WORKING PAPERS

N° 17-866

November 2017

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Abstract

Collective labels are widespread in food markets, either separated or nested with private brands; the latter known as *nested names*. We propose a model to explain the rationale of nested names, with collective labels being effective in reaching unaware consumers while individual brands help firms to reach aware consumers. We also incorporate the decision-making within the group of producers joining collective labels, taking into account their heterogeneity in providing quality. We show that nested names emerge when consumers become more aware of information on the label's quality and when producers become more heterogeneous. Welfare may decrease, however, when the group switches to nested names, because nested names may lead to lower quality incentives for the majority producers. The results also provide insights into the historical and recent trends in food industries, such as within-label differentiation and label fragmentation, and their welfare implications.

JEL classification: D71, D83, L15, L66, Q13.

Keywords: nested names; individual brands; collective labels; consumers' awareness; producer heterogeneity; quality provision.

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1 Introduction

Agricultural producers and food firms can build their own brands, but they can also join collective labels, such as the Protected Designation of Origin (PDO) and Product of Geographical Indication (PGI) labels in the European geographical indication system that was formally established in 1992 at the EU level (EU Reg. 2081/1992). The coexistence and the simultaneous use of private brands and collective labels is also common in agricultural and food markets. Such a labeling strategy, known as 'nested names', has received attention in recent empirical studies (see, e.g., Costanigro et al., 2010). In this article, we introduce an original model to investigate the choice of labeling strategies when firms can use both individual brands and collective labels.

One of the objectives of promoting collective labels is to ensure the quality of regional products (see, e.g., article 1 of Regulation (EU) No 1151/2012). Besides Europe, collective labels are given public recognition and support at regional and national government level in many countries. In the USA, for instance, American Viticultural Areas (AVA) have been in use since 1978. New Zealand has decided to bring into force the so-called 'GI Act' to acknowledge and register Geographical Indications (GIs) produced domestically and abroad. In British Columbia, wineries may join Vintners Quality Assurance (VQA) standards. More recently, China's emerging Ningxia wine region has announced plans for its first winery classification based on a Bordeaux-like system (Wu, 2016). Besides wine, one could also mention Colombian coffee, Jaffa oranges from Israel, Anji and Longjin tea from China, and many other examples throughout the world.

The EU has long been seeking recognition for these collective labels, while other countries have preferred to rely on private brands and have maintained a more lenient approach towards the possible 'improper' use of foreign collective names by domestic firms. A great deal of controversy in recent trade negotiations between the EU and Canada on the one side (Comprehensive Economic and Trade Agreement) and the USA on the other side (Transatlantic Trade and Investment Partnership) has surrounded GIs (see, e.g., Breteau and Audureau, 2016). As the use of collective labels is spreading throughout many countries and evolving towards more nested names and proliferation, some questions emerge naturally. What are the firm's best labeling strategies: to use collective labels or nested names? How is product quality chosen under different labeling schemes? Are firms' labeling strategies good or bad for economic welfare? Do they deserve preferential treatment – if not explicit subsidization – by governments and policy-makers?

The effects of collective schemes such as GIs have been studied quite extensively. The empirical evidence suggests that private brands and collective labels, used separately or jointly, may have disparate impacts on consumers' quality perception.[1] Despite the large number of empirical studies on the simultaneous use of different labels for food products,

[1] For example, Bonnet and Simioni (2001) and Hassan and Monier-Dilhan (2006) show that consumers are willing to pay a price premium for brand names. Deselnicu et al. (2013) find that collective labels, such as PDOs, can add value to food products. Loureiro and McCluskey (2006) show that for beef meat the PGI label is mostly valued by consumers for cuts of average quality. Similar evidence has been found in the US wine market (Costanigro et al., 2007). Costanigro et al. (2010) argue that individual brands and collective labels can be complementary: the evidence in the wine sector shows that collective (or aggregate) names add price premia to expensive wines using firm-specific names.

on the theoretical side there are only a few studies that explicitly take into consideration this coexistence. Most of the models in this vein assume that labels convey full information or can perfectly inform consumers at some cost (see, e.g., Crespi and Marette, 2001 and Moschini et al., 2008 among others). Zago and Pick (2004) for instance, consider the market segmentation effect of the label, showing that its welfare effects are positive when the high-quality segment remains sufficiently competitive. Labels have also a differentiation effect, transforming a homogeneous market into a differentiated one – with a possible detrimental effect for some consumers – thus making the labeling policy less appealing than a mininum quality standard (Baltzer, 2011).

An exceptional case is that of Bonroy and Constantatos (2008), who consider the situation of an 'imperfect' label, that is, when the labeling information is not perceived by all consumers. They identify two types of labels: an 'easy-to-grasp' label that can improve the information for unsophisticated consumers, and a 'sophisticated' label that provides detailed information but is totally ignored by unsophisticated consumers. They derive the welfare impact of these labels under a two-quality duopoly structure. However, in their analysis they do not investigate the coexistence of different labels, nor do they consider the endogenous quality choices under different labeling patterns.

Another strand of literature studies the reputation effects of brands or labels for credence goods. While most work investigates individual and collective (or regional) reputations independently (see, e.g., Tadelis, 1999, Mailath and Samuelson, 2001, and Shapiro, 1983 for firm individual reputations; Tirole, 1996, Winfree and McCluskey, 2005, and Fishman et al., 2014 for collective or regional reputations), very few works consider the coexistence of different labels. Costanigro et al. (2012) investigate the quality incentives of firms choosing nested names. They devise a model of a differential game that combines Shapiro's (1983) model of private reputation and Winfree and McCluskey's (2005) model of collective reputation. Using simulations, they find evidence consistent with Costanigro et al. (2010), that is, private reputations become more valuable than collective ones the more expensive the product is. However, the model mainly focuses on the dual reputation effect of the nested names, without investigating the endogenous formation of other labeling schemes, for example, the individual brand and collective label emerging separately. Moreover, they do not provide the implications of different labeling schemes in relation to quality provision and social welfare.

In this paper, we develop an original model to analyze the labeling strategies of producers within a region, taking into account their different impacts on consumers' perception about product quality and the effects on producers' quality investment incentives. Our analysis builds on the evidence of Costanigro et al. (2010; 2012), but adds also to the theoretical literature on labeling. We can thus explain recent industry trends. As is further illustrated in Section 2, when producers sharing a common regional label have different quality potentials, divergent interests concerning the quality rules within the collective label may emerge. Differentiation within the label may follow, with some producers using nested names, while others hold on to the collective label only.

These trends and controversies are difficult to reconcile with existing models of quality labels. For example, most of the models in the labeling literature consider two types of producers, but once the label is introduced it usually leads to a market segmentation between high- and low-quality producers, where producers within each segment are homogeneous

(Bonroy and Constantatos, 2015).[2] Moreover, Costanigro et al. (2012) show results in which nested names are associated with heterogeneity, leading to the conclusion that nested names "are inherently prone to intra-regional controversies" (p. 262). Given our results, we would argue for a reverse causality, that is, for the alternative testable hypothesis that nested names may emerge when firms are heterogeneous.

Our first contribution is to capture the heterogeneity of consumers regarding the information they have or that they can collect about the quality implied in the labeling schemes. While some consumers are aware about the firm-specific brands, the general public tends to be unaware about the brand information. Instead, they are more likely to be informed about or by the collective label, which conveys information on the average quality in the region. High-quality producers may therefore join a collective label that has negative spillovers for them in order to access consumers who may be unaware of their individual brands. We thus propose an economic rationale for a phenomenon usually explained in terms of product differentiation involving heterogeneous consumers.

Our second contribution is to incorporate heterogeneity across producers within the group that chooses the labeling strategies and the associated quality standards. We show how choices of quality standards and labeling strategies can differ according to which type of producers have more influence within a group and on the available outside options. We thus explain the emergence of label differentiation, showing how an increase in the degree of heterogeneity may lead to different labeling choices and hence name patterns, that is, from collective labels to nested names or separated labels.

In the next section, we describe recent cases that illustrate the coexistence of different labeling schemes and some controversies that emerge when groups decide on the quality rules within the collective label. In Section 3, we introduce the model, highlighting the information structure underlying the possible name patterns. In Section 4, we determine the equilibrium name patterns that emerge and the associated welfare impact. In Section 5, we discuss the robustness of our main results to alternative specifications of the model. In the final section, we discuss the policy implications, and conclude.

2 Industry trends

The coexistence of private brands and collective labels is common in the wine industry, where well-known firms typically use private brands together with regional brands, while other firms benefit mostly, if not only, from the PDO. This is the case, for instance, in Valpolicella, the second most important region for red wine production in Italy. Here, some of the major wine producers with established brand names have grouped into the *'Famiglie dell'Amarone d'Arte'*. Historically, they have been one of a number of firms to heavily invest in the Amarone production technology and have established a worldwide reputation for their wines. These firms recently argued vehemently against the *Consorzio per la tutela dei vini Valpolicella*, the body managing the PDO and to which all its wine producers belong, as a

[2] In the reputation literature, on the other hand, the high-quality producers establish a collective label to separate from low-quality firms, and therefore there is no differentiation within the collective label group (see, e.g., Fishman et al., 2014).

significant part of Amarone production is taking place in valley vineyards.[3]

This valley production, though, is in contrast to the long established PDO rules that have allowed Amarone to be produced mainly in the 'classical', that is, traditional, hilly areas. The Consorzio di Tutela has recently suggested amending its own rules to explicitly allow for the production of Amarone in plain vineyards as well (dell'Orefice, 2013). However, different firms, notably those grouped into the *Famiglie dell'Amarone d'Arte*, were against such changes, arguing that Amarone production should remain confined to the hilly areas where quality is higher (Guerrini, 2013a).[4] Some of these firms have also threatened to leave the PDO (Guerrini, 2013b) and to use their separate names only.[5] In May 2013, the general assembly of producers, following a suggestion by the Board of Directors, confirmed in a majority vote the possibility of producing Amarone in the valley areas. The decision was probably not a surprise, given that, "The voting system, which is based on grapes' production quota, has given an advantage to the bigger producers who were in favor of the extension" (Costanzo, 2013).

Similar to the Valpolicella case is the situation that has emerged in Oltrepò Pavese, where some of the major and well-known producers have recently left the official *Consorzio di Tutela*. Dissatisfied with the quality policies and its attempts to allow greater yields (thus lowering quality), they accuse the Consorzio of being more concerned with the interests of wine-bottlers than wine-makers because of the distribution of voting rights: "Many wine producers do not feel represented by Consorzio, because its bylaws link production levels to voting rights. With this rule, a single firm, Terra d'Oltrepò controls the votes in the assembly and hence the activities of Consorzio, since it produces over 50% of the wine in the area" (Morra, 2015: 10). And, "given that this firm produces bulk wine to be sold to wine-bottlers, it is these latter's interests that really count" (Bertolli, 2015).

There are also other instances in which groups in the past have split, often when some producers have left the original PDO controlled by so-called 'too conservative' or lower-quality firms. Probably the most famous is the case of Tuscany, where in the last decades the Chianti PDO has expanded, differentiated within (with the original sub-zone distinguishing it as 'Chianti Classico') and even witnessed the exit of some innovative producers, which have left the Chianti PDO (and their required Sangiovese, plus local varieties blend) to experiment blending with other international grapes, that is, Cabernet or Merlot.[6] A more

[3]Firms in Valpolicella produce different types of red wine, but in the last decades, Amarone – the strongest and most full-bodied variety – has been fetching prices well above those for other red wines coming from the same area and grapes. Historically, Amarone was produced mostly in hilly areas, considered to be better suited for the higher-quality grapes. Over the years, however, because of an increasing demand, Amarone wine production has been quietly but steadily extended to other production areas as well, in particular to the plain valleys, where yields are higher but quality is purportedly lower.

[4]S. Boscaini, owner of Masi, explained that, "I'm not convinced that Valpolicella should be made outside the hills. The Classico region is historically one of small growers, but the rest is 90% co-ops, and they try to minimise the differences between the original area and the additional area. I'm not saying that they can't make great wine. But [increasing the size of the AOC] has been a disaster for Valpolicella, driving it down in quality" (Rand, 2013 : 38).

[5]However, by leaving the PDO they could not use 'Amarone della Valpolicella', which is a world-recognized collective label.

[6]These instances of separating producers have led to the production of the so called 'Super-Tuscan' wines, that is wines using international grapes (not allowed by the Chianti regulation). These could initially be produced only outside the PDO rules as 'table wines', thus using only the producers' individual brands.

recent case is in the Rioja region, where one of the most well-known producers left the PDO, with others threatening to follow suit, due to their dissatisfaction with the PDO's labeling rules (Mount, 2016).

We believe the Valpolicella and these other cases are emblematic of the situations we represent with our model. Many producers share a collective label which is recognized by consumers and the market, but they are of different quality potentials. Possible opportunities (or threats) require changes in the (quality) rules adopted by the group, but different producers may have divergent interests and so hold different positions on the matter. Some may be concerned that the suggested changes may lower the quality of the product (or its perception by consumers). To decide on the rule to adopt at the group's level, a collective decision-making mechanism is used, for example, the majority rule. Producers not satisfied with the adopted decision may consider distinguishing themselves within the collective brand (by using nested individual brands, as seen in Valpolicella) or leaving the group altogether with separate names (still only a threat in this case, while a reality in other regions such as Chianti and Oltrepò).

3 The model

To analyze the economics of nested names, we develop a model rich enough to enable the analysis of endogenous quality choices and labeling strategies. Nevertheless, the setting should be simple enough to reveal the basic rationale and effects behind these strategies, including the information effect on consumers' perception over quality, and the potential spillovers among producers with heterogeneous qualities. For this purpose, we start with a simple model with fixed-quantity monopolistic producers facing consumers with homogeneous tastes over quality. We thus abstract from the traditional motive of product differentiation in attracting consumers with heterogeneous tastes and focus on the strategic motive of producers to use different labels to balance the conflicting interests within a group. In Section 5 we show that such a motive still exists in a more generalized setting, taking into account consumers' heterogeneous tastes, producers' competition, and the possibility of label signaling.

3.1 Basic setting

Consider an economy with a unit mass of risk neutral consumers, who face a unit mass of producers of a region. Each consumer purchases one unit of the product. The utility function is $U(s,p) = s - p$ if the consumer purchases, and $U(s,p) = 0$ otherwise, where s denotes the quality of the product and p its price.

Each producer provides at most one unit of product. Producers are heterogeneous in quality provision. We assume that there are two types of producers (denoted by H and L). A proportion β of producers (type H) can *intrinsically* provide high quality δ at zero cost. The other proportion $(1-\beta)$ of producers is of type L and can only provide quality s, with $s \in [s_0, \delta)$, where s_0 is the lowest quality in the market, corresponding to the minimum quality standard level. The production cost is $\Phi(s)$, where $\Phi' > 0, \Phi'' > 0$. We assume $\Phi(s_0) = \Phi'(s_0) = 0$ and $\Phi'(\delta)$ is high enough ($\Phi'(\delta) > 1$ in our setting) so that the L type

Eventually, the exiting producers were allowed to start a brand-new PDO, Bolgheri.

producers have no incentive to reach the quality level of the H type, although they would set a standard higher than s_0 if the quality were known to consumers. To this end, δ reflects the degree of heterogeneity of these two types of producers in their ability to provide quality. The higher the δ, the more likely it is that the quality of the L type differs from that of the H type.[7] With such a setting, the H type producers behave 'mechanically' and commit to the high quality δ, whereas the L type producers behave opportunistically in choosing quality, affecting the overall quality level in the market.[8]

The assumption that the H producers can achieve high quality without unnecessary cost is a simplification of our model, but it is consistent with the geographical nature of many regional products, where some producers enjoy appropriate weather and soil conditions as compared to those located in other parts of the same region. In France, for instance, which "produces among the best wines in the world [..] and defines, classifies, and controls them in more detail and has a longer history of this [..] than any other country" (Johnson and Robinson, 2013: 46), the Burgundy classification system is the most sophisticated, with a very long tradition of classifying vineyards to find the best quality *climats*, that is, plots of land. Its soil quality is very heterogeneous and this, together with differences in altitude and exposition, has always led to wines of "almost unpredictable quality" (Johnson and Robinson, 2013: 48). However, over time traders have learned to distinguish the quality of wines coming from different climats, and so the prices of the grapes have reflected the quality potential of different plots. The best plots were those *able to give quality wines consistently across years with different weather conditions*. In short, nowadays pundits continue to argue for the Bungundy classification system, given that "the general validity of the hierarchy is well supported by the market" (Lewin, 2010, our italics).[9] In what follows, we fix the quality of H producers but focus on the quality choices for the L type producers, which can be stipulated in the quality standard of the collective label.

First best Under perfect information, all consumers are perfectly informed about the product quality. The first-best quality level is defined as the quality of the L type producers which maximizes total social welfare:

$$\max_s W(s) = \beta\delta + (1-\beta)(s - \Phi(s)).$$

[7] A more standard measure of the producers' heterogeneity is the cost difference between L and H. In our setting, the cost of producing quality δ for the two types is $\Phi(\delta)$ and zero, respectively. The cost difference is thus $\Phi(\delta)$, which increases monotonically with δ. We thus use δ to measure the efficiency difference between the two types.

[8] Such a setting is similar to the imitation approach in the reputation literature (see, for example, the survey of Bar-Isaac and Tadelis, 2008 and the seminal paper of Kreps and Wilson, 1982), with the good type being a 'commitment' type and the bad type being a 'strategic' type who tries to imitate the good type in order to benefit from a high price premium. However, instead of investigating the individual incentive in building up reputations, we focus on the quality and labeling choices at a collective level, which have different information effects compared to the individual strategy of reputation building. We also assume absence of fraud (see, e.g., Di Fonzo and Russo, 2015, for an explicit treatment of this).

[9] An interesting case is the appellation of Montagny, on the Côte Chalonnaise, where producers between 1989 and 1991 voluntarily decided to reduce the number of Premiers Crus, that is, the second-top tier climats. "There were plenty of private and public spats over which vineyards kept their status [..] but the fact remains that the winemakers had seen over the preceeding decades that *certain plots in Montagny made unquestionably better wines than others*" (Anson, 2016, our italics).

The first-order condition gives the first-best quality level s^*:

$$1 = \Phi'(s^*). \tag{1}$$

This standard result implies that in the first-best quality level, the marginal valuation of the low-quality type is equal to her marginal production cost.

A more realistic situation is that products have a credence good nature and their attributes cannot be readily assessed by consumers. In the following subsection, we specify the information structure of consumers.

3.2 Information, name patterns, and spillover effects

When quality is not observable, in the absence of any label or brand, consumers have no information and expect only the lowest quality s_0 for the product they purchase; a typical lemon market outcome under information asymmetry (Akerlof, 1970). Labels and the associated names may convey some information on product quality to consumers. However, consumers are often *heterogeneous* regarding the information they have (or can collect) about the quality embodied in the product and how they can benefit from labeling schemes. In the spirit of Costanigro et al. (2010) and Bonroy and Constantatos (2008), we consider two types of consumers having different information about labels: 'aware consumers' accounting for α ($\alpha \in (0,1)$) proportion of the unit population, and 'unaware consumers' with proportion $1-\alpha$. Moreover, we consider two kinds of labeling strategies: individual brands (denoted by 'I') and collective labels ('C'). The principles (i.e., assumptions) of these strategies are defined as follows:

Assumption 1 ***Individual brand (I)****, adopted by individual producers at cost f, can inform the aware consumers about the true quality of the product but provides no information to the unaware consumers.*

This assumption captures the idea that individual brands developed to inform the knowledgeable consumers that the products carrying such a brand are of higher quality are necessarily costly. f captures the costs associated with the development of the brand, due to advertising, promoting and other measures needed to inform consumers, enforce property rights, and/or avoid counterfeiting. However, the individual brand can only inform an α proportion of the population. Without the collective label, unaware consumers cannot recognize the specificity of the brand and expect only the lowest quality of the market, that is, s_0.

