Do European Geographical Indications Supply Excessive Quality?

Pierre Mérel & Richard J. Sexton

1 Introduction

The European Union regulations pertaining to geographical indications (GI) were enacted in 1992 to encourage the creation of high-quality agricultural products, likely in response to the "commodification" of many agricultural markets and the comparative advantage of certain European farmers in supplying higher-quality agricultural products (Council of the European Union, 1992). By guaranteeing that products sold under the European Protected Designation of Origin (PDO) or Protected Geographical Indication (PGI) label meet publicly available, certified production criteria, the system is intended to solve the traditional "lemon" problem associated with asymmetric information regarding the quality of credence goods (Akerlof, 1970). This problem is potentially acute in agricultural markets, where production is typically atomized and spontaneous coordination between farmers to reliably certify production practices often fails to materialize.

In that respect, if the ever-increasing number of product registrations is of any indicative value, the system has definitely been a success. Over 750 European products have been registered under PDO, PGI or Traditional Specialty Guaranteed (TSG) status (European Union, 2008). The product categories most frequently covered by protected designations are cheeses, vegetables, and fruit.

One important element of the European PDO/PGI system is that certified production requirements (including the delimitation of the eligible geographical area), that constitute the basis for registration, are typically developed by the producer organizations themselves (Council of the European Union, 2006). Thus, there can be little doubt that GI producer organizations (hereafter PO) choose the quality level of their products strategically, and it is natural to expect the PO to choose the quality level that maximizes the expected aggregate producer profits.

The purpose of this study is to investigate the profit-maximizing choice of product quality level by a PO. Two effects need to be distinguished to understand the incentives facing the PO. First, to the extent they increase quality, more stringent production requirements should increase consumers' willingness to pay for the product, shifting out the demand curve. We call this the demand-enhancing effect. Second, by making production more costly, they indirectly restrict supply, which contributes to a higher market-clearing price. We call this effect the supply-limiting effect.

The optimal choice of quality by a monopolist in response to the demand-enhancing effect has been studied extensively, including classic studies of quality choice under monopoly by Spence (1975) and Mussa and Rosen (1978). The supply-limiting effect plays no role in these studies because the monopoly sellers can choose quantity directly. However, competitive producers make production decisions independently within a GI, making supply restriction through indirect means a potentially important consideration and the focus of recent research (Lence et al., 2007; Mérel, 2009). However, these studies investigate the use of production requirements as a pure means to indirectly limit supply, and thus they assume that the production requirements are “artificial”, that is, product quality is exogenous and unaffected by them. Such studies therefore ignore the demand-enhancing effect. To our knowledge, this study is the first to investigate the decisions of a PO regarding product quality when both the demand-enhancing and supply-limiting effects are present.

A regulator who had perfect knowledge regarding the cost of quality provision and the distribution of consumer preferences over quality could directly set the quality standard for the GI product. It is doubtful, however, that a regulator would have such information, moreover, even if it did, the regulatory burden of imposing such regulations would be extreme, given the number of GI products in place and under proposal. Thus, the present EU registration system, which is not geared towards imposing quality choices upon applicants and instead delegates the choice to the PO, probably reflects the limitations of the regulatory environment, making analysis of endogenous producer choice of quality level relevant to both the current and likely future environments for GI products.

The demand side of our model is based upon a flexible version of the classic model of vertical differentiation due to Mussa and Rosen (1978). We specify heterogeneity in consumer tastes via the beta distribution with integer parameters a and b. This allows us to simulate a large variety of distributions of consumer tastes by varying the values of a and b, including the special case of uniform distribution, $a = b = 1$, that is often adopted for convenience in applications of the Mussa-Rosen framework. This flexibility is potentially important to investigating the conditions under which GI producer organizations will supply excess or deficient quality. For example, consumers may be clustered at the low-end of the consumer taste spectrum, so that consumers with a high valuation for the GI product are few relative to those with a low valuation. Surely, detractors of the European GI system, or even ministerial departments in charge of consumer protection, may claim that GI niche markets are being tailored by producers to extract rents from a small number of wealthier consumers, leaving the bulk of consumers unable to afford these excessively high-quality (and high-price) products.[1]

The ability of the PO to exploit the supply-limiting effect due to increasing product quality directly depends on the responsiveness of production to changes in product quality. We specify an aggregate cost function that allows us to readily define this responsiveness in terms of a constant elasticity of cost with respect to quality. In addition, the incentives facing the PO regarding the supply-limiting effect are directly related to the potential of the industry to earn quasi-rents in equilibrium, that is, to the convexity of the cost function. (If the cost function displayed constant returns to scale, aggregate profits would be nil for any quality level, making useless any attempt by the PO to raise price through increases in quality.) Therefore, we specify an aggregate cost function that is both convex in quality and convex in quantity, so that marginal cost is increasing in quality and quantity.

