin. This induces the firm producing the labeled good to relax its differentiation with the other firm with respect to the other attribute, that is, gustatory quality. Bringing its gustatory quality closer to that of the other firm results in a smaller q_a when $q_a > q_b$, and a greater q_a when $q_a < q_b$. On the contrary, the firm producing the non-labeled good has an incentive to maintain its gustatory quality differentiation with the other firm, as consumers value only the gustatory quality of the non-labeled good. Preserving this differentiation results in a drop in q_b when $q_a > q_b$ and an increase of q_b when $q_a < q_b$.

Figure 1 illustrates these behaviors in terms of shifts in first-stage reaction functions, which show how each firm determines its optimal quality level, given the quality level chosen by the other firm (the analytical expressions of these reaction functions are given in the appendix). If the labelable good is the high-quality good ($q_a>q_b$), the introduction of labeling causes both reaction functions to shift in, and the equilibrium to feature lower qualities for both goods. On the contrary, if the labelable good is the low-quality good ($q_a<q_b$), the introduction of labeling causes both reaction functions to shift out, and the equilibrium to exhibit higher qualities for both goods.

Insert figure 1.

PDO Labeling with a Minimum Quality Requirement

Actual PDO certification guarantees the fulfillment of requirements on production methods, but not output quality. We study here the extreme case where all production practices have to be maintained on at least their initial level when the PDO label is introduced; thereby assuring that the PDO labeling does not lower the quality level. In this particular case, the PDO specifications on production methods are equivalent to a minimum quality requirement. Therefore, in this section, we assume that the PDO firm gets the PDO label only if its quality level is at least the quality of the no-label case. We study the case where the labelable good is the high-quality good, because it is the only case where the minimum quality requirement is binding. The firm producing the labelable good incurs a fixed cost of certification, independent of the quality level, denoted F^{MQR}. We assume that $F^{MQR} > F^{DS}$*:* it is more costly to certify both production specifications and geographical origin than to certify origin only. Proposition 2 compares the equilibrium with a minimum quality requirement to the equilibrium with denomination standard. Our results are described in Table 2.

Proposition 2. Minimum quality requirement versus denomination standard

- *Assume that the following conditions hold:*
  - *The PDO firm gets a higher profit level with the MQR than in the absence of label*: $F^{MQR} < \frac{576\, cg - 729 + (27+64\, c\, g)\sqrt{81+192\, c\, g}}{5184\, c}$.
  - *The market is covered:* $8\left[8\, c\, g(\bar{\theta}-1) + 3\bar{\theta}(\bar{\theta}-2)\left(\sqrt{81+192\, c\, g} - 6\,\bar{\theta}\right) > 81(\bar{\theta}-1)\right]$,
  - *At equilibrium both firms operate on the market: 64 c g < 81,*

2.A The quality level of the non-PDO good is higher with a minimum quality requirement than with a denomination standard.

2.B The profit of the PDO firm, consumer surplus and total welfare are lower with a minimum quality requirement than with a denomination standard. When the intensity of preferences for the origin is small enough (24 c g < 9), the non-PDO firm obtains a higher profit with a minimum quality requirement than with a denomination standard; otherwise, comparison of profit levels is indeterminate.

- *Assume now that the market is non-covered with* $\underline{\theta} = 0$, $c = \frac{1}{2}$, $g = \frac{1}{50}$ *and* $f = \left[0, \frac{1}{50}, \frac{1}{10}\right]$*:* *The former results still hold, except that consumer surplus is higher with a minimum quality requirement than with a denomination standard, when the non-labelable firm bears a disadvantage cost (*$f = \frac{1}{50}, \frac{1}{10}$*).*

In order to benefit from the geographical indication, the labelable firm now has to meet the minimum standard requirements. This leads to an increase of its own quality level and also of the quality level of the non labelable firm, compared with the case of the denomination standard. A main result for our purpose is that the firm producing the labeled good has no interest in this strengthening of the quality requirement. This result reinforces the findings of Crampes and Hollander (1995a). These authors study the effects of changing the requirement level for a denomination standard already in use. They find that an increase in the minimum quality requirement causes the profit of the firm that already met the standard to decrease. From the consumer's point of view, they find that all consumers lose from a strengthening in the standard; we obtain the analogous result that consumer surplus is smaller if production requirements for the PDO label are binding when the two firms have the same cost function. Nevertheless, we show that consumers can be better off with a minimum quality requirement than with a denomination standard when the market is uncovered and the non-labelable firm bears a cost disadvantage.[9]