Assumption 2 ***Collective Labels (C)****, developed by the group of producers in a region at no cost, can inform both the aware and unaware consumers about the average quality of the group.*

The collective label can be seen as a common regional label that certifies the producers meeting the quality standard s. The quality standard is defined in the code of practice, which is open for the public with the label certification. Therefore, consumers (both the aware and unaware) know the minimum quality of the label, but may not know the precise quality level of a producer belonging to the collective label. This assumption captures the idea that a collective label can reach more of the general public than the specific names. For instance, an unaware consumer cannot recognize the quality of a given Valpolicella producer alone, but she can infer the quality from the regional Valpolicella label, while aware consumers can have a good knowledge of the different producers. In order to develop the collective label, costs due to certification, advertising, promotion, etc., arise, and are shared among the producers in the regional group. We assume that the producer mass is large enough that the cost born by each producer is negligible.

Overall, these assumptions are consistent with experimental evidence. For instance, Gustafson (2015) investigates the effects of information provisions regarding Napa Valley and its Oakville nested AVA, of supposedly better reputation. The experimental evidence shows that, "high knowledge consumers value Oakville more than Napa Valley while the sample of participants on average valued Napa Valley more than Oakville" (p. 41). They also match common industry trends.[10] In addition, these assumptions can be justified in terms of search costs as well (see, e.g., Varian, 1980, Chan and Leland, 1982): aware consumers ('informed consumers' in their jargon) pay lower search costs and can easily spot their favorable products, whereas unaware consumers base their choices on the average product characteristics. Moreover, assumptions about the branding and labeling costs capture the idea that informing consumers is costly but enjoys some scale efficiency, that is, the larger the group's size, the smaller the cost born by an individual producer.[11]

Various name patterns may emerge as a result of the combination of different labeling strategies adopted by the L and H producers. We focus on three name patterns: the uniform name (denoted by U) adopted by both L and H producers in the region; nested names (N), under which the H type producers develop their individual brand, using it together with the collective label of the region; and separate names (S), under which the H producers develop their individual brands separately from the collective label. Based on assumptions 1 and 2, Table 1 summarizes consumers' quality perceptions under the three name patterns.

Table 1: Quality perceptions under different names

Name patterns	Labeling Strategies	Aware consumers' perception	Unaware consumers' perception	Spillover Effects	Examples
Uniform name (U)	L: C H: C	$\bar{s}$ $\bar{s}$		In both aware and unaware market	Previous Chianti & previous Valpolicella
Nested names (N)	L: C H:$C+I$	s δ	$\bar{s}$ $\bar{s}$	Only in the unaware market	Valpolicella, Rioja, Bordeaux, etc.
Separate names (S)	L: C H: I	s δ	s s_0	No spillover effect	Chianti vs. Super-Tuscans

[10]For instance, regarding the US market for young consumers, industry practitioners suggest "not to enter the US market alone, but grouped with other wine producers with the same regional identity" (LARVF, 2015).

[11]The model can be extended to a more general setting where the costs of informing consumers vary with the proportion of aware consumers (α) and the group's size (denote by z), that is, $F(\alpha, z)$, with $F(\alpha, z) \in [0, f]$ and $F_\alpha > 0$ and $F_z \leq 0$. Our simple setting implies that $F(\alpha, 0) = f$ for individual brands I and $F(\alpha, 1) = 0$ for the collective labels C.

$\bar{s} = \beta\delta + (1-\beta)s$: Average quality of the collective label;
s_0: Minimum quality standard.

Table 1 suggests that consumers' perception about the product's quality varies according to the awareness of the consumer and the labeling strategies under different names. Under the uniform name (U), where both the L and H producers adopt the same collective label, consumers know of the existence of the two qualities s and δ, but cannot distinguish which quality is the product they purchase. Therefore, they see the products of L and H as homogeneous, with an average quality $\bar{s} = \beta\delta + (1-\beta)s$. Such a case corresponds with the previous situation of Valpolicella and Chianti PDOs in the 1970s, before the creation of the new PDO Chianti Classico and/or the establishment of individual brands.

Under the nested names (N), where individual brands are developed in addition to the collective label, a similar situation occurs for the unaware consumers who have no knowledge over the brands and perceive all products with the average quality $\bar{s}$. However, the aware consumers are able to distinguish the true quality with the help of the individual brands (Assumption 1). This name pattern corresponds to Valpolicella wines and to many other cases, such as Bordeaux and Rioja, to name only two.

Last, under the separate names (S), the L producers maintain their own collective label without the participation of the H producers, possibly because these latter producers have left the group. Consumers know the composition of the group and hence can identify the true quality of the collective label s (which is also the average quality of the group). However, without being nested with the collective label, the individual brands of H only reveal the true quality to the aware consumers. In the eyes of the unaware consumers, they are not different from the spot market quality s_0 and, again, the lemon market problem arises for H in the unaware market. This name pattern may correspond with the emergence of Super-Tuscan wines, before the creation of the new Bolgheri PDO, and to other cases emerging in different countries (see, e.g., Lewin, 2014 for France, and Mount, 2016 for Spain).

The quality perception specified in Table 1 reveals an important effect of our setting, that is, the spillover effects. Whenever consumers lack precise information and perceive the average quality $\bar{s}$ for the products they purchase, the L producers benefit from positive spillovers with their product being perceived as being of higher quality than its true level ($\bar{s} > s$), whereas the H producers suffer from negative spillovers due to a lower perceived quality ($\bar{s} < \delta$). The spillover effects are higher under the uniform name, reduced somewhat with nested names, and reduced further in the unaware market with separated names.

Table 1 thus summarizes three cases in which the L producers always use the collective label, while the H producers have the option of choosing individual brands, together or separate from the collective label. There may be three other possible cases: first, producers have no incentive to adopt any labels or brands; second, the L producers adopt their own individual brands; or third, the H producers develop their collective label without the participation of the L producers.

The first case may correspond to the situation in which labels convey no information, because of, for example, a lack of well-defined property rights, such as is the case in developing countries where the 'quality standard' is then equal to the minimum level. In our setting, both producers are clearly better off under the collective label defined in Assumption 2. Indeed, the collective label informs the consumers that their qualities are at least at the level s, instead of the spot market minimum level s_0.

In the second case, the L producers may choose to display their individual names on their products. But this is not a means of informing the consumers about their products' true quality, which may be of lower quality in the region. We assume that there is some minimum branding level normalized to zero for the L producers,[12] for example, the winery's bottle label, and we refer to the individual brand as the one defined in Assumption 1. For producer L, individual branding would entail cost f without generating any positive spillover or benefit. Hence, such a strategy is clearly dominated by the collective label.

In the last case, if the collective label of the H producers can costlessly inform the aware and unaware consumers about the true quality δ (which is also the average quality of the H group), the H group would certainly adopt such a label. The L producers, being those without the high-quality collective label, would not benefit from any spillover effects of the label. We are thus in the first-best (perfect information) situation. A more interesting setting is that the H producers can hardly form a group to develop a collective label, or if they can, the label cannot perfectly inform all the consumers about the true quality. For example, when H producers are small-sized and cannot coordinate to develop their own collective label, or the cost of certifying and marketing the collective label is too high to be shared among a limited number of H producers. In what follows, we investigate the situation in which the H producers cannot coordinate to form the collective label, leaving the alternative cases to be discussed in Section 5.1. In summary, we rule out the possibilities of no labels, costly individual brands by the L producers, and high quality collective labels by the H producers. Thus, we are left with the three name patterns in Table 1.

3.3 The game

We investigate the emergence of the different types of names from an initial market structure where all producers form a coalition in a given region and where the name can only be used by the producers who are members of this coalition.[13] The quality and labeling decisions are described in a three-stage game:[14]

- In stage 1, the producers' coalition designs the code of practice, which defines the quality standard s for the collective label;
- In stage 2, producers, observing the quality standard, decide whether to adopt the collective name only, or to develop their individual brands separately, or to develop their individual brands nested with the collective name;

[12] We thank an anonymous referee for suggesting this.

[13] This market configuration is consistent with the existing GI labeling system in the EU, in which for many products there exist a uniform group. Moreover, we astray from problems of sequential joining by heterogeneous producers (as argued in Carter, 2015). We leave these alternative scenarios for future work.

[14] Another timing of the game, where the name pattern is chosen before the choice of the quality standard, could also have been considered. We can show that it would generate similar qualitative results.

- In stage 3, given the labeling strategies, each producer (H and L) randomly meets a consumer and decides the price. Consumers decide whether or not to buy from the producer.

The first stage of the game involves the producers who are within the coalition to make a collective decision on the level of the quality standard of the collective label. However, a consequence of producer heterogeneity is that producers will have conflicting interests. The quality choice thus depends on the decision process within the coalition of producers and on how the coalition balances the divergent interests within the group. We assume a simple *majority rule*: the quality standard is designed in the interests of the type of producers with the largest population, anticipating the possible reaction of the other types when making the quality decision. As shown in Section 2, the majority rule is a common decision-making process within the producer groups using collective labels, for example, in Valpolicella and Oltrepò Pavese. In a given region, producers with intrinsically high qualities are often small in number. We thus assume that the L producers have the majority (i.e., $\beta < \frac{1}{2}$) and focus on a 'L-majority rule', under which the group of L producers makes the quality decision such that it maximizes L's profits, while trying to balance the conflicting interests of H.[15]

The second stage of the game specifies the name pattern chosen by producers under a predetermined level of quality standard for the collective label. Provided that the L producers will stick to the collective label, the name pattern hinges on the labeling choice of the H producers. Specifically, the three name patterns described in Table 1 correspond to the choice made by H producers to adopt the collective label without individual brands (i.e., the name 'U'), to develop the individual brand nested with the collective label ('N') and to develop the brand without the collective label ('S'). It should be noticed that such timing corresponds to the situation where the H producers are *passive* towards the quality standard of the established collective label. In Section 5.1 we discuss an alternative situation where the H producers are strongly rational and anticipate that their labeling choices will have an impact on the standard setting made by the group.

The third stage of the game involves individual pricing decisions, which depend on the competition setting and on the possibility for producers to price discriminate. Competition among producers may affect their labeling choice, generating new effects in addition to the spillover effects. To disentangle these effects, we first investigate the case where producers behave as monopolists on the market so that they can charge up to the consumers' willingness to pay, which depends on the quality perception of consumers. We will then discuss the additional impact of competition in Section 5.4.

The quality perception can differ depending on the type of consumers. Table 1 shows

[15]The L-majority rule is obviously a simplification of the decision process inside the coalition. Depending on the distribution of the producers, their political power or their ability to bargain, there may exist other decision rules which affect the equilibrium name patterns and the level of quality standards. Our results will be affected if the political power of the H producers becomes more important, because the decision will then be biased towards their interests. In this case, the H producers would choose the highest standard δ to prevent the negative spillover of the L producers. As a result, the L producers, unable to reach such a high standard, will choose to separate from H and create their own collective labels in such a first-best (perfect information) situation. However this outcome can only be achieved when the H producers have the power and can implement the standard without cost. So long as the L producers have the power to choose the standard, our results will not qualitatively change.

that with the same label, the quality perception may be different for the aware and unaware consumers. In such a situation, monopolist producers may choose to discriminate among consumers and charge different prices according to their willingness to pay. Perfect discrimination is possible for instance when retailing channels are different, or when markets are geographically separated. For example, the Chinese market for Bordeaux wine becomes attractive not only because of the potential size of the market, but also because of the hugely overpriced bottles preferred by Chinese consumers (Thompson, 2015). In many other situations, however, it may be difficult or impossible to charge different prices and prevent consumers' arbitrage. In the following, we start with a simple case where each monopolistic producer can perfectly discriminate between the aware and unaware consumers. We shall discuss how the results may change when price discrimination is not possible in Section 5.2.

4 Equilibrium standard and name patterns

In this section, we first investigate the conflicting interests of producers under different name patterns and show how the quality standard may be set by the L group to balance the interests and achieve the desirable name pattern. We then derive the equilibrium name pattern, which may vary with the producer and consumer heterogeneities. Furthermore, we derive the welfare effects of the equilibrium labeling strategies and show how a particular name pattern impacts economic welfare.

4.1 Labeling choice under the quality standard

The game is solved by backward induction. The third stage pricing decision is easily derived: under perfect price discrimination, the monopolist producers can charge prices up to the consumers' willingness to pay. Given the utility function $U(s,p) = s - p$ defined in the basic setting (Section 3.1), the consumers' willingness to pay is equal to the level of the perceived quality, described in Table 1. We can then solve for the producers' labeling choice (stage 2), which depends on the comparison of the expected profits under the different name patterns, taking into account the different information conveyed by the collective label and individual brands. Denote by $\pi_i^j(s)$ the profit of a producer of type i ($i \in \{L, H\}$) under the name j, $j \in \{$'U', 'N', 'S'$\}$. The expected profits for each producer are derived in Table 2.

Comparing the profit levels under the different name patterns, the first result is that the separate name pattern 'S' is dominated by the other strategies for both the L and H producers. Indeed, the L producers cannot benefit from any spillover effect (captured by $\bar{s}$, with $\bar{s} > s$) when the H producers are not in the collective label coalition, while the H producers strictly prefer to be part of the collective label nested with their individual brand (N) and to be seen as $\bar{s}$ rather than being out of the coalition (S) and not being recognized by the unaware consumers.[16] We will thus focus on the comparison of the uniform name ('U') and nested names ('N').

[16]Situations where the separate name pattern can arise in equilibrium can be possible in other settings, e.g., when producers compete in price or when price discrimination is not possible. Such situations will be discussed in Section 5.

Table 2: Expected profits under different names

Name patterns	Labeling Strategies	Profit of L	Profit of H
U	L: C H: C	$\pi_L^U(s) = \bar{s} - \Phi(s)$	$\pi_H^U(s) = \bar{s}$
N	L: C H: C+I	$\pi_L^N(s) = \alpha s + (1-\alpha)\bar{s} - \Phi(s)$	$\pi_H^N(s) = \alpha\delta + (1-\alpha)\bar{s} - f$
S	L: C H: I	$\pi_L^S(s) = s - \Phi(s)$	$\pi_H^S(s) = \alpha\delta + (1-\alpha)s_0 - f$

$\bar{s} = \beta\delta + (1-\beta)s$;
s_0: Minimum quality standard.

Second, given the quality standard s, L producers strictly prefer the uniform name rather than the nested names, as they can benefit from the maximal spillover under the uniform name pattern while the spillover effect is reduced under the nested names pattern. Therefore, the second stage subgame equilibrium name pattern hinges on the choice of the H producers. Lemma 1 summarizes these results:

Lemma 1 *Under perfect price discrimination and monopolistic competition, for a given quality standard s:*
i) L producers strictly prefer the uniform name pattern;
ii) H producers prefer the uniform name pattern if and only if: $s \geq \hat{s}^U \equiv \delta - \frac{f}{\alpha(1-\beta)}$; otherwise, they prefer the nested names.

The inequality in Lemma 1 is directly derived from the comparison between the profits of H producers under the uniform and the nested names patterns, that is $\pi_H^U(s) \geq \pi_H^N(s)$. Intuitively, the H producers are facing a trade-off between developing costly individual brands to attract aware consumers, and using the uniform name only but suffering from the negative spillovers from L producers. They will choose the latter only if the L producers' quality is not too low.

From Lemma 1, the minimum threshold $\hat{s}^U$ required by H producers to be part of the uniform name pattern is higher the more heterogeneous producers are in quality provision ($\frac{\partial \hat{s}^U}{\partial \delta} > 0$), the greater the proportion of aware consumers ($\frac{\partial \hat{s}^U}{\partial \alpha} > 0$). When the heterogeneity between L and H producers and the proportion of aware consumers are high enough, the H producers will have an incentive to switch to the nested names pattern, while the L producers would like the H producers to adopt the collective label only. In this case, in which L and H have divergent interests over the name patterns, the L group may have an incentive to increase the quality standard to balance these divergences.

In stage 3, the L-majority sets the quality standard to maximize the profit of L producers, taking into account the possible impact on the labeling decisions. The problem of the L-majority is similar to a principal-agent problem, where the L group (the principal) proposes a standard s to the H producers (the agents).[17] The H producers decide whether to accept the contract or to reject it. If the H producers reject the contract – provided that the L

[17]We thank an anonymous referee for suggesting this interpretation.

producers always prefer the collective label to the individual names – the H producers can only deviate to develop their own individual brands, either by nesting it with the collective label ('N') or by separating altogether from the collective label ('S'). Formally, if the L-majority wants to implement the uniform name, it will choose the standard that maximizes the following problem:

$$\max_{s} \quad \pi_L^U(s) = \bar{s} - \Phi(s) \tag{2}$$
$$s.t. \quad \pi_H^U(s) \geq \max\{\pi_H^N(s), \pi_H^S(s)\};$$

where the second condition is the participation constraint for H producers to accept the uniform name pattern. Note that this condition is equivalent to the condition stated in Lemma 1, that is, $s \geq \hat{s}^U$. The results of problem (2) are summarized in Lemma 2.

Lemma 2 *The quality standard s^U chosen by the L-majority group in the uniform name case solves $1 - \beta = \Phi'(s)$ if and only if:*

$$\delta < \hat{\delta}(\alpha, \cdot) \equiv \frac{f}{\alpha(1-\beta)} + s^U. \tag{3}$$

Otherwise, the standard is set at $\hat{s}^U \equiv \delta - \frac{f}{\alpha(1-\beta)}$, with $\hat{s}^U > s^U$ and $\pi_L^U(\hat{s}^U) < \pi_L^U(s^U)$.

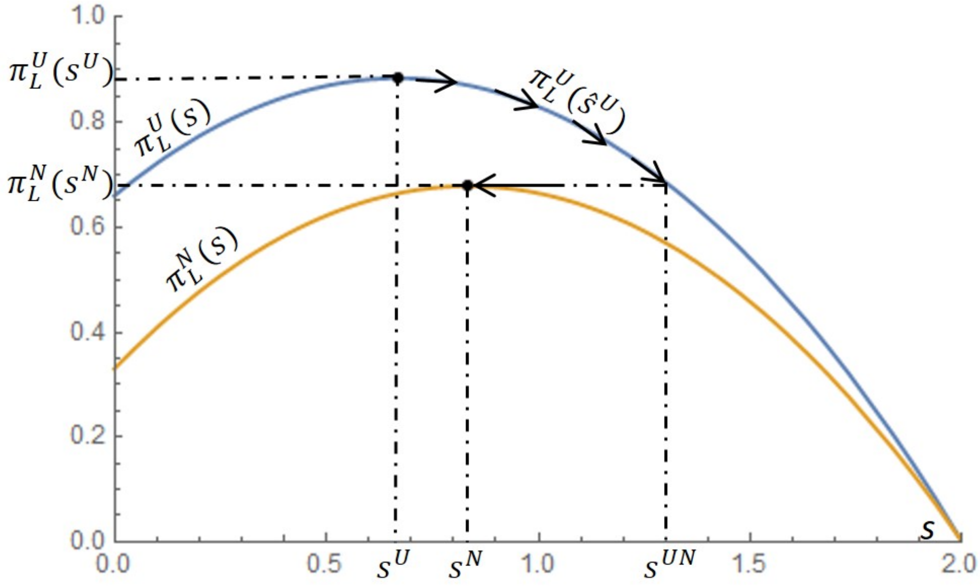
If the level of heterogeneity is not too high, the L group can set their optimal level of quality. However, if the level of heterogeneity becomes higher, the participation constraint of the H producers becomes binding and the L group has to 'distort' the quality standard up to $\hat{s}^U$ in order to keep the H producers in the uniform name pattern. This strategy is costly for the L producers as their profits will decrease with the level of the standard $\hat{s}^U$. We will refer to this situation as the 'constrained uniform name' case (denoted by 'CU').

