IMPACT OF THE CERTIFICATION PROCESS RELIABILITY ON PRODUCERS AND CONSUMERS OF WINE (REFEREED)

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Abstract

For goods having experiment attributes, reliability of the quality signalling process has significant consequences on consumers' behaviour and producers' strategies and profits. We study two characteristics of reliability: importance of the errors in quality determination, and the dissymmetry of these errors (basic wine classified as superior, or superior wine classified as basic). We show, in a simple model of vertical differentiation, that the consumer choice depends on the relationship between the price spread and the variation of average quality between wines labelled superior and wines labelled ordinary. As errors of classification result in reducing the difference between average qualities of the two classes, the proportion of consumers ready to consume wine labelled superior decreases and/or the price of these wines drops. The intensity of these effects (demand fall, lower prices) depends on two principal parameters: the quality of the signal and the difference in size between the two wine classes. The effects of dissymmetry are much complex because, according to its sign, it degrades or increases the average quality of the two classes. The difference between average qualities thus does not evolve in a systematic direction. We also show that the errors of classification decrease the average profit of the wine industry while dissymmetry does not have any impact on this profit. We show finally that errors and their dissymmetry have effects on the competitive position of wines.

Introduction

In the wine industry, the products are strongly differentiated horizontally and vertically but the various aspects of this differentiation are not spontaneously visible to consumers. There is thus an information asymmetry between producers and consumers with regard to the quality (the attributes) of the products. For a better comprehension of the problem of information asymmetry on quality, it is useful to rely on the typology of goods attributes proposed by Nelson (1970). Goods attributes are divided into three categories:

- search attributes: consumers can determine the quality of the good before its purchase, they are the physical attributes like colour, form, size, style...
- experiment attributes: quality can be given only after the purchase, (taste, functionality, performance... belong to this type of attributes).
- credence attributes (Darby & Karni (1973)): quality cannot be completely given even after use. It is the case of the environmental impact during the production, the respect of ethical standards, the consequences on health and safety (nutritional composition of the products, presence of OGM...).

Information asymmetry effects on producers, consumers and on market functioning are largely studied in the literature. When the act of purchase is not repeated, Akerlof (1970) highlighted the phenomenon of adverse selection: the producers of a higher than average level of quality may find it beneficial to withdraw from the market causing a drop in average quality what generates a fall in prices and consequently new withdrawals from the market. Information asymmetry thus puts in danger the existence of markets. When buying is repeated, which is generally the case for wine, the situation is more complex because it is possible to install mechanisms of asymmetry reduction between producers and consumers.

In the wine industry, it is primarily a question of transforming by the mechanism of label deliverance the attributes of experiment and credence into search attributes. It is possible to distinguish two great labelling systems (Raynaud and al. (2002)): brands and certification.

Brand is an indicator of quality because with each name of brand is associated a number of standardized characteristics. In this case, the reliability of the signal on quality rests on the reputation of the company. Models of reputation based on quality premium (Shapiro (1983)) show that the decision of a company to produce goods of high quality rests on dynamic effects: the profit will be earned in the future thanks to the effects of a well established reputation. During the investment period, the producer must sell his product below its marginal cost. The need for carrying out investments in reputation has for consequence that goods of high quality must be sold at a higher price (premium price). This premium remunerates the investment in reputation and motivates the producer to keep a high quality. In short, the fear of losing investments in reputation is supposed to ensure the reliability of the signal on quality.

Certification is a process by which an unobservable level of quality is made public by a system of label emitted by a public or private independent institution. Certification can relate to the product or the production process. The credibility of the certification system thus rests on the independence and competence of the certifier.

In the wine industry, we can observe the two labelling systems (Gaucher and al. (2002)). Wine industry in the "New World" is characterized by wines easy to identify by the consumers, quality is signalled by brands and pricing and promotion policies which accompany them. The organization chosen in the European countries is founded on certification (the Protected Designation of Origin (PDO) system). In this system, quality depends on the individual strategies of producers and on the collective strategies of their syndicates. Promotional budgets are supported by producers and their collective organizations as well.