Our result that the PDO firm obtains a lower profit level with a minimum quality requirement than with a denomination standard appears to contradict the observation that some PDO producer associations reinforce their product specifications through time (as detailed above for the examples of comté and cantal). A possible explanation for this apparent contradiction is that the reinforcement of product specifications observed for some PDOs does not necessarily aim at improving the final quality of the product. As stressed by Menapace and Moschini (2012), certification improves the ability of reputation to operate as a mechanism for assuring quality. Actual reinforcements of product specifications may aim at improving the image of the product (so long as consumers know about these changes, which may be the case through communication and advertising), thereby acting on the parameter g, which describes the utility attached to the PDO label of the product, rather than on the utility attached to its gustatory quality. An increase in g resulting from the shift from a denomination standard to a minimum quality requirement may raise the profit of the labeled firm.[10] The increase in g also benefits the consumers. Alternatively, in line with the arguments developed by Lence et al. (2007) or Mérel (2009) for example, actual reinforcements of product specifications may aim at helping direct or indirect supply control (which is not modeled here). In particular, this may currently be the case for PDO producers of dairy products in the European Union, in order to counteract the effects of the abolition of milk quotas. For example, for cantal, limitations on concentrates may exclude some intensive farms (see Table A2).

Alternative framework with atomistic producers

Our assumption of duopoly is relevant for some PDO processing stages; however, a competitive setting may be more adequate for other PDOs. Here we relax the duopoly assumption and consider an alternative setting based on Mérel and Sexton (2012). We assume that two producer organizations set the gustatory quality of each good in the first stage of the game; in the second stage, within each producer organization, identical atomistic producers choose their quantities.

For producers to obtain rents in this context, marginal costs must increase with quantities. Additionally, to obtain finite quality levels, the elasticity of total cost with respect to quality must be higher than its elasticity with respect to quantity (see Proposition 1 in Mérel and Sexton, 2012). We choose the following total cost function for good i, which satisfies both properties:

(4) $C_i(x_i, q_i) = c\, q_i^3\, x_i^2$.

We simulate the equilibria with no labeling, with a denomination standard and with a minimum quality requirement, assuming that $\underline{\theta} = 0$, $c = \frac{1}{2}$ and $g = \frac{1}{50}$. The results are shown in table A6. We find that all the results obtained in propositions 1 and 2 with a covered market still hold. In other words, our results are robust to the assumption of competitive *versus* strategic behavior at the second stage of the game in these simulations.

Conclusion

This paper analyzes the effects of PDO labeling when quality choices are endogenous and when no a priori assumption is made regarding the relative quality levels of the labelable and non-labelable goods. Our model distinguishes two attributes of goods: gustatory quality and geographic origin.

We find that the labeled good may be the high-quality or the low-quality good. This result gives an additional perspective on PDOs when compared with the theoretical literature, which usually assumes that PDO is a high quality label. Geographical indication may encourage or discourage quality improvement. If the labelable good is the high-quality one, the introduction of labeling causes its quality level to decrease if the regulator authorizes PDO labeling without imposing product specifications that introduce binding requirements on the quality level. The introduction of a denomination standard is a source of profit for the PDO firm and welfare gains for consumers, whereas the non-PDO firm is worse off. When such a PDO labeling is already in use, the PDO firm loses if a binding minimum quality requirement is introduced; unless this new regulation increases the utility consumers derive from the geographic origin. These results are robust to the alternative assumption of uncovered market. They also hold with a cost disadvantage for the firm producing the non-labelable good (except that when this cost disadvantage is high, the PDO firm is necessarily the high-quality producer). They are also robust to the alternative assumption of a competitive framework at the second stage of the game.