The equilibrium standard setting depends on whether the L-majority wants to implement the uniform name or the nested names, which is determined by the comparison of L's profits under these two different name patterns. Figure 1 plots the profit curves of L under the uniform name ($\pi_L^U(s)$) and the nested names ($\pi_L^N(s)$). Because $\pi_L^U(s) > \pi_L^N(s)$, the curve $\pi_L^U(s)$ is above $\pi_L^N(s)$. Define s^N the standard that maximizes L's profit under the nested names "N".[18] It is easily shown that $s^N > s^U$ and $\pi_L^N(s^N) < \pi_L^U(s^U)$. The quality incentives for L under the nested names pattern are higher than under the uniform name because the latter enables the L producers to enjoy the maximum spillover from H and hence they have lower incentives to improve quality.

However, in equilibrium the quality standard has to take into account the participation constraint of H producers, which depends on the level of $\hat{s}^U$. When $\hat{s}^U$ is small ($\hat{s}^U \leq s^U$), this participation constraint is not binding. The L group achieves the maximum profit $\pi_L^U(s^U)$ with a uniform name 'U', choosing the (unconstrained) standard s^U. On the other

[18] Formally, if the L-majority wants to implement the nested names, the quality standard should be set such that $\max_s \pi_L^N(s)$ s.t. $\pi_H^N(s) = \alpha\delta + (1-\alpha)\bar{s} - f \geq \alpha s + (1-\alpha)\bar{s}$, where the right-hand side of the constraint corresponds to the profit that H can gain by commingling with the L producers without individual brands. This constraint is trivially satisfied, because whenever nested names become the candidate equilibrium name pattern, it must be $\delta > \hat{\delta}$ (Lemma 2). Therefore, the equilibrium quality standard is chosen at the unconstrained level s^N, which solves $1 - \beta + \alpha\beta = \Phi'(s)$.

Figure 1: Profit change with the standard (with $\delta = 2.0, \alpha = 0.5, \beta = 0.33, \Phi(s) = \frac{s^2}{2}$)



hand, when $\hat{s}^U > s^U$, the participation constraint is binding. The L group thus chooses $\hat{s}^U$, leading to the constrained uniform name pattern 'CU'. The profit of the L producers decreases along the curve $\pi_L^U(\hat{s}^U)$ when $\hat{s}^U$ becomes larger. If $\hat{s}$ is very large, maintaining such a high standard is too costly for the L producers and the 'CU' name pattern becomes dominated by the nested names *'N'* ($\pi_L^U(\hat{s}^U) < \pi_L^N(s^N)$).

Let's define $s^{NU} = \{s | \pi_L^N(s^N) = \pi_L^U(s)\}$ as the standard level that makes L indifferent between 'CU' and 'N'. The L group switches to a lower standard s^N ($s^N < \hat{s}^U$) if $\hat{s}^U$ surpasses the level s^{NU}. Based on Figure 1, we can thus infer that the equilibrium name pattern may vary from the (unconstrained) uniform name 'U', to a constrained one 'CU' and to the nested names 'N', depending on the comparison of $\hat{s}^U$ with the two thresholds s^U and s^{NU}. As these thresholds are functions of the parameters, the equilibrium thus depends on the range of parameters. Proposition 1 formally shows these results.

Proposition 1 *Under perfect price discrimination and monopolistic competition, there exists $\hat{\delta}(\alpha, \cdot)$ which solves $\hat{s}^U = s^U$, and $\delta^{NU}(\alpha, \cdot)$ which solves $\hat{s}^U = s^{NU}$ for δ, such that $\frac{\partial \hat{\delta}(\alpha, \cdot)}{\partial \alpha} < 0$, $\frac{\partial \delta^{NU}(\alpha, \cdot)}{\partial \alpha} < 0$, $\delta^{NU}(\alpha, \cdot) > \hat{\delta}(\alpha, \cdot)$ and:*

- *if $\delta \leq \hat{\delta}(\alpha, \cdot)$, that is, if producers are not very heterogeneous in quality and consumers are mostly unaware, the L-majority choose standard s^U, leading to the uniform name pattern 'U';*
- *if $\hat{\delta}(\alpha, \cdot) < \delta \leq \delta^{NU}(\alpha, \cdot)$, that is, if producer heterogeneity and consumers' awareness are at intermediate levels, the L-majority chooses the standard $\hat{s}^U$, with $\hat{s}^U > s^U$, leading to the constrained uniform name pattern 'CU'; and*
- *if $\delta > \delta^{NU}(\alpha, \cdot)$, that is, if producers become very heterogeneous and/or a large proportion of consumers are aware, the L-majority chooses standard s^N, with $s^N < \hat{s}^U$, leading to the nested names pattern 'N'.*

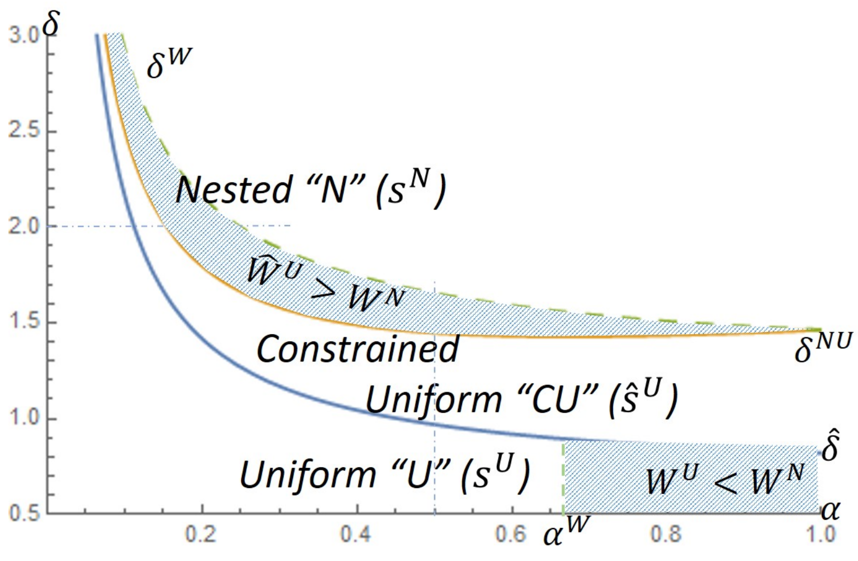
Proof The first item of the result for $\delta \leq \hat{\delta}(\alpha, \cdot)$ is straightforward according to Lemma 2. The proof for the two remaining items depends on the comparison of $\hat{s}^U$ and s^{NU}, which is equivalent to comparing $\pi_L^U(\hat{s}^U)$ and $\pi_L^N(s^N)$. The two profits are derived as follows:

$$\begin{aligned}\pi_L^U(\hat{s}^U) &= \beta\delta + (1-\beta)\hat{s}^U - \Phi(\hat{s}^U), \text{ with } \hat{s}^U \equiv \delta - \frac{f}{\alpha(1-\beta)} \\ \pi_L^N(s^N) &= (1-\alpha)\beta\delta + (1-\beta+\alpha\beta)s^N - \Phi(s^N).\end{aligned}$$

It can be easily checked that $\frac{\partial^2 \pi_L^U(\hat{s}^U)}{\partial \delta^2} = -\Phi'' < 0$ and $\frac{\partial \pi_L^N(s^N)}{\partial \delta} = (1-\alpha)\beta > 0$. Thus $\pi_L^U(\hat{s}^U)$ is continuous and concave in δ, while $\pi_L^N(s^N)$ is increasing with δ. Moreover, when $\delta = \hat{\delta}$, $\hat{s}^U = s^U < s^N$ and hence $\pi_L^U(\hat{s}^U) = \pi_L^U(s^U) > \pi_L^N(s^N)$. On the other hand, when δ increases from $\hat{\delta}$, then $\hat{s}^U$ increases accordingly. It can be shown that when $\delta = s^N + \frac{f}{\alpha(1-\beta+\alpha\beta)}$, the revenue part of $\pi_L^U(\hat{s}^U)$ and $\pi_L^N(s^N)$ are the same and $\hat{s}^U > s^N$, so that the cost part of $\pi_L^U(\hat{s}^U)$ is larger. Hence $\pi_L^U(\hat{s}^U) < \pi_L^N(s^N)$ when $\delta = s^N + \frac{f}{\alpha(1-\beta+\alpha\beta)}$). By continuity, there exists $\delta^{NU} \in (\hat{\delta}, \tilde{\delta})$, which solves $\pi_L^U(\hat{s}^U) = \pi_L^N(s^N)$ such that if $\delta > (<)\delta^{NU}$, $\pi_L^U(\hat{s}^U) < (>)\pi_L^N(s^N)$. Q.E.D.

Proposition 1 is intuitive. When the heterogeneity between producers is relatively small or when a large proportion of consumers are unaware, a small increase in quality standard is enough to keep the H producers in the uniform label so that the uniform name pattern is chosen. Otherwise, the nested names pattern is preferred because of the lower quality standard it requires, while the L producers benefit from having H producers in the uniform label targeting the market of unaware consumers.

Figure 2: Equilibrium labeling schemes



The equilibrium standard depends on the thresholds $\hat{s}^U$ and s^{NU}, that are functions of the degree of producer heterogeneity (δ) and consumer awareness (α). Figure 2 plots the equilibrium labeling schemes in the $\alpha - \delta$ space. The parameter range is separated into three regions. In the lower-left region, where the producer heterogeneity is relatively small and consumers are mostly unaware, the uniform name is achieved without constraint. This case may resemble those situations in which producers are relatively homogeneous and/or not yet known by consumers.[19] In such a case, conflicts of interest among producers are not so severe and the uniform name is more prominent. In the upper-right region, where producers become very heterogeneous and consumers are more aware about the quality information conveyed by the brand names, nested names emerge. This may resemble, for instance, the case of Amarone wines, where the heterogeneity within the group is intensified, more consumers are aware about individual producers, and so the group lets the high-quality types use nested names.

Proposition 1 does not only provide the economic conditions under which the nested names may emerge, but it also suggests that a change in the economic environment (change in the level of heterogeneity between producers or in the fraction of aware consumers) may have a non-monotonic impact on the quality provision of L producers. To see this, Figure 3 plots the equilibrium quality standard and profits for L and H producers as functions of δ (for a given value of α) and α (for a given value of δ). From Figure 3, the equilibrium name pattern switches from the uniform name to the nested names pattern when – everything else constant – the producer heterogeneity becomes large (the left panels) or when there are more aware consumers (the right panels). The equilibrium quality standard increases with δ and α when the uniform name is constrained. However, whenever the nested names pattern is chosen instead of the uniform name pattern, the quality standard drops from $\hat{s}^U$ to s^N. To this extent, the emergence of the nested names, although enabling the H quality producers to differentiate from the collective label, may have a negative impact on the quality incentives of majority producers.

These results provide new insights on the rationale of labeling differentiation. The literature on quality standards and product differentiation generally argues that producers differentiate their quality (or variety) to attract consumers with different tastes (see, e.g., Bonroy and Constantatos, 2015) and/or to soften competition in homogeneous product markets (see, e.g., Shaked and Sutton, 1982). By abstracting from consumers' taste heterogeneity and product competition, our model highlights an additional motive for labeling differentiation, that is, the attempt of heterogeneous producers to balance divergent interests within the group. Indeed, both L and H producers benefit from the nested names pattern. By allowing H producers to develop their individual brands tied with the collective label, L producers can still benefit from the positive spillovers of the high quality provided by H producers, while H producers can reach out to unaware consumers with a relatively higher perceived average quality.

Proposition 1 enables us to also derive some testable predictions: whereby nested (uniform) names are more likely to be observed when consumers are more (less) aware and/or when producers are more (less) heterogeneous. Some ideas can be provided to measure consumers' information and producer heterogeneity. Regarding awareness, while important

[19] This seems consistent, for instance, with the practioners' advice to wine producers "to group with other wine producers with the same regional identity" when facing young (and thus unaware) US consumers (LARVF, 2015).

in our model it has played no role in previous literature, neither empirically nor theoretically. Then, for instance, one could look at consumers' choices, varying with distance and/or across time. Awareness about the quality of a wine may decrease in relation to the distance from the production area, or may increase with long established labels. *Ceteris paribus*, consumers should use more collective labels than private ones the more distant from the region or the shorter the history of the label they purchase. Using an empirical application similar to Costanigro et al. (2010), one could thus test whether distance (or other proxies for awareness or lack of it) is significant.

Regarding the heterogeneity within production areas, a possible way to test this is to check for differences in land prices. Better land quality would capitalize into land market values, as producers should recognize these differences. Our results suggest that the larger such differences are, the more likely we are to observe more differentiated labels.[20] Moreover, notice that Costanigro et al. (2012) show that nested names are associated with heterogeneity, leading them to conclude that nested names "are inherently prone to intra-regional controversies" (p. 262). In other words, they believe that nested names may lead to heterogeneity and thus conflicts. Given our results, we would argue for a reverse causality, thus implying that empirical applications should not only explicitly consider heterogeneity but also implement a suitable strategy to identify casuality.

Last, previous models (e.g., Winfree and McCluskey, 2005, Castriota and Delmastro, 2015) predict that 'conflicts', for example, free-riding, increase with the size of the group. In our model we argue that besides size – which we do not explicitly consider – heterogeneity has a role in explainining conflicts because of different spillover effects. For instance, our model may imply that a relatively small but heterogeneous group may be more conflict-prone. Other models (see, e.g., Castriota and Delmastro, 2015) are relatively agnostic about heterogeneity, but we believe that it should be considered in empirical applications.

4.2 Welfare analysis

Social welfare is a function of the quality standard, given the costs of quality provision for L producers and the costs for developing a private brand for H producers:

$$W(s) = \beta(\delta - f\mathbf{1}_{\{`N',`S'\}}) + (1-\beta)(s - \Phi(s)), \tag{4}$$

where $\mathbf{1}_j = 1$ if the name pattern involves the scheme j ($j \in \{`N', `S'\}$) and 0 otherwise. As discussed in the previous section, the separate names 'S' is not present in equilibrium, and we thus focus on the welfare comparison of the uniform and the nested names pattern. To simplify notation, $W(s^U)$, $W(\hat{s}^U)$ and $W(s^N)$ will be respectively denoted by W^U, $\hat{W}^U$ and W^N. We first compare welfare between nested names and uniform name (W^U vs. W^N) when

[20] Notice that product quality is the result of nature (that is, land quality) and nurture (that is, producer's efforts). The latter may change with the incentive structures embedded in different institutional settings, for example, labeling regulations. Ideally, one could ascertain whether nature is more or less important than nurture by considering, for instance, data on land transactions in the case of the 'same area' with different producers and of the same producer in different areas. All other things equal, by considering differences within the same areas one could gauge a measure of differences across producers, that is, a proxy for 'nurture', while looking, for example, at differences within producers one could gauge the differences across areas, that is, a proxy of 'nature'.

the participation constraint for H producers is not binding ($\delta < \hat{\delta}$). We then investigate the welfare comparison of the constrained uniform name with the nested names ($\hat{W}^U$ vs. W^N).

4.2.1 Comparing welfare under 'U' and 'N' patterns

The welfare difference between the uniform names pattern and the nested names pattern is given by:

$$W^U - W^N = (1-\beta)\left((s^U - \Phi(s^U)) - (s^N - \Phi(s^N))\right) + \beta f \tag{5}$$

with $s^U = \{s|1-\beta = \Phi'(s)\}$ and $s^N = \{s|1-\beta+\alpha\beta = \Phi'(s)\}$. The two quality levels are independent of δ. Hence, the welfare comparison does not depend on producer heterogeneity. Indeed, producer heterogeneity in our setting does not affect L producer's quality incentives at the margin. The impact of δ stems from the change in the labeling strategies as producers have different incentives to provide qualities under the different name patterns. As shown in Lemma 3, the comparison depends on the consumers' awareness parameter α.

Lemma 3 *Under perfect price discrimination and monopolistic competition, there exists a threshold* $\alpha^W(f,\cdot) = \{\alpha|W^U = W^N\}$, *with* $\frac{\partial\alpha^W(f,\cdot)}{\partial f} > 0$, *such that* $W^U \leq W^N$ *(respectively* $W^U > W^N$*) if and only if* $\alpha \geq \alpha^W(f,\cdot)$*(respectively* $\alpha < \alpha^W(f,\cdot)$*).*

Proof: It can be derived from Equation (5) that $\frac{\partial W^U - W^N}{\partial\alpha} = -(1-\beta)\frac{ds-\Phi(s)}{ds}|_{s=s^N}\frac{\partial s^N}{\partial\alpha} < 0$. The negative sign stems from the fact that $s^N < s^*$ ($s^* = \arg\max s - \Phi(s)$) and s^N solves $1-\beta+\alpha\beta = \Phi'(s)$, increasing in α. When $\alpha \to 0$, $s^N \to s^U$ and hence $W^U - W^N \to \beta f > 0$; when $\alpha \to 1$, $s^N \to s^*$, which is the first-best quality level. It is naturally assumed that the welfare under the first best quality is maximized. Thus, we have $W^U < W^N$. Therefore, by continuity, there exists $\alpha^W \in \{0,1\}$ such that $W^U \leq (or >)W^N$ if and only if $\alpha \geq (or <)\alpha^W$. α^W solves $W^U = W^N$ and is a function of f. It is easily checked that $\frac{\partial\alpha^W(f,\cdot)}{\partial f} = -\left(\frac{\partial W^U - W^N}{\partial f}\right) / \left(\frac{\partial W^U - W^N}{\partial\alpha}\right) > 0$. Q.E.D.

From Lemma 3, the nested names pattern leads to higher welfare than the uniform name pattern for larger values of α or smaller values of f. The efficiency of the nested names depends on a trade-off between two effects. On the one hand, such a name pattern reduces the spillover effects for L producers and increases their overall quality provision by perfectly informing the aware consumers through individual brands. On the other hand, such a strategy is costly. As a result, the nested names will be welfare improving only if a high enough proportion of consumers are aware and/or if the cost of doing so is small.

4.2.2 Comparing welfare under 'CU' and 'N' patterns

Analogously, we can derive the welfare difference between the constrained uniform name pattern and the nested names pattern:

$$\hat{W}^U - W^N = (1-\beta)\left((\hat{s}^U - \Phi(\hat{s}^U)) - (s^N - \Phi(s^N))\right) + \beta f. \tag{6}$$

It can be noticed that, differing from the previous case, $\hat{s}^U$ now depends on both δ and α, which makes the comparison less straightforward. Lemma 4 summarizes the results:

Lemma 4 *Under perfect price discrimination and monopolistic competition, there exists* $\delta^W(\alpha,\cdot) = \{\delta | \hat{W}^U = W^N\}$*, with* $\delta^W(\alpha,\cdot) > \delta^{NU}(\alpha,\cdot)$ *and* $\frac{\partial \delta^W(\alpha,\cdot)}{\partial \alpha} < 0$ *such that:*

i) if $\delta \geq \delta^W(\alpha,\cdot)$*, the nested names pattern emerges in equilibrium, and leads to higher welfare than the uniform name pattern;*

ii) if $\delta^{NU}(\alpha,\cdot) \leq \delta < \delta^W(\alpha,\cdot)$*, the nested names pattern emerges in equilibrium, but leads to lower welfare than the uniform name pattern;*

iii) if $\delta < \delta^{NU}(\alpha,\cdot)$*, the uniform name emerges in equilibrium and leads to higher welfare than the nested names so long as* δ *is not too small compared to* $\delta^{NU}(\alpha,\cdot)$*.*

Proof: Notice that $\hat{W}^U - W^N = \left(\hat{\pi}_L^U + \hat{\pi}_H^U\right) - \left(\pi_L^N + \pi_H^N\right)$. At $\delta = \delta^{UN}$, $\hat{\pi}_L^U = \pi_L^N$. Moreover, $\hat{s}^U > s^N$ from the proof of Proposition 1. Hence $\hat{\pi}_H^U > \pi_H^N$, leading to $\hat{W}^U > W^N$. When δ becomes very large, $\hat{s}^U$ increases but not s^N. There can be the case that $\hat{s}^U$ surpasses the social optimal level, that is, $\hat{s}^U > s^*$, so that $\frac{\partial \hat{W}^U - W^N}{\partial \delta} = (1-\beta)\frac{ds - \Phi(s)}{ds}|_{s=\hat{s}^U}\frac{\partial \hat{s}^U}{\partial \delta} < 0$. The negative sign stems from the fact that $s^{=} \arg\max s - \Phi(s)$ and $\frac{\partial \hat{s}^U}{\partial \delta} > 0$ from Lemma 3. Moreover, the second derivative $\frac{\partial^2 \hat{W}^U - W^N}{\partial \delta^2} = (1-\beta)\frac{d^2(s-\Phi(s))}{ds^2}|_{s=\hat{s}^U}\frac{\partial \hat{s}^U}{\partial \delta} < 0$. By continuity, if $\hat{s}^U$ is very large, so that $\Phi(\hat{s}^U)$ is very high, it may be the case that $\hat{W}^U - W^N < 0$. Therefore, there exists a threshold δ^W such that $\hat{W}^U \geq (or <) W^N$ if and only if $\delta \leq (or >) \delta^W$. δ^W solving $\hat{W}^U = W^N$ is a function of α and $\delta^W > \delta^{NU}$. From condition (6), we have $\frac{\partial \delta^W}{\partial \alpha} = -\left(\frac{\partial \hat{W}^U - W^N}{\partial \alpha}\right) / \left(\frac{\partial \hat{W}^U - W^N}{\partial \delta}\right) = -\left(\frac{ds - \Phi(s)}{ds}|_{s=\hat{s}^U}\frac{\partial \hat{s}^U}{\partial \alpha} - \frac{ds - \Phi(s)}{ds}|_{s=s^N}\frac{\partial s^N}{\partial \alpha}\right) / \left(\frac{\partial \hat{W}^U - W^N}{\partial \delta}\right) < 0$. Q.E.D.