We then investigate whether the profit-maximizing choice of quality level for producers in a GI exceeds the quality level that maximizes economic welfare. The conclusion of this study is unambiguous: provided it is socially optimal to offer the GI product with finite quality level (the only case of interest), the PO will *always* choose to supply excessive quality relative to the societal optimum. This result contrasts with traditional results that link monopoly to suboptimal quality. It has direct policy relevance because an important justification for public intervention in GI markets is founded on the asymmetric information argument that product quality will be deficient relative to the social optimum

[1] This view was articulated during interviews of French regulatory agencies and producer organizations conducted by one of the authors.

in the absence of intervention. Thus, our results suggest that the European GI regulations may in essence have replaced a pooling equilibrium with deficient product quality in the absence of intervention with a separating equilibrium involving a "generic" product with fixed low quality and a GI product with excessive quality relative to the social optimum.

2 Prior Work

Our study is related to analyses of quality choice under monopoly. An excellent summary of this literature is provided by Lambertini (2006), and we provide only a brief overview here. Because the monopoly is typically free to set quantity directly, only the demand-enhancing effect of quality choice matters to the monopolist's decision in most settings. Spence (1975) showed that a monopoly will typically set quality either below or above the socially optimal level, and only in special cases will its incentives align with the social optimum. The problem, as framed by Spence, is that the change in price to a monopoly seller due to an increase in quality, Δp, is equal to the valuation of the quality change by the marginal consumer. Therefore, if sales are Q, and market demand is $p(Q)$, the quality increase is profitable for the monopoly seller whenever $\Delta p(Q)Q > \Delta C$, where ΔC is the increase in costs due to the quality improvement. However, the increase in quality is desirable from a societal perspective if the *average* consumer valuation of the quality change exceeds the average cost, $\Delta C/Q$, of implementing it. Thus, the monopolist's choice is consonant with society's choice only if the marginal consumer's valuation equals the average consumer's valuation.

Other work on quality choice by a monopoly seller has emphasized the case where the monopolist can supply multiple varieties (qualities) of the basic product and use them as tools to introduce self selection and, hence, price discrimination, among consumers (Mussa and Rosen, 1978; Maskin and Riley, 1984;

Besanko et al., 1987). These studies showed that the monopolist will offer a broader range of qualities than would be chosen by the social planner so as to increase the price-quality gradient compared to the social optimum. Although some GI specify multiple quality standards, most do not, justifying our assumption of choice of a single quality standard.

Our focus, the profit-maximizing choice of quality by a PO and competitive production of output by members of the PO, has, however, received scant attention. Spence (1975) indicates in a long footnote to his study that if the monopoly sets quality but is constrained to set price at marginal cost—a situation conceptually similar to that of a PO choosing product quality while individual producers collectively set quantity competitively, given quality—then the resulting quality is not optimal. More specifically, he argues that under the conditions that (i) the marginal value of quality is a decreasing function of quantity and (ii) average costs go up faster than marginal costs as quality is increased, the price-constrained monopoly firm will always set quality *below* the socially optimal level.[2]

These results for the monopolist constrained to set price at marginal cost reflect a more general proposition described by Lambertini (2006) that a monopolist generally can choose to distort quantity by setting price above marginal cost, quality by deviating from the socially optimal level, or some combination of the two. A monopolist who chooses not to or is unable to distort quantity has incentive to distort quality choice away from the social optimum. For example, in a pure model of vertical differentiation where consumers buy at most one unit of good and unit costs are quadratic in quality and constant in quantity, the monopolist undersupplies quality relative to the social planner when

[2]The formal demonstration of this claim is actually flawed in Spence (1975). Yet it can be shown that the result indeed holds. Similarly, it can be shown that if the marginal value of quality is an increasing function of quantity and marginal costs go up faster than average costs, the monopoly oversupplies quality. However, this last case is less relevant empirically than the one we investigate in this study.

the market is fully covered, i.e., quantity is constrained (Spence, 1975; Mussa and Rosen, 1978; Lambertini, 2006); but when the market is not fully covered and the number of available qualities is finite, the monopolist does not distort quality (Lambertini, 1997).

While Spence's assumption (i) is preserved in our model of vertical differentiation, we depart from his assumption (ii) by assuming instead that marginal costs increase faster than average costs when quality increases. This situation would seem to represent the "normal" case. In the context of agricultural production, it would be consistent, for example, with the assumption that marginal land may yield better quality output at an additional cost no smaller than infra-marginal, prime acres.[3] Unfortunately, when assumption (ii) does not hold, Spence's parsimonious model specification yields inconclusive results as to whether and under what conditions the monopolist who lacks control over quantity will supply excess or deficient quality.

Studies regarding choice of quality of GI product by a PO are limited to Giraud-Héraud et al. (2003) who studied choice of both quantity and quality in the specific context of wine producer organizations, whereas we analyze the decisions of a PO that is allowed to choose quality without the concomitant ability to choose quantity.