In accordance with the view developed by European regulators in the PDO legislation, theoretical economic models have so far considered GIs as a high-quality label. Yet, and probably more so than for any other food label, PDO products are very heterogeneous, in the sense that product specifications associated with the label are uniquely defined for each PDO product. Therefore, while every GI indicates an origin, the information provided on gustatory quality is far more diverse. We aimed at illustrating this heterogeneity by building a model in which different PDO quality levels may emerge in equilibrium. A main feature of this model is that it distinguishes the origin and quality attributes of PDO goods. The origin attribute is kept simple here: we assume that every consumer gives the same valuation to the origin of the labeled good, whatever its gustatory quality. Further insights on the PDOs could probably be obtained with more complex and realistic assumptions on consumers' preferences with regard to the origin, where the higher the quality level, the more consumers value the geographic origin, and/or where valuations of origin differ among consumers.

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Table 1. Duopoly Equilibrium without a geographical indication

q_h^0	$\frac{4\bar{\theta}+1}{8\,c}$
q_l^0	$\frac{4\bar{\theta}-\ 5}{8\,c}$
p_h^0	$\frac{(4\bar{\theta}+1)^2+\ 24}{64\,c}$
p_l^0	$\frac{(4\bar{\theta}-\ 5)^2+\ 24}{64\,c}$
$\tilde{\theta}^0$	$\bar{\theta}-\frac{1}{2}$
Consumer Surplus CS^0	$\frac{16\bar{\theta}\ (\bar{\theta}-1)-\ 23}{64\,c}$
Profit π_h^0	$\frac{3}{16c}$
Profit π_l^0	$\frac{3}{16c}$
Total Welfare W^0	$\frac{16\bar{\theta}\ (\bar{\theta}-1)+\ 1}{64\,c}$

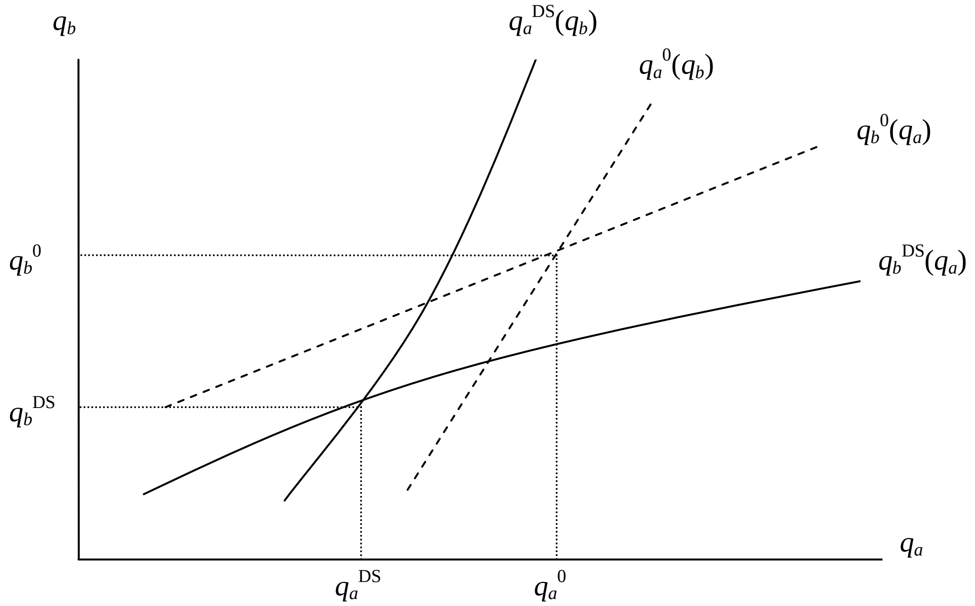
Note: There exist two symmetric equilibria, depending on whether product *a* is of high quality (*h*) or of low quality (*l*). The superscript 0 denotes the equilibrium value.