Lemma 4 implies that nested names welfare dominate the constrained uniform name if the producer heterogeneity and/or the aware consumers' population is very large. In this case, L producers would have to impose a very high standard in order to keep the H producers in the uniform group. However, the cost of improving quality is so high that the constrained uniform name pattern is neither privately nor socially optimal. For an intermediate range of these parameters, on the other hand, the private incentives to let the nested names emerge leads to a lower welfare than the constrained uniform name pattern 'CU'.

4.2.3 Overall welfare result

Based on Lemmas 3 and 4 and linking to Proposition 1, the overall welfare results are summarized in Proposition 2:

Proposition 2 *Under perfect price discrimination and monopolistic competition, the choice of the quality standard of the L-majority group is socially optimal for all ranges of* α *and* δ *but two cases:*

i) when $\delta^{NU}(\alpha,\cdot) \leq \delta < \delta^W(\alpha,\cdot)$*, nested names emerge in equilibrium but may lead to lower welfare than the uniform name because of a lower quality standard;*

ii) when $\delta < \hat{\delta}(\alpha,\cdot)$ *and* $\alpha \geq \alpha^W(f,\cdot)$*, the uniform name emerges in equilibrium but may lead to lower welfare than the nested names.*

The two ranges of parameters capture two cases where the equilibrium is welfare deteriorating. Those ranges can be illustrated in Figure 2. The first case arises in a range of parameters such that the nested names pattern is chosen in equilibrium while the constrained uniform name pattern would be better from a welfare point of view. This situation could emerge when the heterogeneity across producers is high compared to the proportion of unaware consumers. In this case, nested names are characterized by a lower quality standard, while the constrained uniform name could be achieved under a high quality standard with a socially affordable cost.

The second case corresponds to low values of δ and high values of α (shaded area at the bottom right-hand side of the picture). In this case, the uniform name pattern would be chosen by the L group while the nested names pattern would be better from a welfare point of view because a large proportion of consumers are aware and could benefit from the high quality.[21] The welfare impact can be illustrated by simulating the welfare changes with the parameters. The bottom sub-figures of Figure 3 show that welfare in equilibrium also varies in a non-monotonic, discontinuous manner with respect to increases in α and δ parameters.

Our results thus provide some interesting insights in terms of welfare implications. First, because nested names enable high-quality producers to differentiate themselves from low-quality products, it is in general good to allow them to use such an information device when they have the private incentives to do so. However, the highest level of welfare may be achieved under the uniform label in cases where L producers have incentives to increase their quality standard to keep H producers within the group (as shown in Figure 3). This situation arises where there are not too significantly high levels of consumer awareness. Therefore, if an increase in the fraction of aware consumers α induces the group to implement the nested names, it may result in a lower quality provision and hence a decrease in welfare.

This latter result differs from the standard literature on quality and information, which illustrates that the better the information provided to consumers the higher the quality incentives for producers (see, e.g., Chapter 2 in Tirole, 1988 and Bagwell and Riordan, 1991). In this literature, the existence of aware consumers creates a positive externality to unaware consumers because it induces producers to provide high quality. In our model, we emphasize another economic effect: taking into account heterogeneity of producers, our results imply that increasing the proportion of aware consumers (to a moderate extent) may exert a negative externality over the unaware consumers by altering the labeling choice of opportunistic producers. When the group switches to the nested names, the incentives to raise quality standard decrease, leading to a lower welfare than that in the uniform collective label.

5 Robustness of the main results

In the primary setting, we have derived two main results:

- Result 1. The nested names pattern arises because: i) producers become more heterogeneous (i.e., with an increase in δ); and/or ii) a larger proportion of consumers become aware (i.e., an increase in α).

[21]The upper bound of the shaded area surpasses the $\hat{\delta}$ curve. This implies that when the uniform name pattern is constrained ('UC') for higher values of δ, by continuity the 'U' pattern is still welfare dominated by the 'N' pattern.

- Result 2. Whenever the nested names pattern emerges in place of the uniform name, it may lead to lower quality incentives for the majority's producers (i.e., a decrease in s).

The key drivers of these two results are the spillover effects from which the L producers can benefit when they supply consumers who are unaware about quality. Therefore, as long as the spillover effect exists, the main results should hold qualitatively.

In this section, we check the robustness of the main results when changing the main assumptions of our setting. In Subsection 5.1, we first discuss the possibility that H producers can deviate collectively instead of individually. Then, in Subsection 5.2, we consider the situation where producers cannot discriminate between consumers, or where the nested names pattern can be used to signal qualities (see Subsection 5.3). Finally, Subsection 5.4 considers the situation where producers can compete in a market where consumers have heterogeneous tastes over quality.[22] The robustness of our main results under the various assumptions is summarized in Table 3.

Table 3: Robustness of the main results

Setting	Result 1: Nested names arise because i) $\delta \nearrow$	ii) $\alpha \nearrow$	Result 2: Consequences $s \searrow$	Other results
Collective/rational deviation of H	Yes	Yes	Yes	Nested names more likely to emerge
No price discrimination	Yes	It depends	Yes	Separate names emerge when α becomes very large
Nested brand signaling	Yes	N.A.	Yes	Welfare is larger under the nested names than under the uniform name
Heterogeneous taste consumers and producer competition				
Perfect (quantity) competition	N.A.	Yes	Yes	Welfare under the nested names may be larger when numerous producers compete for a small size market
Sophisticated consumers	N.A.	Yes	Yes	
Oligopolistic price competition	Spillover effects vanishe – only separate names exist in equilibrium.			

5.1 Collective or rational deviation of H producers

In the model presented in Section 4, the H producers are passive and cannot coordinate to develop their own collective label. In this section, we check the robustness of the main results when a more sophisticated behavior for the H producers is considered, and analyze first the case where H producers may coordinate to develop their own collective label. A reasonable assumption is that such a collective label may inform more consumers than could a private

[22] We thank an anonymous referee and the editor for pointing out some of these possible market behaviors.

brand but still incur some costs for the H producers because they are only a few. In this case, the participation constraint for H becomes:

$$\pi_H^U(s) \geq \pi_H^N(s) = \alpha_H\delta + (1-\alpha_H)\bar{s} - f_H,$$

where $\alpha_H > \alpha$ and $f_H < f$. The analysis remains unchanged compared to the primary setting. The equilibrium name still follows the same pattern as illustrated in Figure 2, except that nested names now become the case of a sub-group high-quality collective label nested under the grand collective label.[23] Results 1 and 2 still hold with collective deviation.

A second possible behavior may be that the H producers are strongly rational and could anticipate that if they deviate from the uniform name, the quality standard will not be the actual choice made by the L-majority. Instead, the standard (at the off-equilibrium path) should be the rational choice of the L-majority given H producers deviating to develop their individual brands, that is, s^N. With this setting, the participation constraint for H producers becomes $\pi_H^U(s) \geq \pi_H^N(s^N)$. Solving for the equilibrium follows the same methodology used in the initial model and leads to similar results as seen in Proposition 1. Therefore, Results 1 and 2 still hold except that the threshold functions are different.[24]

5.2 No price discrimination

In many situations, it is difficult or impossible for producers to charge different prices and prevent consumers' arbitrage. The only possible pricing policy is then a uniform price for all consumers. In this case, there is a trade-off for monopolist producers facing consumers with different quality perceptions (described in Table 1): charging a higher price for consumers with higher quality perception, but losing the consumers who value quality at a lower level; or charging a lower price, and being able to serve the whole market.

Appendix A provides a thorough analysis on the situation without price discrimination (PD). The results are similar to Results 1 and 2 derived in the primary setting. The only difference is that a separate names pattern emerges when a high proportion of consumers become aware. The intuition stems from the fact that L producers no longer serve the aware market under nested names if they cannot price discriminate, making the nested names pattern less attractive for L producers. Indeed, when choosing the quality standard to implement the name patterns, the L majority trades off between implementing the nested names in order to enjoy a (smaller size) spillover in the unaware market but at the cost of no purchase of the aware consumers, or choosing the separate names to cover both markets but without any spillover. When aware consumers are predominant, the loss of aware consumers outweighs the spillover benefits, leading to the emergence of separate names in equilibrium.

[23]This is the case, for instance, of the collective label system in Burgundy, which goes from the regional to the village (and even climat) level.

[24]For instance, the participation constraint of H producers becomes $s \geq \alpha\delta + (1-\alpha)s^N - \frac{f}{(1-\beta)}$. Compared with the value of threshold $\hat{s}^U$ defined in the condition ii) of Lemma 1, the threshold value becomes larger, implying that the L-majority should set the quality standard to a higher level in order to keep the H producers staying with the uniform name. In other words, implementing the uniform name is more costly for the L-majority in the case of rational H producers than with passive H producers. However, in both cases, profits for L producers remain unchanged under the nested names pattern, suggesting that the nested names pattern is more likely to be implemented when H producers are strongly rational than when they are passive.

5.3 Nested names as a signaling device

The primary setting assumes that the unaware consumers are naive and can get information on quality only through the collective label. Then, the individual name is ineffective in changing beliefs about quality. This is the case if the unaware consumers are ignorant about the cost of the branding strategy and the existence of the aware consumers. In practice, producers H may use individual brands and prices to signal high quality. Linking this to our setting, the signaling possibility lies in the fact that the existence of the aware consumers and the branding costs make the nested names a very costly strategy for the L quality producers. Consequently, the unaware consumers believe that only H producers can afford to use the nested names.[25]

Appendix B provides a thorough analysis of the signaling game. In such a game, the pooling equilibrium corresponds to the situation in which both L and H producers choose the uniform name without label differentiation, whereas the separating equilibrium corresponds to the case of nested names where the H producers choose to develop individual brands and signal the high quality, while the L producers remain in the collective label. We show that the pooling equilibrium, that is, the uniform name pattern, exists when L producers' quality is high, whereas the separating equilibrium, that is, the nested names pattern, appears when quality is low. The reason is that signaling high-quality is more difficult when the low quality is not so different from the high quality level, that is, if producers are not so heterogeneous. In this case, it is easier for the L producers to mimic the H producers by developing individual brands and enjoying a high price.

Again, the equilibrium name pattern depends on the range of parameters. In particular, we show that it depends on the producer heterogeneity parameter δ. When δ is large, the L-majority may set a very high standard in order to implement the uniform name. However, such a high standard may be costly, making the L-majority switch to nested names with a lower quality standard. Results are thus similar to Results 1 and 2 in the primary setting.[26] The difference from the primary setting may lie in the welfare comparison. When signaling is possible, nested names lead to the socially optimal quality because they inform the unaware consumers about the true quality of the L producers, and hence result in higher welfare than the uniform name.

[25]The literature has extensively investigated various mechanisms of quality signals, including prices (e.g., Bagwell and Riordan, 1991, Shapiro, 1983, etc.), advertising (e.g., Milgrom and Roberts, 1986), locations (e.g., Vettas, 1999, Haucap et al., 1997), etc. While much of the literature relies on repeated purchases by consumers who can punish the low-quality producers with a low future payment (e.g., Shapiro, 1983, Vettas, 1999, Haucap et al., 1997), the one-shot game in the present setting resembles Bagwell and Riordan (1986), in which the signaling of quality depends on the existence of aware (in their jargon, 'informed') consumers. The mechanism is much like that of the simple model of Tirole (1988) (see Chapter 2.3.1): the existence of the informed consumer makes it costly for the low-quality monopolist to mimic the high-quality one. However, the present model differs from previous work in that we introduce a costly branding strategy in addition to price as signals of quality. Moreover, we endogenize the quality choice for the L producers, which may affect the equilibrium choice of labeling strategies.

[26]The presence of the aware consumers is a necessary condition for the existence of the separating equilibria, that is, the nested names pattern. However, it does not affect the pooling equilibria, that is, the uniform name. Therefore we cannot derive the result linking it to the consumers' awareness parameter α.

5.4 Consumers with heterogeneous tastes and competition

A more general case would be the situation whereby numerous producers compete for consumers with heterogeneous preferences over quality. In this case, the equilibrium name pattern will be affected by the competition and the associated quantity decision of producers.

Appendix C provides a formal analysis of the impact of various types of competition. Appendix C1 deals with the most common case where a large number of producers compete perfectly in quantity and in a vertically differentiated market. The model is similar to Moschini et al. (2008), where producers with increasing marginal costs face a demand à la Mussa and Rosen (1978), except that we take into account different quality perceptions of consumers under different names, as described in Table 1. Again, we find similar results as in the primary setting.[27] Appendix C2 shows that the results are robust if we allow consumers to be sophisticated enough to update their beliefs about the product quality based on the anticipation of producers' quantity decisions. However, when we investigate the price competition of oligopolistic producers, Appendix C3 shows that Results 1 and 2 fail to hold because neither the uniform name nor the nested names emerge. Only the separate names pattern emerges in equilibrium.

To understand the intuition, first notice that Results 1 and 2 hinge on the incentives for the L producers to exploit the maximum spillover effects while trying to balance the conflicting interests within the group using different names. As long as the spillover effects exist, the basic results will not change qualitatively. Second, the spillover effects occur only if producers can react to the market price, which reflects the different quality perceptions of consumers. When competition changes the way that the producers react to the market price, the spillover effects may vanish, leading the group to choose quite a different name pattern in equilibrium.

Linking this to the settings analyzed in Appendices C1 and C2, when producers with increasing marginal costs compete, spillover effects are weakened under quantity competition. However, as long as the supply reacts to the downward demand curve, which captures consumers' quality perceptions under different names, the spillover effects exist in the same vein as in the primary setting; that is, it is maximized under the uniform name, reduced with nested names, and diminished under separate names. Therefore, Results 1 and 2 still hold under perfect quantity competition. The only difference may lie in the welfare impacts. Indeed, when quantity decisions are taken into account, the H producers are induced to provide a larger quantity under nested names. This effect may outweigh the negative impact on the quality of L producers, leading to a higher welfare under nested names than under the uniform name. This is especially the case when competition becomes more intense (see Figure C2).

When price competition is considered (Appendix C3), the equilibrium price is set up to the marginal costs, implying that the spillover effect vanishes under the collective label. Therefore the equilibrium is shaped by quite a different name pattern. Indeed, it is well acknowledged that the role of labels to segment the market can help producers to restore the market power and to capture the quality premium (Shaked and Sutton, 1982; Zago and

[27]The results only focus on the impact of consumers' information α instead of δ because this parameter is no longer a relevant measure for producer heterogeneity when producers also differ in quantities.

Pick, 2004). However, in the presence of information asymmetry, the role of a collective label is limited because consumers see the same quality for products carrying the uniform label. Indeed, the collective labels are often seen as minimum quality standards (MQS) for producers within the group (Petropoulou, 2013).[28] In this case, collective labels may intensify the competition for producers in the same group and hence squeeze their quality premium. Consequently, the only candidate equilibrium is separate names, adopted by the duopolistic producers L and H, respectively. Such a setting is similar to a setting where large producers or firms compete imperfectly in the market with different qualities.

6 Concluding remarks

Starting with recent policy and industry debates, we present a model to investigate nested names and the coexistence of different labels. When low-quality producers control the collective label, they may prefer a uniform collective label because they benefit the most from the efforts of high-quality producers. The latter, on the other hand, may still find it profitable to join forces with lower-quality producers because with the collective label they can reach unaware consumers and indirectly induce the low-quality producers to adopt a stricter quality standard. When producers' heterogeneity increases, however, the uniform label is less profitable for high-quality producers, who may then prefer to establish individual brands as well. Moreover, when producers cannot price discriminate or when they compete more intensively in price, it may be profitable to use individual brands only and to avoid using the common label, thus separating from it.

Our results explain some of the issues relevant in many food industries by the evidence we document, in particular the coexistence of private and collective labels, the differentiation within collective labels, and label fragmentation and proliferation. While our motivating cases come mostly from the wine industry in the EU, our model and results can be related to other industries, for example, cheese, cured meats, vegetables, etc., as well as to other countries. From the industry's point of view, the decision to use a more or less differentiated label, and all the promoting activities that go with it, may simply depend on the destination market. For new and/or distant markets, where presumably the component of unaware consumers is significant, a uniform label may be a more effective tool. In closer (i.e., national) or knowledgeable markets, where consumers have a good understanding of the products of a region, then a more differentiated label or nested names may be more effective.

Overall, we show that private incentives lead to equilibria which are welfare-improving. In a relatively low number of cases, however, private incentives are not aligned with total welfare. These latter results are mainly driven by the desire of the majority group to enjoy the spillovers of the uniform collective label, while trying to reduce the conflicts of interest within the group. Our model identifies two ways in which to alleviate these conflicts: by making the low-quality producers behave more like high-quality producers, or to enable the latter to partially differentiate themselves. While the former leads to the constrained uniform name, the latter drives to nested names.

According to GI's regulations, in the EU and elsewhere, one of the objectives of collective promotion is to ensure the quality of regional products (see, e.g., Article 1 of Regulation (EU)

[28]We thank the editor and anonymous referees for this comment and reference.

No 1151/2012 on quality schemes for agricultural products and foodstuffs). An interesting implication of our paper is that the two ways to balance the conflicting interests within a group may lead to different quality incentives for the majority of (lower-quality) producers. The former may induce the group to set a higher quality standard for the majority producers in order to retain and keep pace with the high-quality producers. To this extent, the uniform collective labels in the presence of some degree of producer heterogeneity should be advocated because it may lead to an overall higher quality level of the region.

However, the inner incentives to raise quality in line with high-quality producers vanish if the latter are allowed to differentiate. Thus, there may be a drop in quality when nested names arise in place of the uniform name. Such a negative impact on quality may even lead to the lower economic welfare of nested names compared to the uniform label. Only when there are more aware consumers can the nested names lead to higher welfare. To this extent, our results imply that when a region cannot sustain the uniform collective label, making more consumers aware may avoid or reduce the negative quality impact of nested names. This may justify, for instance, the trade promotion policies that governments worldwide implement by supporting individual producers in foreign markets (see, e.g., the EU wine sector market-oriented measures as detailed in the Council Regulation (EC) No 479/2008).

Another possible way to deal with this potential problem is to facilitate the coordination of high-quality producers in developing their own collective label. By this means, they can share the costs of reaching and informing a wider population of consumers: "Because it is costly for consumers to acquire technical information on the quality of wines and the reputation of wineries, institutional signals, such as that of the wine classification system, can be useful as proxies for the aforementioned variables" (Castriota and Delmastro, 2015: 470). The most fitting case of this policy is probably the system of collective labels in Burgundy, which go from the regional to the village (and climat) level.