3 The model

Consider the market for a vertically differentiated product. There are N consumers and two product varieties: generic or GI. Consumers purchase one unit of either the GI product or the generic product. The quality of the GI product is endogenous and measured by a scalar $\mu > 0$. The price of the GI product

[3]Spence's assumption (ii) is mechanically violated for the specification of costs that we use, where costs are a convex function of both quality and quantity.

is p. Each of the N consumers is characterized by a parameter $\theta \in [0,1]$ that measures her taste for quality. The utility a consumer obtains from consuming the generic product is set to $\bar{U}$, while the utility a consumer of type θ gets from consuming the GI product is $\bar{U} - p + \theta\mu$.[4] Therefore, the consumer of type θ has a reservation price for the GI product with quality μ equal to $\theta\mu$. Larger values of θ correspond to a higher preference for the GI product and therefore a larger reservation price.

The density function for θ is given by the beta density

$$f_{a,b}(\theta) = \frac{\theta^{a-1}(1-\theta)^{b-1}}{B(a,b)}$$

where $B(a,b) = \int_0^1 \theta^{a-1}(1-\theta)^{b-1}d\theta$, and we assume that $(a,b) \in \mathbb{N}^2_{++}$. In this case the density function is unimodal (for $a = b = 1$, it coincides with the uniform distribution). We denote the corresponding c.d.f. by $F_{a,b}$. Examples of beta densities with integer parameters are depicted in figure 1.

Variation in the quantity of the GI product demanded arises from consumers shifting between the generic product and the GI product, since each consumer purchases one unit at most and the total market is covered. The parameter taste of the consumer who is indifferent between purchasing the generic product or the GI product of quality μ is $\tilde{\theta} = \frac{p}{\mu}$.[5] Therefore, expansions in sales of the GI product must be obtained by attracting new, marginal consumers by increasing quality, decreasing price, or both.

The PO consists of a large number L of identical farmers. For a typical

[4]Given our focus on the GI product, we specify demand and production for the generic product in a simple way which, nonetheless, does not limit the generality of the analysis. Specifically, we normalize the quality of the generic product to zero and assume it is produced at constant cost by a large number of farmers, so this cost and, hence, the competitive price of the generic product can be set to zero, resulting in the consumer utility, $\bar{U}$ for the generic product.

[5]A similar model of consumer preferences is used by Giraud-Héraud et al. (2003) to study the decision of a PO that chooses quality and quantity simultaneously. These authors assume that the parameter taste θ is uniformly distributed on the segment $[0,t]$, $t > 0$.

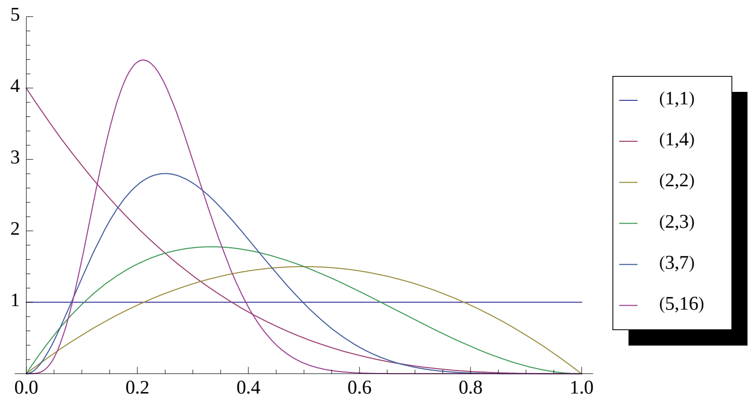

Figure 1: Examples of taste densities from the beta distribution. Although perhaps empirically less relevant to our question, densities that are peaked on the upper-end of the segment can also be represented.

farmer l, the cost of producing q units of the GI product with quality μ is

$$C(q,\mu) = c\mu^{1+\alpha}q^{1+\beta}$$

where c, α and β are positive parameters. Therefore, $1+\alpha$ represents the elasticity of total cost with respect to quality, assumed to be the same at each quantity level q, while $1+\beta$ represents the elasticity of cost with respect to quantity. The cost function C is interpreted as reflecting the full opportunity cost of producing the GI product. For instance, in the special case where farmers can choose between producing the generic product and the GI product, C represents the opportunity cost of diverting assets away from the production of the generic product and towards the production of the GI product. This cost function embeds as a special case the cost function used by Giraud-Héraud et al. (2003) and by Lambertini and Orsini (2001) in a study about the provision of quality by a monopoly in the presence of network externalities.