Table 2. Duopoly Equilibria with a Geographical Indication

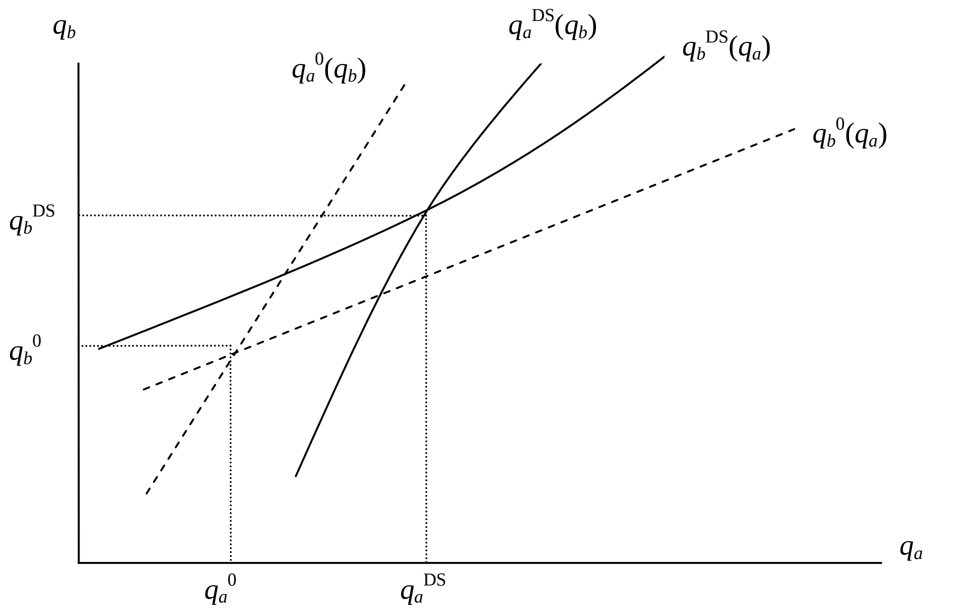
	Denomination Standard, $q_a < q_b$	Denomination Standard, $q_a > q_b$	Minimum Quality Requirement
q_a	$q_l^0 + \frac{2}{3} g$	$q_h^0 - \frac{2}{3} g$	q_h^0
q_b	$q_h^0 + \frac{2}{3} g$	$q_l^0 - \frac{2}{3} g$	$q_l^0 - \frac{\sqrt{81+192cg}-9}{24c} > q_b^{DS}$
p_a	$p_l^0 + \frac{g}{18}(12\bar{\theta} + 8cg - 3)$	$p_h^0 - \frac{g}{18}(12\bar{\theta} - 8cg - 9)$	$p_h^0 + \frac{4g}{9} + \frac{\sqrt{81+192cg}-9}{48c}$
p_b	$p_h^0 + \frac{g}{18}(12\bar{\theta} + 8cg - 9)$	$p_l^0 - \frac{g}{18}(12\bar{\theta} - 8cg - 3)$	$p_h^0 - \frac{g}{9} - \frac{(\bar{\theta}-1)(\sqrt{81+192cg}-9)}{24c}$
$\tilde{\theta}$	$\tilde{\theta}^{\circ} + \frac{8}{9} c\, g$	$\tilde{\theta}^{\circ} - \frac{8}{9} c\, g$	$\tilde{\theta}^{\circ} - \frac{\sqrt{81+192cg}-9}{18}$
Consumer Surplus CS	$CS^0 + \frac{g}{54}(27 - 8\, cg)$	$CS^0 + \frac{g}{54}(27 - 8\, cg)$	$CS^0 + \frac{g}{3} + \frac{(64\, cg - 81)(\sqrt{81+192cg}-9)}{5184c}$
Profit π_a	$\pi^0 + \frac{g(16cg+18)}{27} - F^{DS}$	$\pi^0 + \frac{g(16cg+18)}{27} - F^{DS}$	$\pi^0 + \frac{4g}{9} + \frac{(64\, cg + 27)(\sqrt{81+192cg}-9)}{2592c} - F^{MQR}$
Profit π_b	$\pi^0 + \frac{g(16cg-18)}{27}$	$\pi^0 + \frac{g(16cg-18)}{27}$	$\pi^0 - \frac{4g}{9} + \frac{(64\, cg + 27)(\sqrt{81+192cg}-9)}{2592c}$
Total Welfare W	$W^0 + \frac{g}{2} + \frac{28\, c\, g^2}{27} - F^{DS}$	$W^0 + \frac{g}{2} + \frac{28\, c\, g^2}{27} - F^{DS}$	$W^0 + \frac{g}{3} + \frac{(320\, cg + 27)(\sqrt{81+192cg}-9)}{5184c} - F^{MQR}$