Last, separate names are another possibility in providing more information to consumers, and we show that the quality reaches the socially optimal level if high- and low-quality producers' labels are separate. Further extending our results, one may question how small a label should be, or, in other words, how many sub-labels there should be in a given region. If separating may be good for quality incentives, it may be confusing for consumers who may have too many collective sub-labels to choose from; that is, too much information.

Our model is quite general, and our main results are robust to different extensions. We consider labels as tools for signaling, the coalition formation of the high-quality types in the minority, competition among producers and/or collective labels, and the explicit modeling of quantity choices. However, we make some simplifying assumptions. For example, this model does not consider the issue of 'too much information' for consumers – in fact our collective label is a way to reach otherwise unaware consumers – which may be a problem implied by the brand proliferation that follows from separation. We assume that the collective labels (either the uniform or the sub-regional) are effective in conveying information. Like many other contributions in the literature, we consider a static game with no room for reputation. The size of the group is exogenously given and we do not analyze the formation of producer groups. All of these assumptions may be amended, but we leave them for future studies.

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A Without price discrimination

In this appendix, we analyse how results are changed when producers cannnot discriminate between consumers. All other assumptions remain. As consumers' perceptions over qualities differ according to their knowledge (as described in Table 1 in the primary model), without price discrimination (PD) producers are facing a trade-off between charging higher price but losing the consumers with a lower quality perception. The timing of the game is unchanged and described in Section (3.3). In the no-PD setting, the monopolist pricing strategy in the third stage of the game may differ. For instance, under the nested names pattern, the L producers have a trade-off between targeting only the unaware consumers $(1-\alpha)$ at an average price $\bar{s}$ or targeting the entire market at a lower price based on the true quality s. Any price in the range $(s, \bar{s})$ or outside this range cannot be an equilibrium price, because L producers can always deviate to s or $\bar{s}$ and gain a higher profit.

The same reasoning holds for the H producers: they have a trade-off between targeting only the aware consumers at a high price δ using individual brands (generating a profit $\alpha\delta - f$), or staying with the uniform name to capture the entire market at a lower price $\bar{s}$.

Table A1 shows the pricing strategies and associated profits of producers under the different name patterns. Compared with Table 2 in the primary setting, the uniform name is the same as that in the case with PD. Moreover, it still results in the highest profit for the L producers. However, under the nested names pattern, the L producers have to abandon the aware consumers without the possibility of price discrimination. Whereas they can cover the whole market at the price s under the sepatate names pattern because both the aware and unaware consumers perceive the true quality of L. In this case, it is possible that the nested names pattern results in less profit than the separate names pattern, making this latter to emerge in equilibrium.

Table A1: Prices and profits under different names

Name	Labels	Price in aware market	Price in unaware market	Profit of L	Profit of H
U	L: C	$\bar{s}$		$\pi_L^U(s) = \bar{s} - \Phi(s)$	$\pi_H^U(s) = \bar{s}$
	H: C	$\bar{s}$			
N	L: C	-	$\bar{s}$	$\pi_L^N(s) = (1-\alpha)\bar{s} - \Phi(s)$	$\pi_H^N(s) = \alpha\delta - f$
	H:$C+I$	δ	-		
S	L: C	s		$\pi_L^S(s) = s - \Phi(s)$	$\pi_H^S(s) = \alpha\delta - f$
	H: I	δ	-		
$\bar{s} = \beta\delta + (1-\beta)s$: average quality of the collective label					

Notice that whenever individual branding is chosen - either with or without the nested names (N or S) - the H producers gain the same profit without price discrimination:

$$\pi_H^N = \pi_H^S = \alpha\delta - f.$$

This profit serves as the outside option for the H producers when facing the decisions of the L majority. Formally, if the L producer wants to implement the uniform name, the problem can be described as

$$\begin{aligned} \max_s \quad & \pi_L^U(s) = \beta\delta + (1-\beta)s - \Phi(s) \\ s.t. \quad & \pi_H^U(s) = \bar{s} \geq \alpha\delta - f \end{aligned}$$

Lemma A1 summarizes the equilibrium quality standard outcome:

Lemma A1 *Without PD, the quality standard under the uniform name is the same as that in the case of PD, that is s^U such that $1-\beta = \Phi'$, if and only if the following inequality holds:*

$$\delta < \hat{\delta} \equiv \frac{f + (1-\beta)s^U}{(\alpha - \beta)}. \tag{A1}$$

Otherwise, the standard is set at $\hat{s}^U(\delta, \alpha, \beta) \equiv \frac{(\alpha-\beta)\delta - f}{(1-\beta)}$, which is higher than s^U.

Comparing condition (A1) with condition (3) in the primary setting, it can be easily shown that the right-hand side is larger and the constrained standard level is lower in condition (A1). Therefore, without PD, it is less likely that the L majority 'distorts' the quality standard upwards to keep the H producers in the coalition. Moreover, if the outside option becomes attractive for the H producers, the standard is raised at a lower level compared to the PD case.

Again, an increase in the quality standard to keep H in the uniform name reduces $\pi_L^U(s)$. Such an increase may thus lead L producers not to choose the uniform name but rather opt for a lower standard and implement the nested or separate names patterns. The decrease in $\pi_L^U(s)$ with the quality follows a pattern similar to the pattern described in the primary setting and illustrated in Figure 1. However, which name pattern is chosen in equilibrium depends on the comparison of optimal profits under 'N' and 'S'. From Table A1, the optimal profit for L under the separate names pattern is derived as:

$$\max_s \pi_L^N(s) = s - \Phi(s).$$

The first order conditions $1 = \Phi'(s)$ give the optimal quality standard $s^S = s^*$. Because L producers can be perfectly identified under the separate names pattern, the quality standard is set at the first-best (perfect information) level. Similarly, the quality chosen by L producers under the nested names pattern can be derived from the following maximization problem:

$$\max_s \pi_L^N(s) = (1-\alpha)\bar{s} - \Phi(s) = (1-\alpha)(\beta\delta + (1-\beta)s) - \Phi(s).$$

The optimal standard s^N is given by the first order conditions:

$$(1-\alpha)(1-\beta) = \Phi'(s).$$

Compared with the first order conditions in the PD case (which is derived as $1 - \beta + \alpha\beta = \Phi'(s)$ in footnote 18), it is straightforward to show that s^N is lower than in the PD case because the L producers have to leave the aware market, which gives them more incentives to provide quality. The profit level under the nested names pattern $\pi_L^N(s^N)$ is thus lower than in the PD case, which implies that the L majority may now choose the separate names pattern covering the whole market. Proposition A1 states the formal equilibrium results.

Proposition A1 *Without PD, the separate names pattern S may be chosen in equilibrium. There exists δ^{NS}, which solves $\pi_L^N(s^N) = \pi_L^S(s^*)$, and δ^{SU}, which solves $\pi_L^U(\hat{s}^U) = \pi_L^S(s^*)$ for δ, such that*

- *if $\delta^{SU} < \delta^{NS}$ and $\delta^{SU} < \delta < \delta^{NS}$, the L majority chooses s^*, leading to the separate names pattern in equilibrium;*
- *otherwise, the equilibrium follows the same patterns as in the primary setting provided in Proposition 1.*

Proof We have $\pi_L^N(s^N) = (1-\alpha)(\beta\delta + (1-\beta)s^N) - \Phi(s^N)$ increasing with δ and $\pi_L^S = s^* - \Phi(s^*)$ independent of δ. Moreover, it can be easily checked that when $\delta = s^U + \frac{\pi_L^S(s^*) - \pi_L^S(s^U)}{\beta}$, $\pi_L^N(s^N) < \pi_L^S(s^*)$; and when $\delta = s^* + \frac{\alpha}{(1-\alpha)\beta}\pi_L^S(s^*)$, $\pi_L^N(s^N) > \pi_L^S(s^*)$. Thus, there exists a threshold δ^{NS}, with $\delta^{NS} \in (s^U + \frac{\pi_L^S(s^*) - \pi_L^S(s^U)}{\beta}, s^* + \frac{\alpha}{(1-\alpha)\beta}\pi_L^S(s^*))$, solving $\pi_L^N(s^N) = \pi_L^S(s^*)$ for δ, such that if $\delta > (<)\delta^{NS}$, $\pi_L^N(s^N) > (<)\pi_L^S(s^*)$ and nested (separate) names become a possible equilibrium.

If $\delta > \delta^{NS}$, the equilibrium outcome depends on the comparison of $\pi_L^U(\hat{s}^U)$ and $\pi_L^N(s^N)$. The same argument as that stated in Proposition 1 applies. If $\delta < \delta^{NS}$, the equilibrium depends on the comparison of $\pi_L^U(\hat{s}^U)$ and $\pi_L^S(s^*)$. Similarly to the above analysis, there exists a threshold δ^{SU}, which solves $\pi_L^U(\hat{s}^U) = \pi_L^S(s^*)$ for δ, such that if $\delta > (<)\delta^{SU}$, $\pi_L^U(\hat{s}^U) <$

$(>)\pi_L^S(s^*)$ and the L majority will choose s^* to implement the separate names pattern. Proposition A1 follows. Q.E.D.

The equilibrium name patterns for different values of δ and α are illustrated in Figure A1. Compared to Figure 2 in the PD case, nested names still arise when the producer heterogeneity is high enough (i.e., $\delta > \max\{\delta^{NU}, \delta^{NS}\}$). However, separate names may now be chosen in equilibrium instead of nested names. This is particularly true when the proportion α of aware consumers is large and for intermediate values of producer heterogeneity δ. Indeed, when the L-majority chooses the standard to manipulate the labeling schemes, they have to choose between implementing the nested names pattern and enjoy spillovers in the unaware market but leaving the aware market, or choosing the separate names pattern to cover both markets but without benefiting from any spillover. When the proportion of aware consumers is larger than the proportion of unaware consumers and when producer heterogeneity is not too high, the loss of aware consumers outweighs the spillover benefits, leading to the emergence of separate names in equilibrium.

Simulation results with changes in δ and α are reported in Figure A2.[29] Compared to the PD case (Figure 3 in the primary setting), the equilibrium variables still change in a discontinuous and non-monotonic way, because the equilibrium name pattern changes. In particular, the separate names pattern emerges leading to a higher quality standard and a higher welfare than the nested names pattern. However, the basic result derived in the primary setting, that is, that the quality standard for the majority producers drops with the emergence of the nested names pattern (either in place of the uniform name or of the separate names pattern), still holds.

B Nested names as a signaling device

In this section, we consider a signaling game, in which the H producers can use individual brands nested with the collective label to signal their high quality to consumers.

B.1 The signaling game model

The timing of the game is the same as in the primary setting. In the first stage, the L majority decides the quality standard s ($s < \delta$). Once the quality s is fixed, L producers incur the cost $\Phi(s)$, which is sunk in the following stages and will not affect the ex-post profit of producers. Therefore, the quality cost cannot be used as a signaling device that could change consumers' beliefs.

In the second stage, each producer decides whether to develop an individual brand nested or not with the collective name, or to stay in the uniform coalition wihtout differentiating from the L producers. The difference between the nested names pattern and the separate names pattern for H producers lies in their ability to signal the high quality to unaware consumers. Indeed, under the nested names H producers nested with the collective label for which the lowest quality observed by unaware consumers is s; whereas under the separate

[29]We deliberately choose the parameter values $\delta = 0.8$ and $\alpha = 0.7$ that enables the name pattern to emerge successively when the parameters change. Moreover, we set $f = 0$ for ease of calculation. Setting $f > 0$ will not change the results qualitatively.

names pattern, they cannot been identified by unaware consumers as they are in the spot market and the lowest perceived quality of this market is the minimum quality standard s_0 ($s_0 \leq s$). Therefore, signaling high quality from a regional group is easier than from the spot market. In what follows, we thus assume that the separate names pattern is a dominated strategy for H producers, and hence the choice set of the name patterns in the second stage of the game is $\{U, N\}$.

In the third stage, each producer (H or L) randomly meets a consumer and individually decides the price. Consumers decide whether to purchase from the producer based on observed prices and labels. In the third stage, consumers face a product with two possible quality levels δ and s (depending on the predetermined quality standard). Their prior distribution is β and $1-\beta$, respectively. As in the primary setting, α proportion of consumers knows the quality for the product carrying individual brands, that is, with nested names; however, $1-\alpha$ consumers are unaware about the precise quality and can only infer the quality based on their available information. We assume that the unaware consumers know how costly it is to develop an individual brand (that is, the cost f) and that they know that there exists α proportion of aware consumers. In this case, it is possible for the H producers to signal their product quality with nested names. The signaling possibility lies in the fact that the existence of aware consumers and branding cost make nested names a very costly strategy for L quality producers. Consequently, unaware consumers know that only the H producers can afford the use of nested names.

We use the concept of Perfect Bayesian Equilibria of the game and restrict attention to pure strategy equilibria. When making purchasing decisions, unaware consumers, observing the price p and the name pattern j ($j \in \{U, N\}$), update their beliefs about the product quality based on these signals. We denote by $b(p, j)$ a consumer's posterior belief that quality is high, that is, equal to δ) and hence $1 - b(p, j)$ is the belief of the low quality (that is, s). For simplicity, we assume that producers are charging monopolist prices to consumers. Hence, a consumer will purchase only if the price is not higher than her expected willingness-to-pay (WTP), that is, $p \leq E(s|b(p, j)) = b(p, j)\delta + (1 - b(p, j))s$. Given the belief b and the predetermined quality standard s, a producer i ($i \in \{H, L\}$) chooses the labeling strategy j and the price p to maximize her expected profit. We denote by $\pi_i(p, j; b, s)$ the expected profit after the first stage quality investment.

We first investigate the separating equilibrium, where H producers choose the nested names pattern and L producers stay with the uniform label. We then determine the pooling equilibrium, in which both H and L producers adopt the uniform name. We show that the conditions supporting these equilibria depend on the quality standard s, which is determined in the first stage. Finally, we discuss the possibility that the L-majority 'manipulates' the quality standard to achieve the desirable equilibrium outcome – a result which is consistent with the basic results in the primary setting.

B.2 Separating equilibrium under the nested names pattern

At any separating equilibrium, H producers choose (p_H, N) and L producers choose (p_L, U). Unaware consumer's beliefs are given by $b(p_H, N) = 1$ for (p_H, N) and $b(p', j) = 0$ for all $(p', j) \neq (p_H, N)$. To find the separating equilibria, we follow Milgrom and Roberts (1986) and focus on the equilibria for which dominated strategies are removed and the associated beliefs of the type playing the dominated strategies are set to zero. Thus, at any separating equilibrium, the choice (p_H, N) of a H producer must be a solution of her profit maximization program. The maximizing program ensures that the choice of p is not dominated by other p' in equilibrium:

$$\begin{aligned}
\max_p \quad & \pi_H(p, N; 1, s) = p - f \\
s.t. \quad & \pi_L(p, N; 1, s) = (1-\alpha)p - f \leq \pi_L(p_L, U; 0, s) = s && \text{(B1)} \\
& \max_p \pi_H(p, N; 1, s) = p - f \geq \pi_H(p_L, U; 0, s) = s && \text{(B2)} \\
& 0 \leq p \leq \delta.
\end{aligned}$$

Condition (B1) is the incentive compatibility constraint such that a L producer do not mimic a H producer. The left hand side corresponds to the payoff of L when choosing the nested names pattern (with cost f) and charging a price p. Obviously, only the unaware consumers $(1-\alpha)$ are willing to purchase from L if she tries to mimic H. The right hand side corresponds to the profit that a L producer can get if she stays with the uniform name. With the existence of individual brands, all consumers know the true quality of the products and L producers can charge a price up to consumers' WTP, that is, $p_L = s$. Condition (B2) ensures that H has no incentive to deviate from the separating equilibrium. The last condition guarantees that consumers will purchase under the equilibrium belief $b(p, N) = 1$.

By solving the program, we find that the separating equilibrium, in which H chooses $(p_H(s), N)$ and L chooses (s, U) exists if the following condition is satisfied:

$$s \leq \delta - f. \tag{B3}$$

Then, the price for H producers $p_H(s)$ can be derived as:

$$p_H(s) = \min\{\delta, \frac{f+s}{1-\alpha}\}. \tag{B4}$$

The equilibrium solution can be illustrated in Figure B1 where the range of prices at which the separating equilibria exist are depicted in the gray area. Maximizing $\pi_H(p, N; 1, s)$ implies that all prices in the range below the kinked thick line are equilibrium-dominated by $p_H(s)$. Note that $(p_H(s), N)$ is the unique separating equilibrium that satisfies the 'intuitive criterion' of Cho and Kreps (1987) because there does not exist any other (p', j) such that $\pi_H(p', j; 1, s) > \pi_H(p_H(s), N; 1, s)$ and $\pi_L(p', j; 1, s) < \pi_L(s, U; 0, s)$. Thus, if $s < \delta - f$, there exists a unique separating equilibrium that satisfies the 'intuitive criterion' and this equilibrium depends on the predetermined quality standard s. In this equilibrium, H will charge the monopolist price $p_H(s) = \delta$, when s is not too low, i.e. $s > (1-\alpha)\delta - f$. When the level of the standard s is very low, L producers have more incentives to mimic H producers at a high price than to stay with the uniform name. Therefore, the price of H has to be reduced to $\frac{f+s}{1-\alpha}$ so that the unaware consumers believe that L producers cannot profitably deviate by mimicking H producers.

It should be mentioned that the existence of aware consumers is a necessary condition for the existence of separating equilibrium. Indeed, if α tends to zero, the separating equilibria area shrinks to a single line defined by $p = f + s$, making both H and L producers indifferent between the separating equilibrium and pooling with a price equal to s. Thus, in the absence of the aware consumers, there is no possibility for H producers to signal the high quality with individual brands. When α becomes larger, the upper bound curve $\frac{f+s}{1-\alpha}$ shifts upward, and it becomes then more likely that the separating equilibrium exists with H producers charging the monopolist price δ. However, if the separating equilibrium exists, the profit of a L producer (equal to s) does not depend on α. To this extent, the information effect under the signaling game does not change the quality incentives of L producers in a continuous way as it does in the primary setting.

B.3 Pooling equilibrium under the uniform name

We denote by p^U the pooling price charged by both L and H producers. With the uniform name, both the aware and unaware consumers' beliefs follow the prior $b(p^U, U) = \beta$. The equilibrium price is equal to consumers' WTP, that is, $p^U(s) = \beta\delta + (1-\beta)s$. Notice that the best a producer can gain from deviating tfrom he pooling price is by choosing the out-of-equilibrium belief $b(p, N) = 1$. With such a belief, the most profitable deviation is to set $p = \delta$. The conditions for the existence of the pooling equilibria are thus derived as:

$$\pi_L(p^U, U; \beta, s) = \beta\delta + (1-\beta)s \geq \pi_L(\delta, N; 1, s) = (1-\alpha)\delta - f, \tag{B5}$$
$$\pi_H(p^U, U; \beta, s) = \beta\delta + (1-\beta)s \geq \pi_H(\delta, N; 1, s) = \delta - f. \tag{B6}$$

The incentive compatibility constraint (B5) for producer L is less stringent than (B6) for producer H due to the existence of aware consumers. Therefore, the condition for pooling equilibria hinges on condition (B6) and is given by:

$$s \geq \delta - \frac{f}{1-\beta}. \tag{B7}$$

This condition implies that the uniform name exists in equilibrium only if the predetermined quality standard s is not too low. Similar to Lemma 1 stated in the primary setting, the uniform name will more likely arise only if producers are not too heterogeneous, that is, if s is not too low compared to δ.