An implicit assumption of the model is that this direct relationship between product quality and production costs is common knowledge. Consistent with EU rules on product registration, the government is in charge of overseeing applications prior to registration, and we assume that this oversight includes preventing the PO from adopting "artificial" production requirements that raise marginal costs without improving quality.[6] Therefore, although the PO is free to chose product quality, producers are forced to produce on the efficiency frontier. This assumption prevents the PO from imposing cost-enhancing production requirements that do not enhance product quality, for instance by limiting an input (e.g., land) to restrict supply (Lence et al., 2007; Mérel, 2009). The supply-limiting effect thus must be obtained from increases in quality that directly translate into upward shifts of the social marginal cost curve.[7]

Given the farmers' individual cost functions C, the aggregate social cost of producing Q units of the GI product with quality μ is obtained by solving the following program:

$$\min_{q^l \geq 0} \quad \sum_l C(q^l, \mu) \quad \text{subject to} \quad \sum_l q^l = Q.$$

The first-order conditions to this program imply that output should be divided equally among the L farmers, so that the total cost can be written

$$\mathscr{C}(Q, \mu) = Lc\mu^{1+\alpha} \left(\frac{Q}{L}\right)^{1+\beta} = cL^{-\beta}\mu^{1+\alpha}Q^{1+\beta}.$$

[6]The EU regulations on geographical indications explicitly require Member States to "scrutinize the application by appropriate means to check that it is justified and meets the conditions of [the] Regulation". One essential condition for registration is the establishment of a "link" between product quality and the geographical region delimited in the application.

[7]This assumption derives some support from empirical observation. For example, government officials in France typically ask that proposed production requirements result in significant quality improvements. Yet, the exact relationship between costly requirements and product quality is sometimes difficult to establish. Therefore, our assumptions should be understood as reflecting the "ideal" situation where government, without having the authority to impose the quality level itself, can impose that any quality must be achieved at the lowest possible cost.

3.1 The socially optimal quality level

The socially optimal bundle $(\bar{\theta}, \bar{\mu})$ solves

$$\max_{\tilde{\theta},\mu} \quad N\left[\int_0^{\tilde{\theta}} \bar{U} dF_{a,b} + \int_{\tilde{\theta}}^1 (\bar{U} + \theta\mu) dF_{a,b}\right] - \mathscr{C}\left(N\int_{\tilde{\theta}}^1 dF_{a,b}, \mu\right). \tag{1}$$

The first-order conditions to program (1) are

$$\begin{cases} \bar{\theta}\bar{\mu} = \frac{\partial\mathscr{C}}{\partial Q}\left(N\int_{\bar{\theta}}^1 dF_{a,b}, \bar{\mu}\right) \\ N\int_{\bar{\theta}}^1 \theta dF_{a,b} = \frac{\partial\mathscr{C}}{\partial\mu}\left(N\int_{\bar{\theta}}^1 dF_{a,b}, \bar{\mu}\right) \end{cases}. \tag{2}$$

The first equation is standard and implies that at the social optimum, the willingness to pay of the indifferent consumer must equal the marginal cost of production, for the given quality. The second relation equates the social benefit of increasing quality marginally, identified as the added utility to consumers purchasing the GI product, to its cost.

The following proposition establishes a restriction on the model parameters that ensures that in the socially optimal allocation, the optimal quality $\bar{\mu}$ is finite and a positive quantity of the GI product is offered.

Proposition 1 *For $(a, b) \in \mathbb{N}^2_{++}$, a necessary and sufficient condition for the GI product to be offered with finite quality $\bar{\mu}$ in the socially optimal allocation is that*

$$\beta < \alpha. \tag{3}$$

Proof. The first-order conditions to program (1) can be written, for the specified functions $f_{a,b}$ and $\mathscr{C}$, as

$$\begin{cases} \bar{\theta}\bar{\mu} = c\left(\frac{N}{F}\right)^\beta (1+\beta)\bar{\mu}^{1+\alpha}\left[\int_{\bar{\theta}}^1 \frac{\theta^{a-1}(1-\theta)^{b-1}}{B(a,b)} d\theta\right]^\beta \\ \int_{\bar{\theta}}^1 \frac{\theta^a(1-\theta)^{b-1}}{B(a,b)} d\theta = c\left(\frac{N}{F}\right)^\beta (1+\alpha)\bar{\mu}^\alpha\left[\int_{\bar{\theta}}^1 \frac{\theta^{a-1}(1-\theta)^{b-1}}{B(a,b)} d\theta\right]^{1+\beta} \end{cases}. \tag{4}$$

Dividing the first equation by the second one and rearranging, one obtains the expression that implicitly defines $\bar{\theta}$:

$$\bar{\theta}\left(\frac{1+\alpha}{1+\beta}\right)\int_{\bar{\theta}}^{1}\theta^{a-1}(1-\theta)^{b-1}d\theta=\int_{\bar{\theta}}^{1}\theta^{a}(1-\theta)^{b-1}d\theta. \tag{5}$$

For any $\bar{\theta}\in[0,1)$, we have that $\bar{\theta}\int_{\bar{\theta}}^{1}\theta^{a-1}(1-\theta)^{b-1}d\theta<\int_{\bar{\theta}}^{1}\theta^{a}(1-\theta)^{b-1}d\theta$, so that (5) can only have a solution in $[0,1)$ if $\frac{1+\alpha}{1+\beta}>1$, that is, $\alpha>\beta$. When $\alpha>\beta$, equation (5) can be rewritten

$$\phi(\bar{\theta})=\frac{1+\alpha}{1+\beta} \tag{6}$$

with $\phi(\bar{\theta})=\frac{\int_{\bar{\theta}}^{1}\theta^{a}(1-\theta)^{b-1}d\theta}{\bar{\theta}\int_{\bar{\theta}}^{1}\theta^{a-1}(1-\theta)^{b-1}d\theta}$. The function ϕ is continuous on $(0,1)$ and satisfies $\phi(x)>1$ for all $x\in(0,1)$, $\lim_{x\to0}\phi(x)=+\infty$ and $\lim_{x\to1}\phi(x)=1$. Therefore, equation (6) has a solution in $(0,1)$ for all values of $\alpha>\beta$. This, in turn, ensures through (4) that the corresponding quality level $\bar{\mu}$ is finite.