Figure 1. Equilibria in the Quality Space

If $q_a > q_b$



If $q_a < q_b$



Note: $q_i^k(q_j)$ is a reaction function while q_i^k is an equilibrium value, $i, j = a, b$, in an equilibrium with no labeling (k=0) or with a denomination standard (k=DS).

Appendix.

Table A1. Evolution of the specifications of the Comté AOC: Additional rules added by successive decrees

	1986	1998	2007
Milk production	– Cows must belong to the Montbéliarde or French Simmental breeds – Silage and other fermented feed are prohibited	– Stocking rate limited to one cow per hectare of grassland pasture – Less than 30% of the total dry matter of feed must originate from concentrates – Two milkings per day are mandatory	– Production limited to 4,600 litres – Stocking rate limited to 1.3 livestock units per hectare of main fodder area – Farm comté is forbidden (comté must be produced mixing milks from different farms)
Cheese dairy processing	– Cheese from raw milk – Regulations on the duration and temperatures of the various processing stages	Milk has to be collected within a radius of 25 kilometers	Size limits to cheese dairies are introduced
Ripening	Minimum of 90 days of cheese ripening	– Minimum of 120 days of cheese ripening – Mandatory manual operations during the ripening stage	
Other changes	– Casein plate for cheese identification – Specific labelling other than Comté is forbidden	– A special exemption must be granted for prepacking outside the PDO area – Brand labelling is authorized	Grated comté production is authorized

Source: INAO 1986, INAO 1998, INAO 2007.

Table A2. Current specification of the cantal AOC: perspective with the initial terroir description and the evolution of production practices

	Excerpts from the 1956 court decision having ruled out for the cantal AOC, according to which "cantal production implies a series of precise factors that occur together in no other region"	Specification of the cantal AOC in the 2007 decree and production practices in the cantal production area in 2006
Production area	– "rather rough and rainy climate"; – "particular property of the volcanic grounds, rich in phosphoric acid, in potassium hydroxide or in magnesia"; both "contributing to the development of rich grasslands brightened up with a varied and original spontaneous flora … making for cows feeding on them a milk not only very fat, but also of a special taste, determining in a way a milk vintage particularly suitable for cantal production"	The cantal AOC production area includes the Châtaigneraie, which characteristics differ from those described in the 1956 ruling (its grounds have very few tracks of volcanism). Milk production there was marginal in the 1950s, but has developed since then, with intensive breeding methods based on corn silage. Châtaigneraie accounted for around 30% of total milk production in the AOC cantal area in 2006 (when around 40% of milk produced in the area went to cantal production with no differentiation of milk according to its use).

Milk production	– "another added important natural factor, concerning the bovine species, Salers and Aubrac, exclusively and specially adapted to the region; close breeds, rustic and very climate-resistant, fitted for transhumance and estivage"; "these two breeds, though producing less milk than those of the plain, do produce fatter milk, and above all, milk of an aromatic flavor, thanks to the rich flora of the pastures of the Cantal massifs" – "The manufacturing of cantal remains subordinate to the breeding and feeding methods… in the sense that the milk used to produce cantal results only from animals on pastures with no other feed, so that the cheese may be described as a fruit of terroir because of the close and total union of the animal and the ground"	– Milk for cantal AOC must be from animals born and raised in the AOC production area, but the specification does not mandate any specific breed. Many dairy farms in the cantal area now have only intensive Holstein cow breeds. – Stocking rate is limited to one cow per hectare of cultivated area. – Forage must originate from the AOC area; at least 70% of the daily ration of the dairy herd comes from grazed or preserved grass; no more than 1,800 kilograms of concentrates per cow and per year. These rules are constraining mainly for intensive farm types based on corn silage which represented around 45% of milk production in 2006. – Farm cantal is authorized
Cheese dairy processing	"Manufacturing is based on very ancient processes and […] cannot be realized by industrial processes, because it must be made on spot with still warm milk the collection of which, twice a day, can be made only in a low range".	– Cheese from raw or heat-treated milk – Regulations on the duration and temperatures of the various processing stages – In 2006 production was quite industrialized: a main player, the cooperative group 3A, produced around 40% of cantal AOC, mainly in one factory. Together the first three players, 3A, Lactalis and the union of cheese cooperatives of cantal accounted for 63% of the cantal market.