The pooling equilibrium condition (B7) may overlap with the separate equilibrium condition (B3) when

$$\delta - \frac{f}{1-\beta} \leq s < \delta - f.$$

For values of s satisfying the above condition, we thus have multiple equilibria and both pooling and separating equilibria are possible. However, conditions (B5) and (B6) imply that the profits for both L and H producers under the pooling equilibrium are higher than those under separating equilibrium, that is, the separating equilibrium is Pareto-dominated by the pooling equilibrium. We thus choose the pooling equilibrium whenever multiple equilibria appear. Lemma B1 summarizes the possible outcomes:[30]

[30]The lemma gives the pure strategy equilibrium that satisfies the 'intuitive criterion'. There may be other equilibria (for instance, mixed strategy equilibria) that may occur depending on the range of parameters. Lemma B1 can be seen as the likelihood that a particular equilibrium outcome occurs.

Lemma B1 *The equilibrium of the signaling game depends on the quality standard chosen by L producers (s):*

- *when $s < \delta - \frac{f}{1-\beta}$ and $\alpha > 0$, there is a unique separating equilibrium (satisfying the intuitive criterion), in which nested names pattern is adopted: H develops the individual brands and L stays in the collective label with profit $\pi_L^N(s) = s$;*

- *when $s \geq \delta - \frac{f}{1-\beta}$, pooling equilibrium arises: both the H and L producers adopt the uniform name and gain a profit $\pi_L^U(s) = \pi_H^U(s) = \beta\delta + (1-\beta)s$.*

The lemma implies that given the quality standard s, the more heterogeneous producers are (δ is large), the more likely H producers will signal their high quality with nested names. However, the effect of consumers' information (α) is discontinuous. In what follows, we focus only on the effect of δ.

B.4 Quality setting

In the quality setting stage, the L-majority chooses the quality standard under a name pattern j ($j \in \{U, N\}$) that maximizes L producers' equilibrium profit taking into account the quality cost. Let $\Pi_L^j \max_s \pi_L^j(s) - \Phi(s)$ denote the maximum profit under a name pattern j. Without any constraint, the equilibrium quality standards under the uniform name (that is, pooling equilibrium) and the nested names (that is, separating equilibrium) are respectively defined by $(1-\beta) = \Phi'(s^U)$ and $s^N = s^*$. It is straightforward to show that $s^U < s^N = s^*$ and $\Pi_L^U > \Pi_L^N$, implying that without any constraint the L producers strictly prefer the uniform name to the nested names pattern because of the spillover effect under the uniform name. Therefore, if H producers want to signal their quality with individual brands because s^U is low, that is, $s^U < \delta - \frac{f}{1-\beta}$ (Lemma B1), the L group will increase the standard to $s = \hat{s}^U = \delta - \frac{f}{1-\beta}$ in order to achieve the pooling equilibrium outcome. We are thus in the constrained uniform name case (CU) as is studied in Lemma 2 of the primary setting.

Again, whether the L-majority will adjust the quality standard to induce the unconstrained uniform name (U), the constrained one (CU) or the nested names pattern (N), depends on the range of parameters. In particular, it depends on the heterogeneity among producers, which is captured by δ. These results are similar to those seen in Proposition 1 of the primary setting of the main text.

Proposition B1 *Under the signaling game, the L-majority faces a trade-off between choosing a high standard to induce the uniform name pattern (pooling equilibrium) or a low standard to induce the nested names pattern (separating equilibrium). There exists $\hat{\delta} = \frac{f}{1-\beta} + s^U$ and δ^{NU} solving $\Pi_L^N = \hat{\Pi}_L^U \equiv \pi_L^U(\hat{s}^U) - \Phi(\hat{s}^U)$ such that $\hat{\delta} < \delta^{NU}$ and*

- *if $\delta < \hat{\delta}$, the L group chooses $s = s^U$, leading to the uniform name;*

- *if $\hat{\delta} \leq \delta < \delta^{NU}$, the L group chooses $s = \hat{s}^U$ with $\hat{s}^U > s^U$, leading to the uniform name;*

- *if $\delta \geq \delta^{NU}$, the L group chooses $s = s^N$ with $s^N = s^* < \hat{s}^U$. H producers develop individual brands, leading to nested names.*

Proof The first item of the proposition is straightforward from Lemma B1, which implies that the pooling equilibrium exists if the quality standard s^U is such that $s^U > \delta + \frac{f}{1-\beta}$. This leads to the condition $\delta < \hat{\delta} = \frac{f}{1-\beta} + s^U$ and the equilibrium profit $\Pi_L^U = \pi_L^U(s^U) - \Phi(s^U)$, which is larger than Π_L^N. When $\delta > \hat{\delta}$, $s^U < \hat{s}^U$ and the L-majority has to raise the quality standard to $\hat{s}^U$ in order to implement the uniform name. It is easily derived that $\frac{\partial \hat{\Pi}_L^U}{\partial \delta}|_{\hat{s}^U = s^U} > 0$, $\frac{\partial \hat{\Pi}_L^U}{\partial \delta}|_{\hat{s}^U = s^*} = 0$ and $\frac{\partial^2 \hat{\Pi}_L^U}{\partial \delta^2} < 0$. Therefore, $\hat{\Pi}_L^U$ is concave in δ and reaches its maximum when $\hat{s}^U = s^*$, i.e., $\delta = \frac{f}{1-\beta} + s^*$. When $\delta > \frac{f}{1-\beta} + s^*$, $\hat{\Pi}_L^U$ decreases at an increasing rate. However $\Pi_L^N = s^* - \Phi(s^*)$ does not change with a change of δ. By continuity, there exists δ^{NU} solving $\Pi_L^N = \hat{\Pi}_L^U$, such that $\Pi_L^N \geq \hat{\Pi}_L^U$ if and only if $\delta \leq \delta^{NU}$. In this case, the nested names pattern is preferred by the L-majority, and hence the quality standard is set at s^* to implement the separating equilibrium. If $\delta < \delta^{NU}$, the pooling equilibrium is still preferred by the L-majority. In this case, a higher quality standard $\hat{s}^U > s^*$ is chosen to implement the uniform name. Q.E.D.

Therefore, we obtain results similar to those in the primary setting: nested names arise when the producer heterogeneity is high enough. Moreover, whenever the nested names pattern is chosen to replace the uniform name, it leads to lower quality incentives for the L producers. From a welfare point of view, nested names under the signaling game are socially optimal because they result in the first-best quality levels. The uniform name, on the other hand, is suboptimal because it may result in either under-provision (in the case of unconstrained uniform name) or over-provision (in the case of constrained uniform name) of quality.

C Consumers with heterogeneous tastes and competition

We investigate now a framework where producers with different qualities compete for consumers with different preferences over quality. This framework corresponds to the case where numerous producers within a region compete perfectly (hence, act as price-takers) in a vertically differentiated market (see, e.g., Moschini et al., 2008). In this section, we show that our two main results 1) and 2) still hold as long as producers can capture positive quality premium, even if the premium is small under competition.

C.1 Consumers with heterogeneous tastes and perfect competition

Consumer heterogeneity Consider a market with a mass m of consumers who are heterogeneous both in their tastes and in their information about qualities. The utility function is captured by $U(s,p) = \theta s - p$, where θ is the consumers' taste parameter uniformly distributed in $[0,1]$.

Producers with quantity decisions There are n producers, competing in offering products with different qualities. We denote by $\rho = \frac{n}{m}$ the competition intensity. We assume that ρ is low enough so that the market is uncovered by the group of producers. Because of the geographical area constraint, we assume no free-entry of producers in the area.[31]

For simplicity, we assume that both the H and L producers have the same production costs $c(q)$ but producer L incur a fixed-quality dependent cost, $\Phi(s)$ in order to achieve the standard level s. The H producer, however, can provide quality δ without cost. To ensure an interior solution, we assume quadratic cost functions: the total costs born by producer L and H are $C_L(q,s) = c(q) + \Phi(s) = \frac{\lambda}{2}q^2 + \frac{\gamma}{2}s^2$ and $C_H(q,\delta) = c(q) = \frac{\lambda}{2}q^2$, respectively. We also assume that $s < \delta$, implying that γ is large enough so that L producers never find optimal to provide the quality level δ.

The game Compared to the primary setting, we introduce a quantity decision in the final stage of the game: In stage 1, the L majority decides the quality standard for the collective label. In stage 2, producers decide whether to adopt only the collective label, or develop their individual brands, nested or separate with the collective label. The L producers incur a quality cost $\Phi(s) = \frac{\gamma}{2}s^2$ if joining the collective label, and H pays f if developing the individual brands. These costs are sunk at this stage and will not affect the following decision of producers. The name patten is formed following the labeling decision. In stage 3, given the quality standard and the name pattern, demand is formed. Producers decide quantity. Market is cleared with demand equal to supply.

The game is solved with backward induction. At the last stage, producers behave as price-takers so that their marginal cost of quantity $c'(q) = \lambda q$ is equal to the market price, which depends on the demand under different names. As in the previous setting, we investigate three name patterns: the uniform name ('U'), nested names ('N') and separate names ('S'), which convey different information to consumers about the product quality. We assume that consumers' perception of quality under different names is the same as that stated in Table 1. Such a simplification implies that the unaware consumers are naive and only perceive the average quality ($\bar{s} = \beta\delta + (1-\beta)s$) based on the prior distribution of H and L producers under the collective label. That is, they do not update their beliefs about the product quality based on the anticipation of the producers' quantity decision. A more sophisticated behavior of consumers is discussed in subsection C.2, where consumers perceive $\bar{s} = \frac{\delta Q_H + sQ_L}{Q_H + Q_L}$, with Q_i ($i \in \{H, L\}$) being the total quantity supplied by producers i.

The uniform name ('U') Under this name pattern, both aware and unaware consumers consider producers as homogeneous. Given the perceived quality $\bar{s} = \beta\delta + (1-\beta)s$ and the market price p, the indifferent consumer is defined by $\theta\bar{s} - p = 0$, so that consumers with taste $\theta \in [\frac{p}{\bar{s}}, 1]$ will purchase the product. By symmetry, we have $Q_L = n(1-\beta)q_L$ and

[31]Introducing free-entry may lead to different results, depending on the timing of entry. In Moschini et al. (2008), free entry drives the profit to zero for producers with exogenous qualities. This means that producers would have no incentive to provide costly quality if the quality decision took place before the entry decision. In a more standard vertical differentiation model (Shaked and Sutton, 1982; Roe and Sheldon, 2007, etc.), entry occurs before the quality decision and price competition implies that only a limited number of producers with positive profits remain in the market. In this case, label plays a role to restore the market power of producers under harsh competition and only the separate names pattern exists in equilibrium. We investigate this situation in subsection C.3.

$Q_H = n\beta q_H$. The inverse demand function under the uniform name pattern is derived as:

$$p^U = \bar{s}(1 - \frac{Q_L + Q_H}{m}) = \bar{s}\left(1 - \rho(\beta q_H + (1-\beta)q_L)\right).$$

Thus, under the uniform name, the spillover effects reflected in $\bar{s}$, still exist in the competitive market, even if their effect is weakened by the competition among H and L producers ($\frac{\partial^2 p^U}{\partial \bar{s} \partial \rho} < 0$). Because both H and L producers face the same demand and have the same cost of production ($c(q) = \frac{\lambda}{2}q^2$), they will supply the same quantity in equilibrium. The equilibrium quantity $q^U(s)$ is defined by:

$$p^U = \bar{s}(1 - \rho q^U) = c' = \lambda q^U.$$

The nested names pattern ('N') Under this name pattern, the market is segmented into the aware and unaware markets, with sizes αm and $(1-\alpha)m$, respectively. In the unaware market, the demand faced by both H and L producers are similar to the case of the uniform name, except that the market is smaller. We denote by q_i^u the quantity supplied by a producer i ($i \in \{H, L\}$) in the unaware market. The inverse demand function is then given by:

$$p^{N(u)} = \bar{s}\left(1 - \frac{Q_L^u + Q_H^u}{(1-\alpha)m}\right) = \bar{s}\left(1 - \frac{\rho}{1-\alpha}(\beta q_H^u + (1-\beta)q_L^u)\right).$$

Again, the spillover effecst still exist in the unaware market, and their effect is smaller the more intensive the competition is (larger ρ) and the smaller the relative size of the unaware market $(1-\alpha)$.

In the aware market, the two qualities (s and δ) are identified by consumers. Denote by $p_L^{N(a)}$ and $p_H^{N(a)}$ the market prices for the two qualities. Following Mussa and Rosen (1978), consumers with taste ranging in $[\frac{p_H^{N(a)} - p_L^{N(a)}}{\delta - s}, 1]$ will purchase from producers H, and those with tastes in $[\frac{p_L^{N(a)}}{s}, \frac{p_H^{N(a)} - p_L^{N(a)}}{\delta - s}]$ will buy from producers L. Denoting by q_i^a the quantity supplied by a producer i in the aware market, following Moschini et al. (2008), we derive the inverse demand function as:

$$p_H^{N(a)} = \delta - \frac{\rho}{\alpha}(\delta\beta q_H^a + s(1-\beta)q_L^a), \tag{C1}$$

$$p_L^{N(a)} = s(1 - \frac{\rho}{\alpha}(\beta q_H^a + (1-\beta)q_L^a)). \tag{C2}$$

Thus, there are no spillover effects in the aware market. A producer L enjoys the price premium of quality s, which is reduced if the producers face intensive competition in a small market (that is, for large values of ρ and small values of α).

The inverse demand functions imply that under the nested names pattern each producer is facing a segmented demand in the aware and unaware markets. Under perfect competition, the quantity allocation should be such that producers will leave the market with lower price or produce until the two market prices are equalized. It can be shown that when the quality standard is not too high (or when the quality cost is not too small, that is, γ is large enough), market prices are ranked as in the following: $p_L^{N(a)} < p^{N(u)} < p_H^{N(a)}$. It follows that L producers will only supply the unaware market ($q_L^a = 0$) and H producers will only supply the aware market ($q_H^u = 0$).[32] The equilibrium quantities $q_L^N(s)$ and $q_H^N(s)$ are defined by the following conditions:

$$p^{N(u)} = \bar{s}\left(1 - \frac{\rho}{1-\alpha}(1-\beta)q_L^u\right) = \lambda q_L^u, \tag{C3}$$

$$p_H^{N(a)} = \delta(1 - \frac{\rho}{\alpha}\beta q_H^a) = \lambda q_H^a. \tag{C4}$$

The separate names pattern ('S') Under this name pattern, unaware consumers can identify the L producers' true quality s, which is also the average quality of the L group. However, without the collective label, unaware consumers cannot identify the individual name of H producers and perceive only the minimum quality in the spot market (s_0 with $s_0 < s$). Denoting respectively by $p_L^{S(u)}$ and $p_H^{S(u)}$ the market prices for L producers with quality s and for H producers with perceived quality s_0, the inverse demand functions in the unaware market (with market size $(1-\alpha)m$) are then given by:

$$p_L^{S(u)} = s - \frac{\rho}{1-\alpha}(s(1-\beta)q_L^u + s_0\beta q_H^u), \tag{C5}$$

$$p_H^{S(u)} = s_0(1 - \frac{\rho}{1-\alpha}(\beta q_H^u + (1-\beta)q_L^u)). \tag{C6}$$

For the aware consumers (with market size αm), the two qualities δ and s are perfectly identified. We are thus in the same situation as in the aware market under the nested names pattern. The inverse demand $p_H^{S(a)}$ and $p_L^{S(a)}$ are of the same form as defined in conditions (C1) and (C2), respectively.

Again, each producer faces different demands in the aware and unaware markets. If the quality cost is not too small, the market price can be ranked, that is, $p_H^{S(a)} > p_L^{S(u)} > p_L^{S(a)} > p_H^{S(u)}$. L producers will only target the unaware market ($q_L^a = 0$), while H producers, facing a low demand in the unaware market, will leave this market, that is, $q_H^u = 0$. The equilibrium quantities $q_L^S(s)$ and $q_H^S(s)$ are defined in the following conditions:

$$p_H^{S(a)} = \delta(1 - \tfrac{\rho}{\alpha}\beta q_H^a) = \lambda q_H^a, \tag{C7}$$

$$p_L^{S(u)} = s(1 - \tfrac{\rho}{1-\alpha}(1-\beta)q_L^u) = \lambda q_L^u. \tag{C8}$$

The inverse demand and equilibrium quantities under the three name patterns are derived in table C1.

[32]It can be shown that when γ is small so that the equilibrium quality standard s^N is high, two cases may occur depending on the relative size of the aware market: when the aware market is small ($\alpha < \beta$), producers H can supply both the aware and unaware markets ($q_H^u > 0$). This is the case when s^N is above a threshold level ($s^N > s_1$ where $s_1 \in (0, \delta)$ is a function of parameters) so that $p^{N(u)} = p_H^{N(a)}$. On the other hand, when the aware market is large ($\alpha > \beta$), L producers may have incentives to supply the aware market ($q_L^a > 0$). This is the case when $s^N > s_2$ (where $s_2 \in (0, \delta)$ is a function of parameters), leading to $p_L^{N(a)} = p^{N(u)}$. Analyzing these cases involve more complex calculations but the basic results will not change qualitatively. In the following analysis, we assume that the quality cost parameter γ is large enough so that the equilibrium quality s^N does not surpass the threshold levels.

Table C1: Demand and equilibrium quantities under different name patterns

Name	Labels	Market covered	Demand	Equilibrium quantities
U	L: C H: C	Both aware and unaware markets	$p^U = \bar{s}(1-\rho q^U)$	$q_L^U(s) = q_H^U = \frac{\bar{s}}{\rho\bar{s}+\lambda}$
N	L:C	Only unaware market	$p^{N(u)} = \bar{s}\left(1 - \frac{\rho}{1-\alpha}(1-\beta)q_L^u\right)$	$q_L^N(s) = \frac{(1-\alpha)\bar{s}}{\rho(1-\beta)\bar{s}+(1-\alpha)\lambda}$
	H: $C+I$	Only aware market	$p_H^{N(a)} = \delta(1 - \frac{\rho}{\alpha}\beta q_H^a)$	$q_H^N(s) = \frac{\alpha\delta}{\rho\beta\delta+\alpha\lambda}$
S	L:C	Only unaware market	$p_L^{S(u)} = s\left(1 - \frac{\rho}{1-\alpha}(1-\beta)q_L^u\right)$	$q_L^S(s) = \frac{(1-\alpha)s}{\rho(1-\beta)s+(1-\alpha)\lambda}$
	H: I	Only aware market	$p_H^{S(a)} = \delta(1 - \frac{\rho}{\alpha}\beta q_H^a)$	$q_H^S(s) = \frac{\alpha\delta}{\rho\beta\delta+\alpha\lambda}$

Labeling choice Given the quality standard s, producers choose the label that gives the highest profits. We denote by $\pi_i^j(s)$ the third stage (post quality investment) profit of a producer i under a name pattern j ($j \in \{U, N, S\}$). In equilibrium, $p_i^j = c'(q_i^j) = \lambda q_i^j$ and hence,

$$\pi_i^j(s) = p_i^j q_i^j - c(q_i^j) = \frac{\lambda}{2} {q_i^j}^2.$$

The third stage profit is thus monotonically determined by the equilibrium quantity, which is derived in the last column of table C1. Investigating the equilibrium quantities leads to three observations. First, $q_L^N > q_L^S$, implying that L producers strictly prefer the nested names pattern to the separate names pattern due to the spillover effects that arise under nested names (from table C1, $p^{N(u)} > p^{S(u)}$ for given quantity q_L^u). Second, while the uniform name is always preferred by the L producers in the primary setting, now nested names may be preferred by them. It is easily checked that when $\alpha < \beta$, then $q_L^N > q_L^U$ and hence $\pi_L^N > \pi_L^U$. Indeed, in the presence of producer competition, nested names have an advantage for the L producers: compared to the uniform name where all producers compete, nested names enable L producers to operate in the segmented (unaware) market without competing with the H producers. The larger the proportion of unaware consumers relative to the number of L producers, the more beneficial it is for the L producers to adopt nested names. Third, the quantities for H, q_H^N and q_H^S, are the same and independent of s if H producers develop their individual brands. Therefore, the labeling choice of H producers can be derived by the comparison between the profits obtained under 'U' and 'N'. Again, since q_H^U and π_H^U are strictly increasing in s, it is more likely for H producers to adopt the name pattern 'U' when s is high. The above analysis can be summarized in Lemma C1.