When $\alpha\leq\beta$, the solution to the social welfare optimization program involves setting $\mu\to\infty$ and $Q\to0$, an unrealistic and hence uninteresting case.

3.2 The quality level chosen by the GI producer association

The GI producer organization is assumed to choose the quality level that maximizes aggregate producer surplus, given that once the quality is set producers within the appellation behave competitively, so that the equilibrium price $p(\mu)$ is equal to aggregate marginal cost. Thus, $p(\mu)$ is implicitly defined by the equation

$$p=\frac{\partial\mathscr{C}}{\partial Q}\left(N\int_{\frac{p}{\mu}}^{1}dF_{a,b},\mu\right). \tag{7}$$

This relation, together with (2), shows that if the PO were to chose the socially optimal quality level $\bar{\mu}$, the allocation would be socially optimal altogether, since the indifferent consumer is defined by $\tilde{\theta} = \frac{p}{\mu}$.

The optimization program solved by the PO, conditional on a competitive supply behavior by individual producers, is thus

$$\max_{\mu} \quad p(\mu) N \int_{\frac{p(\mu)}{\mu}}^{1} dF_{a,b} - \mathscr{C}\left(N \int_{\frac{p(\mu)}{\mu}}^{1} dF_{a,b}, \mu\right) \tag{8}$$

with first-order condition

$$N p'(\hat{\mu}) \int_{\frac{p(\hat{\mu})}{\hat{\mu}}}^{1} dF_{a,b} = \frac{\partial \mathscr{C}}{\partial \mu}\left(N \int_{\frac{p(\hat{\mu})}{\hat{\mu}}}^{1} dF_{a,b}, \hat{\mu}\right) \tag{9}$$

where $\hat{\mu}$ denotes the PO choice of quality and we have made use of (7). Equation (9) expresses the condition that at the producer optimum, a marginal increase in quality is such that the marginal benefit, defined as the increase in revenue due to the rise in equilibrium price, keeping the market share constant, must be equal to the corresponding increment in cost. Market share effects do not appear in this equation because the change in revenue from capturing additional customers, keeping price constant is exactly offset by the increase in cost at fixed quality from additional production, due to equality (7).[8]

4 Condition for the PO to oversupply quality

Given the sets of first-order conditions (2) and (9), it is easily seen that the PO will supply excess quality if and only if, at the socially optimal quality $\bar{\mu}$, the benefits to producers of increasing quality marginally outweigh the social benefits of doing so (which in this case are equal to the marginal social costs

[8] Note that $p' > 0$, and an increase in quality may therefore result in an increase or a decrease in the market share of the GI product. In any event, the market share effect is nil.

$\frac{\partial \mathscr{C}}{\partial \mu}\left(N \int_{\bar{\theta}}^{1} dF_{a,b}, \bar{\mu}\right)$. This condition can be written as

$$\int_{\bar{\theta}}^{1} (p'(\bar{\mu}) - \theta) dF_{a,b} > 0 \tag{10}$$

where as before $\bar{\theta}$ denotes the taste parameter of the indifferent consumer in the socially optimal allocation. It expresses the fact that at the optimum quality level, the producer benefits from additional quality, understood as the increase in equilibrium price $p'(\bar{\mu})$ multiplied by the current market share, exceed the social benefits, defined as the additional utility obtained by current customers.

The inequality in (10) implies that for the PO to oversupply quality, the marginal increase in equilibrium price from additional quality at the socially optimal quality level, $p'(\bar{\mu})$, must be strictly larger than $\bar{\theta}$, the taste parameter of the indifferent consumer in the socially optimal allocation, although this property alone is not sufficient to guarantee the result.

It is shown in the appendix that for the specified functions $f_{a,b}$ and $\mathscr{C}$ the condition for the PO to oversupply quality is equivalent to

$$\frac{1+\alpha}{1+\beta} > \frac{\bar{\theta}^{a-1}(1-\bar{\theta})^{b-1}[\int_{\bar{\theta}}^{1}(\theta-\bar{\theta})\theta^{a-1}(1-\theta)^{b-1}d\theta]}{[\int_{\bar{\theta}}^{1}\theta^{a-1}(1-\theta)^{b-1}d\theta]^2}. \tag{11}$$

The left-hand side of inequality (11) depends only on the quality and quantity elasticities of the cost function $\mathscr{C}$, while the right-hand side depends on all the parameters of $\mathscr{C}$ (that is, c, L, α and β), a and b, and N.