Ripening		– Minimum of 30 days of cheese ripening, with three categories: young (30 to 60 days); "entre-deux" (middle age) (90 to 210 days); old (at least 240 days)
Other		Grated cantal is authorized

Source: Tribunal civil de Saint Flour (1956); Colinet et al. 2007; INAO 2007.

Table A3. Equilibria with a non-covered market, $\bar{\theta} = 1, c = \frac{1}{2}, g = \frac{1}{50}, f = 0$.

	No Labeling[*]	Denomination Standard, $q_a < q_b$	Denomination Standard, $q_a > q_b$	Minimum Quality Requirement
q_a	0.820	0.434	0.780	q_h^0 = 0.820
q_b	0.399	0.858	0.365	0.381
p_a	0.453	0.171	0.435	0.467
p_b	0.150	0.472	0.130	0.140
$\tilde{\theta}_0$	0.376	0.395	0.357	0.368
$\tilde{\theta}_{lh}$	0.721	0.756	0.685	0.700
Consumer Surplus *CS*	0.0940	0.104	0.0959	0.0958
Profit π_a	0.0328	0.0279−F^{DS}	0.0411−F^{DS}	0.0394−F^{MQR}
Profit π_b	0.0243	0.0254	0.0209	0.0224
Total Welfare *W*	0.151	0.1574−F^{DS}	0.1579−F^{DS}	0.1577−F^{MQR}

[*] With no labeling, a symmetric equilibrium exists in which firms *a* and *b* are inverted.

Table A4. Equilibria with a non-covered market, $\bar{\theta} = 1, c = \frac{1}{2}, g = \frac{1}{50}, f = \frac{1}{50}$.

	No Labeling, $q_a < q_b$	No Labeling, $q_a > q_b$	Denomination Standard, $q_a < q_b$	Denomination Standard, $q_a > q_b$	Minimum Quality Requirement
q_a	0.3413	0.789	0.373	0.754	0.789
q_b	0.685	0.3408	0.711	0.313	0.326
p_a	0.116	0.442	0.132	0.427	0.456
p_b	0.347	0.125	0.351	0.109	0.116
$\tilde{\theta}_0$	0.339	0.365	0.355	0.348	0.357
$\tilde{\theta}_{lh}$	0.673	0.708	0.708	0.676	0.689
Consumer Surplus *CS*	0.0930	0.0877	0.105	0.08967	0.08969
Profit π_a	0.0192	0.0381	0.0222$-F^{DS}$	0.0462$-F^{DS}$	0.0449$-F^{MQR}$
Profit π_b	0.0273	0.0205	0.0187	0.0177	0.0189
Total Welfare *W*	0.140	0.146	0.156$-F^{DS}$	0.1536$-F^{DS}$	0.1535$-F^{MQR}$

Table A5. Equilibria with a non-covered market, $\bar{\theta} = 1, c = \frac{1}{2}, g = \frac{1}{50}, f = \frac{1}{10}$.

	No Labeling, $q_a > q_b$	Denomination Standard, $q_a > q_b$	Minimum Quality Requirement
q_a	0.734	0.706	q_h^0 = 0.734
q_b	0.222	0.206	0.212
p_a	0.429	0.419	0.442
p_b	0.077	0.069	0.072
$\tilde{\theta}_0$	0.348	0.334	0.340
$\tilde{\theta}_{lh}$	0.688	0.660	0.670
Consumer Surplus *CS*	0.0722	0.0745	0.0746
Profit π_a	0.0499	0.0577$-F^{DS}$	0.0569$-F^{MQR}$
Profit π_b	0.0129	0.0113	0.0118
Total Welfare *W*	0.135	0.14347$-F^{DS}$	0.14341$-F^{MQR}$

Note : with the high fixed cost for firm *b*, there is no equilibrium in which $q_a < q_b$, in the absence of labeling or with the denomination standard.