Lemma C1 *When producers compete for consumers with heterogeneous tastes, for a given quality standard s,*

- *L producers prefer the uniform name only if $\alpha > \beta$;*
- *H producers prefer the uniform name only if $s \geq \hat{s}^U$, where $\hat{s}^U$ solves $\frac{\lambda}{2}q^U(s)^2 =$*

$\frac{\lambda}{2}{q_H^N}^2 - f$*, that is, the participation constraint for H to adopt the uniform name is*

$$\frac{\lambda}{2}\left(\frac{\bar{s}}{\rho\bar{s}+\lambda}\right)^2 \geq \frac{\lambda}{2}\left(\frac{\alpha\delta}{\rho\beta\delta+\alpha\lambda}\right)^2 - f. \tag{C9}$$

Lemma C1 is similar to Lemma 1 in the primary setting. Notice that the participation constraint for H holds for small α and large f; however, the effects of δ is less straightforward. On one hand, δ increases the conflicts inside the uniform group, which gives H producers incentives to deviate and develop individual brands. On the other hand, a large δ stimulates the production of H producers inside the uniform group, and may eventually lead to a higher profit for H producers than the profits they would have gained in the "narrow" aware market. The ultimate effects of δ are thus ambiguous. Indeed, when L and H compete in quantities, the quantity difference implies that δ is no longer a pertinent measure for producer heterogeneity. In what follows, we focus on the effect of α and f. Moreover, we first investigate the case where $\alpha > \beta$, so that L producers prefer the uniform name for a given standard, as we did in the primary setting. Other parameter ranges will be discussed after deriving the main results.

Quality setting When $\alpha > \beta$, the L-majority wants to implement the uniform name by setting the quality, taking into account the participation constraint of H producers. Let $\Pi_L^j(s) = \pi_L^j(s) - \Phi(s)$ be the (first-stage) net profit of producer L under the name pattern j. The problem for the L-majority can be written as:[33]

$$\begin{aligned} \max_s \quad & \Pi_L^U(s) = \pi_L^U(s) - \Phi(s) \\ s.t. \quad & \text{condition } (C9). \end{aligned}$$

By solving the problem, we derive the following lemma:

Lemma C2 *When producers compete for consumers with heterogeneous tastes, in order to implement the uniform name, the L-majority chooses standard s^U, which solves*

$$\frac{\partial \pi_L^U}{\partial s} = \lambda q^U \frac{\partial q^U}{\partial s} = \Phi'(s)$$

if and only if $\alpha < \hat{\alpha}$, where $\hat{\alpha}$ solves $\frac{\lambda}{2}\left(\frac{\beta\delta+(1-\beta)s^U}{\rho(\beta\delta+(1-\beta)s^U)+\lambda}\right)^2 = \frac{\lambda}{2}\left(\frac{\alpha\delta}{\rho\beta\delta+\alpha\lambda}\right)^2 - f$. Otherwise, it will chooses $\hat{s}^U$ with $\hat{s}^U > s^U$ to make condition (C9) binding.

[33]The H producer's outside option can be interpreted as the single deviation profit of producer H when developing the individual brand to attract the aware consumers. Since producers are small and the market size is large, it is reasonable to assume that the deviating producer H serves only for $\frac{1}{\beta n}$ part of the aware market. The inverse demand function is thus $\delta(1 - \frac{\rho\beta q_H^a}{\alpha})$, which is similar to $p_H^{S(a)}$ defined in Table C1. Thus, the deviating producer H behaves as if she competes in the aware market with the separate names pattern. The equilibrium quantity is thus q_H^S. So the outside option condition becomes $\frac{\lambda}{2}{q^U(s)}^2 \geq \frac{\lambda}{2}{q_H^S}^2 - f$, which is the same as condition (C9).

Lemma C2 is similar to Lemma 2 in the primary setting, except that the outside option condition should be interpreted from the consumers' information perspective. Indeed, when consumers become more aware, the threat from the high-quality producers to develop their own brand makes the L group increase their quality standard so as to keep producers H in the uniform label. This leads to the constrained uniform case ('CU') with the quality standard being set at a high level. Again, nested names may be chosen to replace the uniform name when the L group cannot sustain the high quality standard. Proposition C1 shows that for a large range of parameters the main results still hold.[34]

Proposition C1 *When producers compete for consumers with heterogeneous tastes, there exist α^{NU}, which solves $\Pi_L^U(\hat{s}^U) = \Pi_L^N(s^N)$, such that if $f > \hat{f} \equiv \frac{\lambda}{2}\left(\frac{\delta}{\rho\delta+\lambda}\right)^2 - \frac{\lambda}{2}\left(\frac{\beta\delta+(1-\beta)s^U}{\rho(\beta\delta+(1-\beta)s^U)+\lambda}\right)^2$, then $\alpha^{NU} > \hat{\alpha} > \beta$ and*

- *if $\alpha \leq \hat{\alpha}$, the L-majority chooses standard s^U, leading to the uniform name pattern 'U';*
- *if $\hat{\alpha} < \alpha \leq \alpha^{NU}$, the L-majority chooses standard $\hat{s}^U$, with $\hat{s}^U > s^U$, leading to the constrained uniform name pattern 'CU';*
- *if $\alpha > \alpha^{NU}$, the L-majority chooses s^N, with $s^N < \hat{s}^U$, leading to the nested names pattern 'N'.*

Proof: The first item is directly derived from Lemma C2. For the second and third items we need to look at α^{NU}, which is defined as $\alpha^{NU} = \{\alpha | \Pi_L^U(\hat{s}^U) - \Pi_L^N(s^N) = 0\}$. First, note that when α is very high, the condition (C9) is binding and $\hat{s}^U$ becomes increasing with α. Then, we can have:

$$\frac{\partial \Pi_L^U(\hat{s}^U) - \Pi_L^N(s^N)}{\partial \alpha} < 0, \tag{C10}$$

implying that when $\alpha >$ (or $\leq$) α^{NU}, $\Pi_L^U(\hat{s}^U) <$ (or $\geq$) $\Pi_L^N(s^N)$, so that the L producers prefer nested names (or the 'CU'). The equilibrium name depends on the comparison of $\hat{\alpha}$ and α^{NU}. Second, note that the two thresholds are functions of f. We have $\frac{\partial\hat{\alpha}}{\partial f} = 1/\left(-\frac{\partial \pi_H^N}{\partial \alpha}\right) > 0$ and $\frac{\partial \alpha^{NU}}{\partial f} = 1/\left(-\frac{\partial \pi_H^N}{\partial \alpha} - \frac{\partial \pi_L^N}{\partial \alpha}\frac{\partial \pi^U}{\partial s}/\frac{\partial \Pi_L^U}{\partial s}|_{s=\hat{s}^U}\right) > 0$, where $\frac{\partial \pi_H^N}{\partial \alpha} = \lambda q_H^N \frac{\partial q_H^N}{\partial \alpha} > 0$, $\frac{\partial \pi_L^N}{\partial \alpha} = \lambda q_L^N \frac{\partial q_L^N}{\partial \alpha} < 0$, $\frac{\partial \pi^U}{\partial s} = \lambda q^U \frac{\partial q^U}{\partial s} > 0$ and $\frac{\partial \Pi_L^U}{\partial s}|_{s=\hat{s}^U} = \lambda q^U(s^U)\frac{\partial q^U}{\partial s} - \Phi'(\hat{s}^U) < 0$ for $\hat{s}^U > s^U$. Therefore, we have:

$$\frac{\partial \alpha^{NU}}{\partial f} > \frac{\partial \hat{\alpha}}{\partial f} > 0. \tag{C11}$$

Notice that $\hat{\alpha}$ and α^{NU} may intersect for some values of f. Denoting by $\hat{f} = \{f | \hat{\alpha} = \alpha^{NU}\}$, then at $f = \hat{f}$ we have $\alpha = \hat{\alpha} = \alpha^{NU}$. From the definition of $\hat{\alpha}$ and α^{NU}, we have $s^U = \hat{s}^U$, and thus $\Pi_L^U(s^U) = \Pi_L^N(s^N)$. Note that $s^U = \arg\max \Pi_L^U(s) = \frac{\lambda}{2}q^U(s) - \Phi(s)$,

[34] It should be noted that when $\alpha < \beta$, nested names are preferred by the L group. However, in the case that $\alpha < \hat{\alpha}$, H producers are better off under the uniform name. Anticipating this, the L group has to reduce the quality at the level $\hat{s}^N$, with $\hat{s}^N < s^N$, to prevent the H producers from competing in the unaware market. However, by doing so, it can be proved that $\pi_L^N(\hat{s}^N) < \pi_L^U$, such that the uniform name is chosen in equilibrium.

$s^N = \arg\max \Pi_L^N(s) = \frac{\lambda}{2} q_L^N(s) - \Phi(s)$. In order to have $\Pi_L^U(s^U) = \Pi_L^N(s^N)$, we must have $q^U(s) = q_L^N(s)$. From Table C1, $q^U(s) = q_L^N(s)$ if $\alpha = \beta$ and hence we derive $\hat{f} = \pi_H^N - \pi^U(s^U)|_{\alpha=\beta} = \frac{\lambda}{2}\left(\frac{\delta}{\rho\delta+\lambda}\right)^2 - \frac{\lambda}{2}\left(\frac{\beta\delta+(1-\beta)s^U}{\rho(\beta\delta+(1-\beta)s^U)+\lambda}\right)^2$. At this point, $\hat{\alpha} = \alpha^{NU} = \beta$. When $f > \hat{f}$, both $\hat{\alpha}$ and α^{NU} increase with f but α^{NU} increases more from condition (C11). Therefore, we have $\alpha^{NU} > \hat{\alpha} > \beta$ when $f > \hat{f}$. From Lemma C2 and condition (C10), we have the second and third items of the proposition. Q.E.D.

Proposition C1 is similar to Proposition 1 in the primary setting, except that the results are derived from the perspective of the consumers' awareness. Thus in the presence of producer competition and consumer heterogeneous tastes, the results are similar to the main results 1 and 2: the nested names pattern is chosen if a larger proportion of consumers become more aware, and whenever it arises in place of the uniform name pattern the quality for the majority of L producers is reduced.

As an illustration, we can draw the equilibrium name pattern in the $\alpha - f$ space. For the ease of presentation, we represent the threshold conditions on f which are functions of α. Let $\hat{F}^U(\alpha) = \{f : \Pi_H^U(s^U) = \Pi_H^U\}$ and $F^{NU}(\alpha) = \{f : \Pi_L^U(\hat{s}^U) = \Pi_L^N\}$, $\hat{F}^N(\alpha) = \{f : \Pi_H^N = \Pi_L^N(s^N)\}$ and $F^{UN}(\alpha) = \{f : \Pi_L^U(s^U) = \Pi_L^N(\hat{s}^N)\}$. The equilibrium name patterns can be plotted in Figure C1. The figure shows that the $\alpha - f$ space is divided into four regions. In the upper-left grey area, where the size of the aware market is small and the cost of H to develop individual brand is large, the uniform name is chosen without any constraint. In the lower-right grey area, with more information and lower costs to develop the individual brand, nested names are chosen without any constraint. However, in the intermediate range, if $f > \hat{f}$, the L group has to increase the quality standard to (α) in order to keep H producers inside the uniform name.

Discussion about other parameter ranges It should be noted that similar results still hold if f is low, that is, if $f \leq \hat{f}$. In this case, nested names are more likely to be chosen in equilibrium. In particular, when $\alpha > \beta$ it is impossible for the L group to raise s and have the H producers to accept the uniform name, even if the uniform name gives L producers higher profit. When $\alpha < \beta$, L producers prefer the nested names pattern ($q^U < q_L^N$ so that $\pi^U < \pi_L^N$). However, when α becomes small ($\alpha < \hat{\alpha}^N$ with $\hat{\alpha}^N$ making H indifferent between targeting only the aware market and competing with L producers in the unaware market), H producers may have incentives to serve the unaware market instead of developing their costly individual brands. To prevent the H producers from competing in the unaware market, the L group may choose a lower quality standard than the optimal level ($\hat{s}^N < s^N$), that is, the L group chooses the nested names pattern under the constraint that H producers will not target the unaware market. If α becomes very small ($\alpha < \alpha^{UN}$, with α^{UN} such that L producers are indifferent between the nested names pattern with constrained low quality standard $\hat{s}^N$ and the unconstrained uniform name), the constrained quality standard $\hat{s}^N$ will be so low that the profit for the L producers under the nested names pattern is lower than under the uniform name. Therefore, the uniform name will be chosen for a small size of the aware market.

To conclude, we have the same result pattern as the one stated in proposition C1: if $f < \hat{f}$, there exists $\hat{\alpha}^N$ and α^{UN} such that $\alpha^{UN} < \hat{\alpha}^N < \beta$; in addition, if 1) $\alpha < \alpha^{UN}$, the uniform name pattern is chosen with quality standard s^U; 2) if $\alpha^{UN} < \alpha < \hat{\alpha}^N$, the nested names pattern is chosen with a lower standard $\hat{s}^N < s^U$; 3) if $\alpha > \hat{\alpha}^N$, the nested names pattern is chosen with quality standard s^N. Again, nested names are chosen when consumers become more aware, and whenever they are chosen in place of the uniform name, they lead to a drop in the level of quality standard.

Effect of competition It should be noted that although the threshold $\hat{\alpha}$ and α^{NU} are functions of the competition intensity parameter ρ, the comparison of the threshold values is not affected by ρ. Therefore, our results derived in proposition C1 hold for a wide range of ρ. In fact, the effect of ρ is ambiguous. From the participation constraint (C9), ρ simultaneously reduces the profit of H inside the uniform name and outside the collective label. Therefore, it is difficult to derive a monotonic impact of ρ. The effect can be illustrated from a simulation (cf. Figure C2). The changes of equilibrium variables when competition is less intensive ($\rho = 0.1$ implying that the market size m is ten times larger than the number of producers n) is represented on the left panel while the right panel represents the outcome with a more intensive competition ($\rho = 1.0$). Both figures still show a discontinuous change in the equilibrium quality for the majority group. The difference is that the constrained uniform case 'CU' becomes less likely when competition is more intense.

The competition intensity may lead to different welfare impact compared to the primary setting. We focus on the comparison of welfare under the uniform and nested names. Under the uniform name, among all the units $Q^U = nq^U$ purchased, there is a proportion β of high quality good units (with quality δ) and a proportion $(1-\beta)$ of low quality good units (with quality s^U or $\hat{s}^U$ depending on the size of the aware market α) purchased by consumers with mass m and with tastes ranging in $[\frac{p^U}{\bar{s}}, 1]$. The purchasing price is $p^U = p^U(q^U)$. The welfare can thus be derived as:

$$\begin{aligned} W^U &= m\left(\beta\int_{\frac{p^U}{\bar{s}}}^{1}\delta\theta d\theta + (1-\beta)\int_{\frac{p^U}{\bar{s}}}^{1} s\theta d\theta\right) - n\left(c(q^u) + (1-\beta)\Phi(s)\right) \\ &= m\left(\int_{\frac{p^U}{\bar{s}}}^{1}\bar{s}\theta d\theta - \rho\left(\frac{\lambda}{2}{q^U}^2 + (1-\beta)\frac{\gamma}{2}{s^U}^2\right)\right). \end{aligned} \tag{C12}$$

Under nested names, consumers are segmented according to the information they have. In the aware market (with size $m\alpha$), consumers ranging in $[\frac{p_H^{N(a)}}{\delta}, 1]$ purchase $n\beta q_H^N$ units of high quality goods at price $p_H^{N(a)}$; in the unaware market (size $m(1-\alpha)$), consumers ranging in $[\frac{p^{N(u)}}{\bar{s}}, 1]$ purchase $n(1-\beta)q_L^N$ units of low quality goods (with quality s^N) at price $p^{N(u)}$. The welfare function W^N is thus derived as:

$$\begin{aligned} W^N &= m\left(\alpha\int_{\frac{p_H^{N(a)}}{\delta}}^{1}\delta\theta d\theta + (1-\alpha)\int_{\frac{p_L^{N(u)}}{\bar{s}}}^{1} s\theta d\theta\right) \\ &\quad -m\rho\left(\beta(\frac{\lambda}{2}{q_H^N}^2 + f) + (1-\beta)(\frac{\lambda}{2}{q_L^N}^2 + \frac{\gamma}{2}{s^N}^2)\right) \end{aligned} \tag{C13}$$

The comparison of welfare under the two name patterns is ambiguous. As can be seen from Figure C2, the welfare change still follows the same pattern as in the primary setting when the competition is less intense (the left panel where $\rho = 0.1$). Again, whenever the nested names pattern is chosen to replace the uniform name, we observe a reduction in the welfare because of a lower quality standard and less quantity to be produced under the nested names pattern. However, when competition becomes intense (the right panel where $\rho = 1$), nested names lead to a higher welfare than the uniform name. One explanation is the quantity effect: under quantity competition, the nested names pattern enables H producers to operate in the aware market with higher WTP, and hence induces H producers to supply more quantity than L producers. Moreover, the difference in quantity becomes larger when competition becomes more intense. The welfare benefit from larger supplied quantity of high quality may mitigate the negative impact of the nested names pattern on L producers' quality choice, leading to an increase in welfare when nested names emerge. The intuition is clearer if we investigate the average quality $\tilde{s} = \frac{\delta Q_H + s Q_L}{Q_H + Q_L}$. As can be seen from Figure C2, the left bottom subfigure implies that the average quality under the nested names pattern is below that emerging with the constrained uniform name, that is, $\tilde{s}^N < \hat{\tilde{s}}^U$ when $\alpha > \alpha^{NU}$. However the relationship is reversed when competition is more intense (the right bottom figure), leading to higher welfare under nested names in this case.

C.2 Sophisticated consumers perceiving $\tilde{s} = \frac{\delta Q_H + s Q_L}{Q_H + Q_L}$

The above analysis assumes that the unaware consumers are naive, that is, their perception about the average quality of the collective label will not be adjusted based on the quantities purchased. In this subsection, we consider consumers' quality perception described in Table 1 but now assume that the unaware consumers know the production technology of L and H producers and can thus update their perception of the average quality based on their anticipation of the equilibrium quantities supplied by H and L producers. Thus, we follow Zago and Pick (2004) and assume that the average quality of the collective label perceived by the unaware consumers is $\tilde{s} = \frac{\delta Q_H + s Q_L}{Q_H + Q_L}$.

The uniform name pattern ('U') results in the same equilibrium quantities q^U and the same profits $\pi_L^U = \pi_H^U = \frac{\lambda}{2}(q^U(s^U))^2$ as we derived in the last section of naive consumer case, because sophisticated consumers should anticipate that L and H producers produce the same quantity ($q_L = q_H$) and hence the average quality of the uniform name is still given by $\tilde{s} = \bar{s} = \beta\delta + (1-\beta)s$. The separate names pattern ('S') also results in the same equilibrium, since the unaware consumers are perfectly informed about the true quality of the product.

However, the perceptions of naive and sophisticated consumers may differ in the case of nested names ('N'), where the demand in the unaware market becomes

$$p^{N(u)} = \tilde{s}\left(1 - \frac{\rho}{1-\alpha}(\beta q_H^u + (1-\beta) q_L^u)\right).$$

However, if we assume that the quality cost (γ) is large, the ranking in market prices will still be $p_L^{N(a)} < p^{N(u)} < p_H^{N(a)}$, such that H producers will only target the aware market.[35] With this assumption, we have $\tilde{s} = s$. The spillover effect vanishes and hence the nested names

[35] Again, this requires the equilibrium quality level to be $s^N < s_1$, with s_1, such that the prices in the aware and unaware markets are equalized, that is, $p^{N(u)} = p_H^{N(a)}$.

outcome becomes the same as that of the separate names pattern, with the equilibrium quantities being defined in condition (C7) and (C8). Therefore, the equilibrium quality standard is $s^N = s^S$, which gives $\Pi_L^N = \Pi_L^S = \max_s \pi_L^S(s) - \Phi(s)$ and $\Pi_H^N = \Pi_H^S = \frac{\lambda}{2} {q_H^S}^2 - f$.