International competition on quality being increasingly strong, national industries are thus confronted with difficulties, not only to improve quality, but also to improve quality signalling. The problem is then to determine the labelling system (brand, certification, or combination of both) the more adapted to specificities of the various wine industries and the most capable to promote and signal quality.

In the New World, quality depends essentially on the vertical degree of coordination within the industry. This coordination is carried out by various forms of integration or contracts between producers, wine makers and traders. The suppliers (grape growers) are selected according to rigorous specifications. There is thus a strong link between the signalling mechanisms, quality control and industry organization (Raynaud and al. (2002)).

In Europe, individual signalling strategies are coupled with the PDO system. To improve quality it is therefore necessary to work on these two pillars:

- the reform of the DPO system and the installation of mechanisms which ensure the rigour of approvals,
- the development of contracts between producers and traders based on more demanding specifications than those on which the definition of PDO rests.

The second strategy is analyzed in detail by Gaucher and al. (2002). These authors, starting from incomplete contracts theory (Hart & Moore (1988)) and its developments in the field of sequential investments (Fraja (1999)), give three conditions so that such contracts exist and are stable: the trader must invest in promotion before proposing his contracts, he must have all the bargaining power *ex ante*, the rules of renegotiation must allow an exchange *ex post* of the optimal quantities, the contractor interested in renegotiation is able to propose a side payment bringing his partner back to his utility of reservation.

We will thus concentrate on the first strategy. We will not discuss all the different projects of reform of the PDO system [1]. Our objective is much more restricted, it consists in analyzing the consequences of the degree of reliability of the certification process on the consumers, the producers and the position of the national wine industry in the international competition. From a simple model of vertical differentiation, we analyze the characteristics of the selection committee in charge of approvals. We suppose that this committee makes errors in the classification of wine quality and we study the consequences of the characteristics of these errors on the various actors of the industry. In the first section we study the consequences of the behaviour of only one committee, in the second section the consequences of competition between the committees.

1. SELECTION COMMITTEE BEHAVIOUR IN A VERTICAL DIFFERENTIATION MODEL

There exist several reasons which explain the unreliability of certification systems. The checking of quality is not exhaustive, only a sample of producers who post a label of high quality is selected for checking. There is thus a possibility that some producers post a quality label without justification. Anania & Nistico (2002) study the properties of this type of imperfection. They show that the producers of low quality but also those of high quality can have interest to accept an imperfect system of certification. If the verification of quality is exhaustive, the unreliability can rise from the imperfection of the classification carried out by experts [2]. Classification errors can be due to various reasons: a lack of competence of the selection committee, a lack of resources (time and money) to carry on an in depth product analysis, direct or indirect actions of pressure groups (producers, consumers, government…), cultural and interest proximity between producers and members of the selection committee (it can occur if member of the selection committee are producers of the same denomination), failure in the quality checking process (non respect of the anonymity for example).

[1] Cf. Berthomeau (2002) for a presentation of reform projects in France.
[2] In France, specialists of the wine industry estimates that 15% to 20 % of the AOC wines doesn't merit the label.

We will examine the characteristics of the errors made by the experts within the framework of a simple vertical differentiation model. Then we will study the consequences of these errors on consumers and producers.

The wine can be of two qualities, quality is measured by a positive real number q:

- q_1 : wine of basic quality, it is sold with the price p_1,
- q_2 : wine of higher quality, it is sold with the price p_2 $(q_2 > q_1,\ p_2 > p_1)$.

The utility function of consumers takes the following form [(3)]: $U = \begin{cases} \theta q - p \ \text{ si achat} \\ 0 \ \text{sinon} \end{cases}$

The utility function expresses the surplus derived from consumption of wine.