Table A6. Equilibria with competition at the second stage of the game, with a non-covered market, $\bar{\theta} = 1$, $c = \frac{1}{2}$, $g = \frac{1}{50}$.

	No Labeling*	Denomination Standard, $q_a < q_b$	Denomination Standard, $q_a > q_b$	Minimum Quality Requirement
q_a	2.19	1.695	2.14	2.19
q_b	1.693	2.24	1.690	1.693
p_a	1.50	1.09	1.47	1.52
p_b	1.08	1.53	1.07	1.07
$\tilde{\theta}_0$	0.635	0.640	0.630	0.634
$\tilde{\theta}_{lh}$	0.857	0.863	0.851	0.855
Consumer Surplus *CS*	1.018	0.122	0.121	0.110
Profit π_a	0.107	1.121	0.109808$-F^{DS}$	0.109805$-F^{MQR}$
Profit π_b	0.119	0.105	0.117	0.119
Total Welfare *W*	0.344	0.348	0.348$-F^{DS}$	0.347$-F^{MQR}$

* With no labeling, a symmetric equilibrium exists in which firms *a* and *b* are inverted.

Proof of proposition 1

In the covered market case, demand functions are given by $x_a = \bar{\theta} - \tilde{\theta}^{DS}$ and $x_b = \tilde{\theta}^{DS} - \underline{\theta}$ in the case where $q_a > q_b$, or $x_a = \tilde{\theta}^{DS} - \underline{\theta}$ and $x_b = \bar{\theta} - \tilde{\theta}^{DS}$ in the case where $q_a < q_b$. For each of the two possible cases ($q_a > q_b$ and $q_a < q_b$), the equilibrium is solved by backward induction with Mathematica. For each case, a unique equilibrium satisfies the second order condition of profit (see table 2). The PDO firm gets a higher profit level with the denomination standard than in the absence of label if $F^{DS} < \frac{g(16c\,g+18)}{27}$. The market is covered if $\frac{p_b}{q_b} < \underline{\theta}$ (case $q_a > q_b$) or $\frac{p_a - g}{q_a} < \underline{\theta}$ (case $q_a < q_b$), that is, if $\theta^2 > 1 + (\frac{9-16cg}{12})^2$. Both firms operate on the market if $\underline{\theta} < \tilde{\theta} < \overline{\theta}$, that is, if $16\,c\,g < 9$.

At the second stage of the game, we have:

$$\text{If } q_a > q_b, \begin{cases} p_a^*(p_b,\ q_a,\ q_b,\ g) = \frac{1}{2}\ (p_b + c\,q_a^2 + g + (q_a - q_b)\,\overline{\theta} \\ p_b^*(p_a,\ q_a,\ q_b,\ g) = \frac{1}{2}\ (p_a + c\,q_b^2 - g - (q_a - q_b)\,\underline{\theta} \end{cases}$$

$$\text{If } q_a < q_b, \begin{cases} p_a^*(p_b,\ q_a,\ q_b,\ g) = \frac{1}{2}\ (p_b + c\,q_a^2 + g + (q_a - q_b)\ \underline{\theta} \\ p_b^*(p_a,\ q_a,\ q_b,\ g) = \frac{1}{2}\ (p_a + c\,q_b^2 - g - (q_a - q_b)\,\overline{\theta} \end{cases}$$