Again, under the uniform name, H producers may have incentives to deviate and develop their individual brand if more consumers become aware $\alpha > \hat{\alpha}$. The argument is exactly the same as that in Lemma C2 and results similar to those in Proposition C1 still hold, except that the threshold parameter α^{NU} now becomes α^{SU} (with $\alpha^{SU} > \alpha^{NU}$), which solves $\Pi_L^U(\hat{s}^U) = \Pi_L^S$. Therefore, our main results 1) and 2) still hold when the unaware consumers are sophisticated.

C.3 Heterogeneous consumers and price competition

In this section, we follow Shaked and Sutton (1982) and Roe and Sheldon (2007) to investigate a framework where producers compete in price in a vertically differentiated market.[36] Consumers' preferences are unchanged and described as in the subsection C.1. Roe and Sheldon (2007) show that if consumers' taste is not too dispersed and the qualities are perfectly perceived by consumers, the market will be covered so that all consumers are served and only two firms can survive on the market. In this spirit, we depart from the former assumption of a large mass of producers but consider only two producers representing the H and the L types, respectively.[37] Furthermore, we assume zero production costs for both H and L firms. We also assume that the L firm incurs a fixed quality cost $\Phi(s)$, which is sunk before the price competition stage.[38] The game still follows the three stages described in subsection C.1, except that in the third stage, L and H producers compete in price.

Uniform name With the uniform label, the two varieties H and L are seen as identical by both aware and unaware consumers. The average quality is equal to $\bar{s}$. The two producers play a standard Bertrand game with homogeneous products, such that prices are set at (zero) marginal cost level in equilibrium and both producers gain zero profits. Thus, in the quality setting stage, the L producers have no incentives to provide quality and soquality is set at the minimum quality level $s^U = s_0$.

Nested names Under this name pattern, the unaware consumers still consider the two producers as homogeneous, leading to zero profits for both producers in the unaware market. However, aware consumers can fully identify the quality with nested individual brands. Denoting by p_h, p_l the prices chosen by H and L producers in the aware market, respectively,

[36]A well-recognized result of the model with vertical differentiation is that price competition leads to a concentrated industry so that there are only a limited number of producers existing in the market (Shaked and Sutton, 1982).Therefore, we simply consider a duopolistic competition model to investigate the concentrated industry.

[37]To endogenize the number of firms, we can followRoe and Sheldon (2007) and add an entry stage before the quality setting stage. When consumers' preferences are not too dispersed, two qualities will remain, resulting in the competition of a firm H providing a quality δ, and a firm L providing a quality s ($s \geq s_0$).

[38]As is argued by Roe and Sheldon (2007), "the assumption of zero variable production costs can be relaxed if we assume that variable production costs do not increase in quality more than consumer WTP increases in quality."

the duopoly profits for the two producers in the aware market(with size αm) are then derived as:

$$\pi_L(p_L, p_H, s) = \alpha m \left(\frac{p_H - p_L}{\delta - s} \right) p_L, \tag{C14}$$

$$\pi_H(p_L, p_H, s) = \alpha m \left(1 - \frac{p_H - p_L}{\delta - s} \right) p_H. \tag{C15}$$

The game is solved backward. The detailed calculation is derived in Roe and Sheldon (2007). Denote by $\pi_i^N(s)$ the equilibrium profits for the producer i ($i \in \{H, L\}$) in the price competition stage. The equilibrium quality standard s^N and profits for producer L are thus defined by $\Pi_L^N = \max_s \pi_L^N(s) - \Phi(s)$. The profits for producer H are $\Pi_H^N = \pi_H^N(s^N) - f$. It is easy to check that $\frac{\partial \Pi_i^N}{\partial \alpha} > 0$.

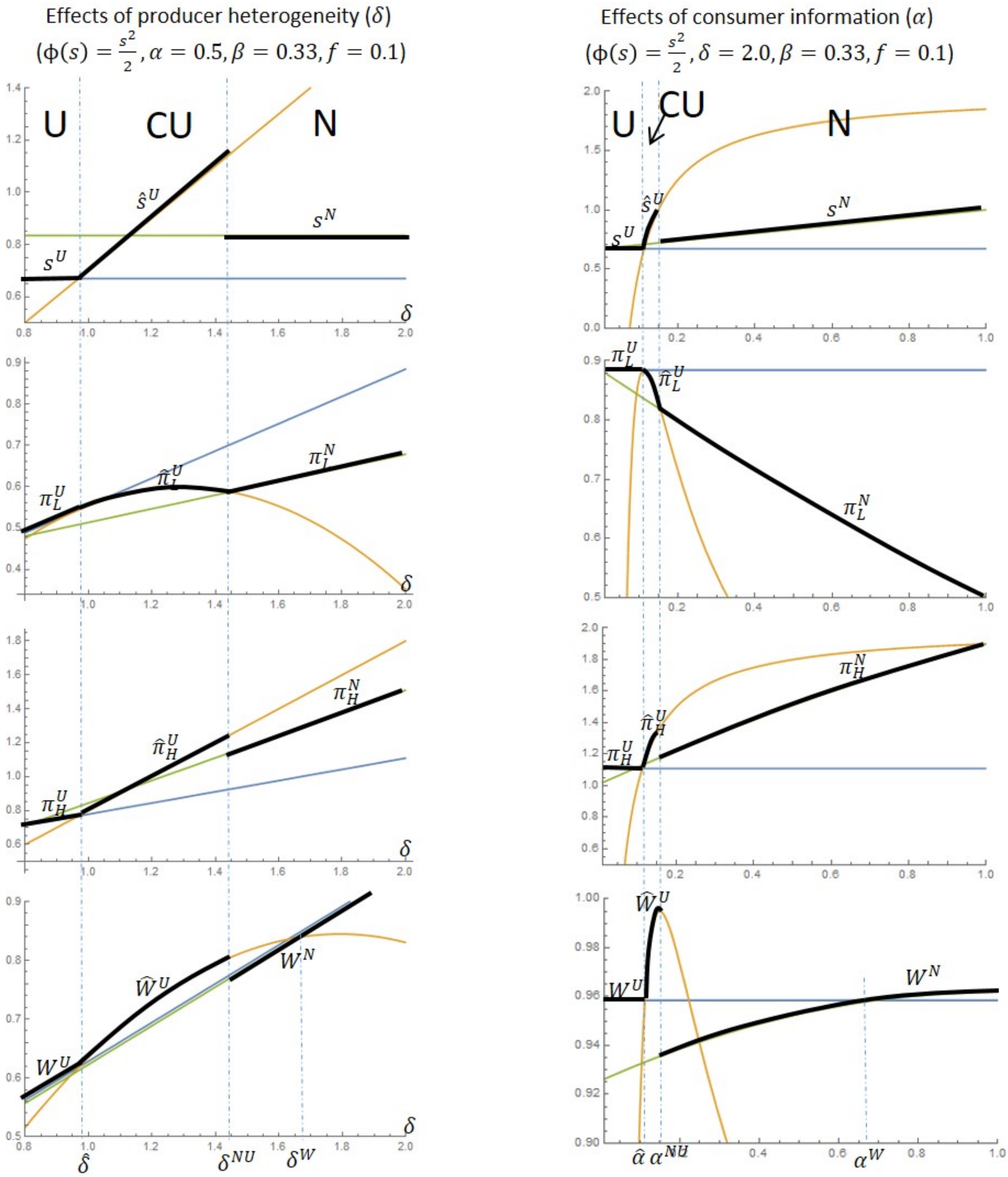
Separate names When the two producers adopt different labels, both the aware and unaware consumers can fully identify the true qualities of the products. Thus, the unaware consumers see the products like the aware ones. The market is fully segmented such that producers L and H can exploit their duopoly power in the whole market. That is, producer i, facing the market with size m, gains the duopolistic profit $\Pi_i^S = \Pi_i^N|_{\alpha=1}$. The profit is clearly larger than what i can gain under nested names (with market size αm).

The equilibrium name patterns depend on the profit comparison of the L producer under the three name patterns. The above analysis implies that $\Pi_i^S > \Pi_i^N > \Pi_i^U = 0$. Thus we obtain:

Proposition C2 *If producers compete in price and consumers have heterogeneous tastes, the spillover effects of collective label vanish so that producers strictly prefer the separate names pattern.*

This result is different from the results found in the primary setting. It is mainly due to the fact that the spillover effects vanish if firms compete intensively. Adding restrictions to competition may restore the spillover effects. For instance, by restricting supply when producers face increasing marginal costs, as shown in Subsection C.1. Another instance could be when producers have market power and can charge a price in reaction to the demand condition, that is, the case analyzed in the primary setting.

Figure 3: Producer heterogeneity, consumer information and equilibrium name



The left panel of the figure shows the change of variables with the producer heterogeneity δ when we fix the level of α (which corresponds to the vertical line $\alpha = 0.5$ in Figure 2) and the right panel captures the effect of consumer awareness α when we fix the level of δ (which corresponds to the horizontal line $\delta = 2.0$ in figure 2). The dark and thick curve in each sub-figure represents the equilibrium variables, which change with the parameters and the equilibrium name patterns.

Figure A1: Equilibrium name patterns without PD

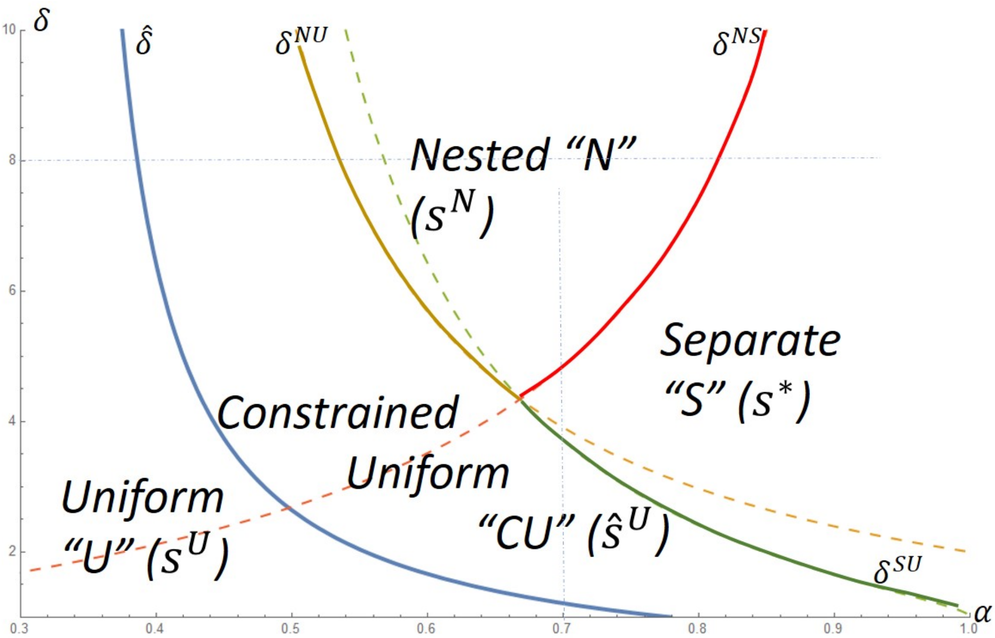


Figure A2: Equilibrium variables without PD

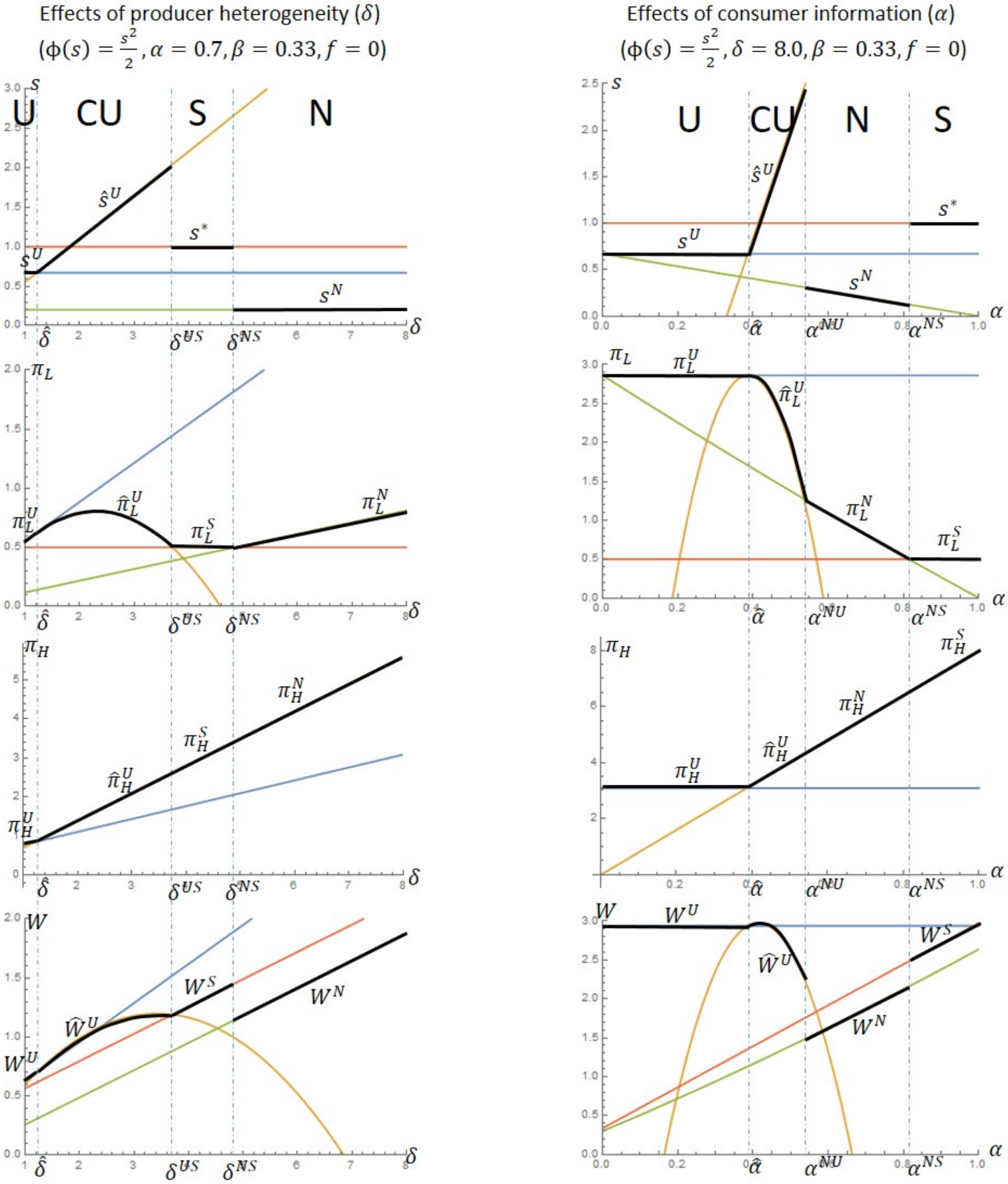


Figure B1: Separating equilibrium

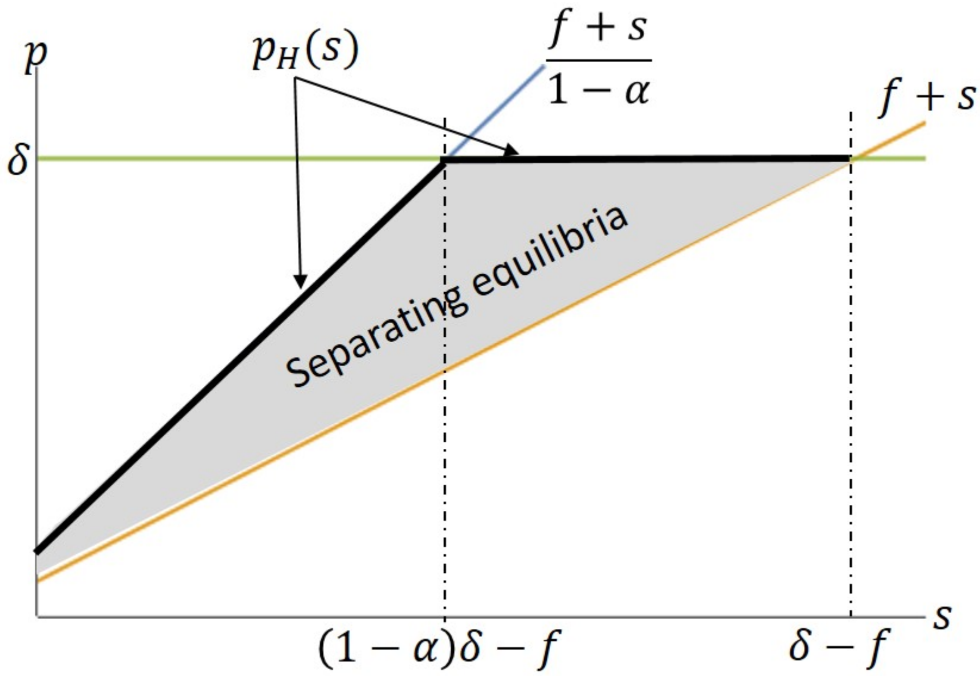


Figure C1: Equilibrium name patterns ($\delta = 10.0, \beta = 0.33, \rho = 0.1, \lambda = 1.0, \gamma = 0.5$)

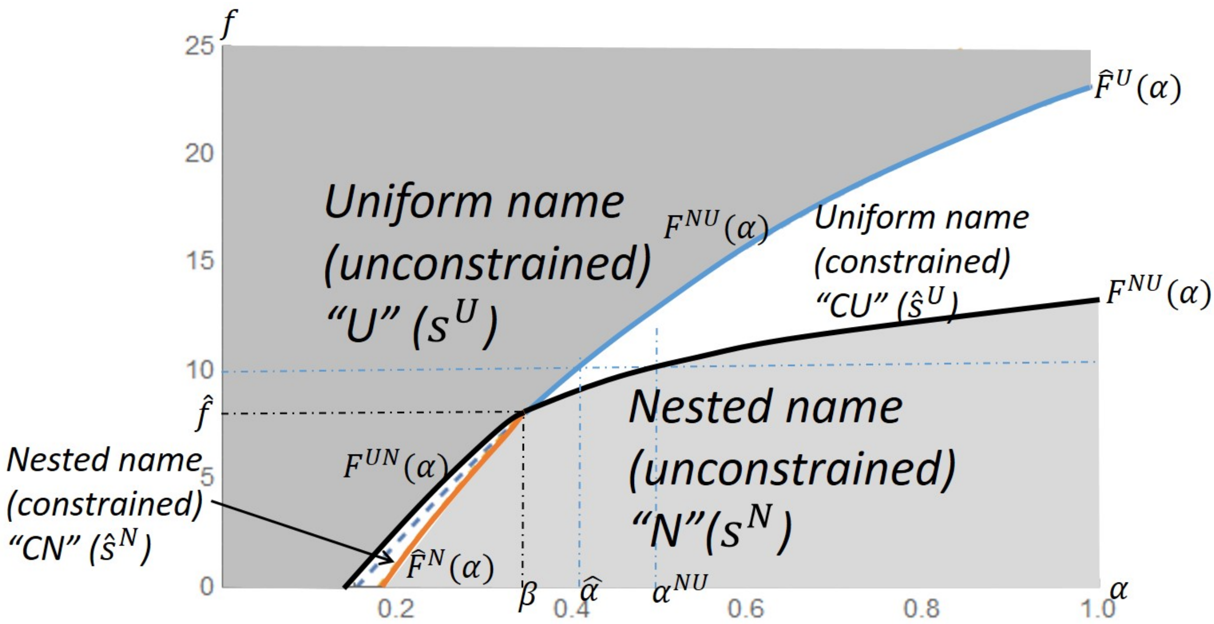


Figure C2: Change of equilibrium variables $\delta = 10.0, \beta = 0.33, \lambda = 1.0, \gamma = 0.5$