Lemma 1 *The function* $h(\bar{\theta}) = \frac{\bar{\theta}^{a-1}(1-\bar{\theta})^{b-1}[\int_{\bar{\theta}}^{1}(\theta-\bar{\theta})\theta^{a-1}(1-\theta)^{b-1}d\theta]}{[\int_{\bar{\theta}}^{1}\theta^{a-1}(1-\theta)^{b-1}d\theta]^2}$ *is increasing in* $\bar{\theta}$*.*

Lemma 2 *For* $(a, b) \in \mathbb{N}_{++}^2$*, we have* $h(1) = \frac{b}{b+1}$*.*

Proposition 2 *For* $(a, b) \in \mathbb{N}_{++}^2$*, a sufficient condition for the PO to oversup-*

ply quality is that

$$\frac{1+\alpha}{1+\beta} > \frac{b}{b+1}. \tag{12}$$

Proof. Proposition 2 follows directly from condition (11), Lemma 1 and Lemma 2.

Proposition 3 *For $(a, b) \in \mathbb{N}^2_{++}$, whenever the GI product is produced with finite quality in the socially optimal allocation, the PO oversupplies quality.*

Proof. Proposition 3 is a direct consequence of Proposition 1 and Proposition 2.

The intuition behind Proposition 3 is illustrated in Figure 2 for the case of a uniform distribution of consumer tastes. Quality is assumed to be set at the socially optimal level $\bar{\mu}$. Marginal willingness to pay (demand) for the GI product, taking account of self selection and the availability of the generic product, is represented by the equation $p = \theta\bar{\mu}$. Marginal cost, $\frac{\partial \mathscr{C}}{\partial Q}(Q, \bar{\mu})$ is depicted for the case of $\beta = 2$, so it is linear in Q. The figure illustrates the social optimum with $p(\bar{\mu})$ and $\bar{\theta}$, obtained where the marginal cost curve and the demand curve intersect.

Now suppose the PO increases quality by a small amount $\Delta\mu$. Both the demand for the GI product and marginal cost rotate upward as a consequence, and the indifferent consumer moves towards the right. This move is necessary for $(\bar{\theta}, \bar{\mu})$ to represent the socially optimal allocation. In the limit where $\Delta\mu \to 0$, the additional benefit to current customers, depicted as the darkly shaded area, must equal the increase in costs at the initial quantity, depicted as the dotted area. It is easily seen on the figure that if the indifferent consumer were to move to the left, the additional benefit from increased quality would always exceed the additional costs, thereby contradicting the second optimality condition in (2).

Given that the indifferent consumer moves towards the right, equilibrium price rises so that $\Delta p > \bar{\theta}\Delta\mu$. This is because $p(\bar{\mu}) + \Delta p = (\bar{\theta} + \Delta\theta) \times (\bar{\mu} + \Delta\mu)$, which implies (given $p(\bar{\mu}) = \bar{\theta}\bar{\mu}$) that $\Delta p = \bar{\theta}\Delta\mu + \Delta\theta(\bar{\mu} + \Delta\mu)$. The fact that the PO oversupplies quality is illustrated in the figure by the fact that the lightly shaded area is larger than the darkly shaded area (which, in the limit where $\Delta\mu \to 0$, must equal the dotted area).

As Proposition 3 establishes formally, the fact that the PO chooses to supply excessive quality of the GI product in fact holds very generally. As Figure 2 makes clear, it does, however, depend upon marginal cost rising faster than average cost as a function of quality. As noted, we believe that this represents the typical case for an agricultural production setting.

5 Conclusion

This study has demonstrated that the profit-maximizing choice of product quality level chosen for a European GI product by a producer organization will generally exceed the quality level that maximizes societal welfare. An increase in quality induces shifts in both demand for the GI product and the marginal cost of producing it, the latter outcome being what we call the supply-limiting effect. The result was shown to hold within the context of the classical model of vertical differentiation for a flexible beta distribution of consumers in the preference space and with a cost function that is convex in quality and in quantity and which nests the typical specifications used to study firms' choices of quantity and quality.