At the first stage of the game, we obtain the following reaction functions:

$$\text{If } q_a > q_b, \begin{cases} q_a^*(\,q_b,\ g) = \dfrac{\overline{\theta}+1+4\,c\,q_b+\sqrt{(\overline{\theta}+1-2\,c\,q_b)^2-12\,cg}}{6c} \\ q_b^*(\,q_a,\ g) = \dfrac{\overline{\theta}-2+4\,c\,q_a-\sqrt{(2\,c\,q_a+2-\overline{\theta})^2+12\,cg}}{6c} \end{cases}$$

$$\text{If } q_a < q_b, \begin{cases} q_a^*(\,q_b,\ g) = \dfrac{\overline{\theta}-2+4\,c\,q_b-\sqrt{(\,2\,c\,q_b+2-\overline{\theta})^2-12\,cg}}{6c} \\ q_b^*(\,q_a,\ g) = \dfrac{\overline{\theta}+1+4\,c\,q_a+\sqrt{(\overline{\theta}+1-2\,c\,q_a)^2+12\,cg}}{6c} \end{cases}$$

Results are obtained by simulations for the uncovered market case, where demand functions are given by $x_a = \bar{\theta} - \tilde{\theta}^{DS}$ and $x_b = \tilde{\theta}^{DS} - \frac{p_b}{q_b}$ in the case where $q_a > q_b$, or $x_a = \tilde{\theta}^{DS} - \frac{p_a - g}{q_a}$ and

$x_b = \bar{\theta} - \tilde{\theta}^{DS}$ in the case where $q_a < q_b$.

Proof of proposition 2. Here we only study the case where $q_a > q_b$. The equilibrium is solved as in proposition 1, except that at the first stage of the game we calculate the best quality choice of firm *b* given that quality of firm *a* is set to q_a^0.

Endnotes

[1] AOC, which stands for “Appellation d’Origine Contrôlée”, is the French equivalent of the European PDO.

[2] The four main French AOC cheeses are comté, roquefort, reblochon and cantal, with respectively 25%, 10%, 8% and almost 8% of total volumes sold on that market in 2010.

[3] Menapace and Moschini (2012) model the high-quality good as an experience good in a dynamic framework, with a one-dimensional quality level.

[4] Status goods are “goods for which the mere use or display of a particular branded product confers prestige on their owners, apart from any utility deriving from their function” (Grossman and Shapiro, 1988). An indication of the collective reputation of the PDO label is, for example, the results of a study on food consumption conducted in France in 2007, in which 94% of 1013 interviewed people declared that they knew the AOC quality sign and 86% declared that they had confidence in food products bearing an AOC label (Tavoularis, Recours and Hebel, 2007). Besides, empirical studies show that, on average, geographical indications command a positive price premium (see the meta-analysis by Deselnicu *et al.*, 2011). It is, however, not possible to assess to what extent this willingness to pay results from the higher quality of the labeled product (our parameter q), and to what extent it comes from a valuation of the origin (our parameter g).

[5] Cremer and Thisse (1994) and Lambertini (1996) model endogenous quality choices with a covered market and variable costs functions and are able to solve their model analytically. In the case of a non-covered market, Motta (1993) assumes (in terms of our model's parameters) that $\underline{\theta} = 0$, and has to choose a numerical value for $\bar{\theta}$ in order to solve the model.

[6] This assumption is identical to that of Crampes and Hollander (1995b), who support the idea that variable costs of quality are empirically more relevant that fixed costs of quality, as most quality standards pertain to materials and ingredients.

[7] Typically models of GIs assume that the PDO product is of higher quality and therefore more costly to produce than the non-PDO product, but do not model cost functions covering the whole range of possible qualities for both products. An exception is Menapace and Moschini (2012), who assume that PDO producers have a comparative advantage for the production of high quality while non-PDO producers have a comparative advantage for the production of low quality, with all costs being variable costs. Their assumption is intended to cover the notion of "terroir": "the fact that the nature and characteristics of the conditions of production in the GI region facilitate the attainment of quality". With our assumption, "terroir" is seen as the combined result of accumulated know-how, the reputation of the local product and specific investments, rather than natural conditions in the GI region.

[8] Marette et al. (1999), Marette and Crespi (2003), Zago and Pick (2004), Lence et al. (2007) and Mérel (2009) consider that PDO certification entails a fixed certification cost.

[9] This is due to the lower quality level of the non-labelable good and a better coverage of the market.

[10] A sufficient condition is that $g_m > \frac{g_{d\,(9+8\,c\,g_d)}}{6}$.