As argued in section 2, Spence's (1975) more general model yields inconclusive results regarding the quality choice of a monopolist forced to set price at marginal cost in the case where marginal costs rise faster than average costs. This result suggests that there are cases where the monopolist could undersup-

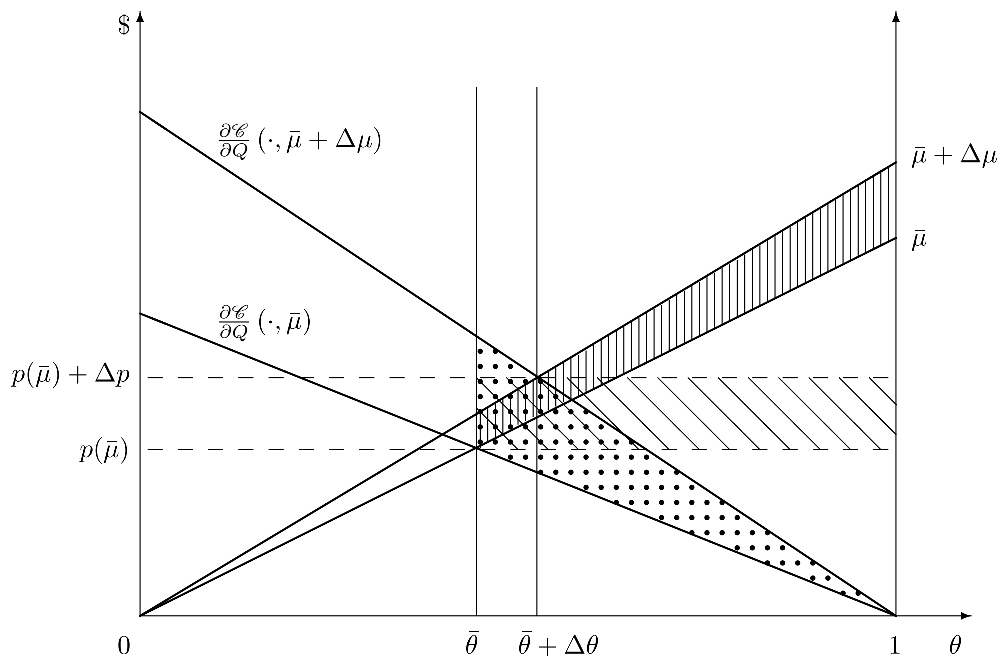

Figure 2: Effect of a marginal increase in quality, starting from the social optimum $(\bar{\theta}, \bar{\mu})$. The lightly shaded area represents the increase in producer revenue from existing customers. The darkly shaded area represents the increase in utility from current customers. The dotted area represents the increase in the cost of production at the current quantity.

ply quality. Despite the relative generality of our demand and cost specification, the structure we imposed on the model ruled out such cases, and when and why they may occur remains an open question, which can only be answered using a model specification that is more structured than Spence's, yet more flexible than ours.

Despite this limitation, and in light if the relative generality of our model, we believe our result is relevant for policy regarding GI products because it suggests that, in setting up the GI framework in response to incipient adverse selection problems, European policy makers may have "overshot" in the sense of creating a decision-making apparatus that is likely to produce excessive quality. It also lends credence to the arguments of consumer advocates that GI products tend to be over priced and targeted to a narrow class of high-income consumers.

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Appendix

Derivation of condition (11)

Applying the implicit function theorem to equality (7), we obtain

$$p'(\mu) = \frac{(1+\alpha)(1+\beta)cL^{-\beta}\mu^{\alpha}Q^{\beta} + N\beta(1+\beta)cL^{-\beta}\mu^{\alpha}Q^{\beta-1}f_{a,b}(\tilde{\theta})\tilde{\theta}}{1 + N\beta(1+\beta)cL^{-\beta}\mu^{\alpha}Q^{\beta-1}f_{a,b}(\tilde{\theta})}$$

where $Q = N\int_{\tilde{\theta}}^{1} dF_{a,b}$ and $\tilde{\theta} = \frac{p}{\mu}$. Evaluating this derivative at the socially optimal bundle $(\bar{\theta}, \bar{\mu})$, we have

$$p'(\bar{\mu}) = \frac{(1+\beta)cL^{-\beta}\bar{\mu}^{\alpha}\bar{Q}^{\beta}\left[(1+\alpha) + \beta N\bar{Q}^{-1}f_{a,b}(\bar{\theta})\bar{\theta}\right]}{1 + N\beta(1+\beta)cL^{-\beta}\bar{\mu}^{\alpha}\bar{Q}^{\beta-1}f_{a,b}(\bar{\theta})}.$$

Condition (10) can then be written as

$$(1+\beta)cL^{-\beta}\bar{\mu}^{\alpha}\bar{Q}^{\beta}\int_{\bar{\theta}}^{1} dF_{a,b}\left[(1+\alpha) + \beta N\bar{Q}^{-1}f_{a,b}(\bar{\theta})\bar{\theta}\right] > \int_{\bar{\theta}}^{1}\theta dF_{a,b}\left[1 + N\beta(1+\beta)cL^{-\beta}\bar{\mu}^{\alpha}\bar{Q}^{\beta-1}f_{a,b}(\bar{\theta})\right]$$

that is,

$$(1+\alpha)(1+\beta)cL^{-\beta}\bar{\mu}^{\alpha}\bar{Q}^{\beta}\int_{\bar{\theta}}^{1} dF_{a,b} > \int_{\bar{\theta}}^{1}\theta dF_{a,b} + N\beta(1+\beta)cL^{-\beta}\bar{\mu}^{\alpha}\bar{Q}^{\beta-1}f_{a,b}(\bar{\theta})\int_{\bar{\theta}}^{1}(\theta-\bar{\theta})dF_{a,b}.$$

Taking account of (2), we can rewrite this last condition as

$$(1+\alpha)(1+\beta)cL^{-\beta}\bar{\mu}^{\alpha}\bar{Q}^{\beta}\int_{\bar{\theta}}^{1} dF_{a,b} > N^{-1}(1+\alpha)cL^{-\beta}\bar{\mu}^{\alpha}\bar{Q}^{1+\beta} + N\beta(1+\beta)cL^{-\beta}\bar{\mu}^{\alpha}\bar{Q}^{\beta-1}f_{a,b}(\bar{\theta})\int_{\bar{\theta}}^{1}(\theta-\bar{\theta})dF_{a,b}$$

or equivalently

$$(1+\alpha)cL^{-\beta}\bar{\mu}^{\alpha}\bar{Q}^{\beta}\int_{\bar{\theta}}^{1} dF_{a,b} > (1+\beta)cL^{-\beta}\bar{\mu}^{\alpha}\bar{Q}^{\beta}\left[\int_{\bar{\theta}}^{1} dF_{a,b}\right]^{-1} f_{a,b}(\bar{\theta})\int_{\bar{\theta}}^{1}(\theta-\bar{\theta})dF_{a,b}$$

where we have used $\bar{Q} = N\int_{\bar{\theta}}^{1} dF_{a,b}$. Equation (11) follows.

Proof of Lemma 1

Still under way. The result has been proven for $a \in \{1,2,3,4\}$ and $b \in \mathbb{N}_{++}$.

Proof of Lemma 2

First note that, for $(n,p) \in \mathbb{N}^2$,

$$\begin{aligned}
\int_x^1 \theta^n (1-\theta)^p d\theta &= \int_0^{1-x} \theta^p (1-\theta)^n d\theta \\
&= \int_0^{1-x} \theta^p \sum_{k=0}^{n} \mathrm{C}_n^k (-\theta)^k d\theta \\
&= \sum_{k=0}^{n} \mathrm{C}_n^k (-1)^k \int_0^{1-x} \theta^{p+k} d\theta \\
&= \sum_{k=0}^{n} \frac{\mathrm{C}_n^k (-1)^k}{p+1+k} (1-x)^{p+1+k}.
\end{aligned}$$

Thus, we have

$$\int_{\bar{\theta}}^1 \theta^a (1-\theta)^{b-1} d\theta = \sum_{k=0}^{a} \frac{\mathrm{C}_a^k (-1)^k}{b+k} (1-\bar{\theta})^{b+k}$$

and

$$\int_{\bar{\theta}}^1 \theta^{a-1} (1-\theta)^{b-1} d\theta = \sum_{k=0}^{a-1} \frac{\mathrm{C}_{a-1}^k (-1)^k}{b+k} (1-\bar{\theta})^{b+k}.$$

We thus have

$$\begin{aligned}
h(\bar\theta) &= \frac{\bar\theta^{a-1}(1-\bar\theta)^{b-1}\left[\sum_{k=0}^{a}\frac{\mathrm{C}_a^k(-1)^k}{b+k}(1-\bar\theta)^{b+k}-\sum_{k=0}^{a-1}\frac{\mathrm{C}_{a-1}^k(-1)^k}{b+k}\bar\theta(1-\bar\theta)^{b+k}\right]}{\left[\sum_{k=0}^{a-1}\frac{\mathrm{C}_{a-1}^k(-1)^k}{b+k}(1-\bar\theta)^{b+k}\right]^2}\\
&= \frac{\bar\theta^{a-1}(1-\bar\theta)^{-1}\left[\sum_{k=0}^{a}\frac{\mathrm{C}_a^k(-1)^k}{b+k}(1-\bar\theta)^{k}-\sum_{k=0}^{a-1}\frac{\mathrm{C}_{a-1}^k(-1)^k}{b+k}\bar\theta(1-\bar\theta)^{k}\right]}{\left[\sum_{k=0}^{a-1}\frac{\mathrm{C}_{a-1}^k(-1)^k}{b+k}(1-\bar\theta)^{k}\right]^2}\\
&= \frac{\bar\theta^{a-1}\left[\frac{1}{b}+\sum_{k=1}^{a}\frac{\mathrm{C}_a^k(-1)^k}{b+k}(1-\bar\theta)^{k-1}-\sum_{k=1}^{a-1}\frac{\mathrm{C}_{a-1}^k(-1)^k}{b+k}\bar\theta(1-\bar\theta)^{k-1}\right]}{\left[\sum_{k=0}^{a-1}\frac{\mathrm{C}_{a-1}^k(-1)^k}{b+k}(1-\bar\theta)^{k}\right]^2}.
\end{aligned}$$

Hence, $h(1)=\frac{\frac{1}{b}-\frac{a}{b+1}+\frac{a-1}{b+1}}{\frac{1}{b}}=\frac{b}{b+1}$.