θ: a parameter of taste (positive real number), the higher it is, the more the consumer is willing to pay for a given quality. This parameter is distributed in the economy according to the cumulative distribution function F(θ). F(θ) represents the fraction of the consumers whose parameter of taste is lower than θ. θ can also be interpreted as the inverse of the marginal rate of substitution between income and quality. As consumers with high income have a lower marginal utility of income, their θ is higher. They thus tend to consume products of higher quality.

1.1. PERFECT SELECTION COMMITTEE

A perfect committee can make the difference between the two qualities without error. The committee decision (wine is basic or wine is superior) is perfectly known by consumers [(4)]. So the asymmetry of information is completely removed, quality level becomes a search attribute. Consumer choice is represented by his utility function maximization.

Utility difference between the two qualities is:

$$U(q_2) - U(q_1) = (\theta q_2 - p_2) - (\theta q_1 - p_1) = p_2\left(\theta \frac{q_2}{p_2} - 1\right) - p_1\left(\theta \frac{q_1}{p_1} - 1\right)$$

[3] Cf. Tirole (1993) T1, chapter 2 for a pedagogical presentation of this function in a vertical differentiation model framework.

[4] The committee decision is written on the bottle and the consumers know the link between this decision and the wine quality.

If $\frac{q_2}{p_2} > \frac{q_1}{p_1}$, the quality price ratio of the higher quality wine is greater than that of the basic quality, the utility difference is positive whatever the value of θ. Consequently, all the consumers choose the higher quality wine. If the inequality is reversed, they choose the basic quality wine.

When quality price ratios are identical for the two quality levels, a demand exist for the two wines. Hence there is a value of θ dividing consumers in two classes: those drinking the higher quality wine and those drinking the basic quality wine. This value of θ must be such as the variation of utility is null:

$$
\begin{aligned}
&U(q_2) - U(q_1) = (\theta q_2 - p_2) - (\theta q_1 - p_1) = 0 \\
&\Leftrightarrow \theta(q_2 - q_1) = (p_2 - p_1) \\
&\theta^* = \frac{(p_2 - p_1)}{(q_2 - q_1)}
\end{aligned}
$$

If his θ is superior to the trigger value ($\theta > \theta^*$), the consumer chooses the higher quality wine. If $\theta < \theta^*$, the consumer chooses the basic quality wine.

As expected, the proportion of consumers who choose the higher quality wine decreases with the price difference (θ^* increases) and increases with the quality difference between the two wines (θ^*decreases).

1.2. IMPERFECT SELECTION COMMITTEE

A committee is imperfect if it makes errors in wines quality classification. These errors can be due to its lack of competence or to the influence of pressure groups. The committee thus gives a disturbed signal, noted i, on the quality level of the wine. Consumers do not have access to the intrinsic quality of the wine but, as in the preceding section, they know the opinion of the committee. If:

i = o the wine is signalled as basic,

i = s the wine is signalled as superior.

The consumer thus will choose the wine after having observed the signal so as to maximize his expected utility. We therefore make the strong assumption that the consumer knows the probabilities of the errors of the selection committee [5]. The expected utility of a wine labelled as superior is worth:

$$E\left[U / i=s\right]=\left(\theta q_1-p_2\right) pr\left(q_1 / i=s\right)+\left(\theta q_2-p_2\right) pr\left(q_2 / i=s\right)$$

$pr\left(q_1 / i=s\right)$: probability that the bottle is ordinary, knowing that the committee labelled it as superior,

$pr\left(q_2 / i=s\right)$: probability that the bottle is superior, knowing than the committee judged it such.

There is thus a risk that the consumer pays a high price for a bottle of basic quality.

The expected utility of a wine labelled as ordinary is worth:

$$E\left[U / i=o\right]=\left(\theta q_1-p_1\right) pr\left(q_1 / i=o\right)+\left(\theta q_2-p_1\right) pr\left(q_2 / i=o\right)$$

$pr\left(q_1 / i=o\right)$: probability that the bottle is ordinary, knowing that the committee judged it such,

$pr\left(q_2 / i=o\right)$: probability that the bottle is superior, knowing than the committee considered it to be ordinary.

The consumer can make a good bargain by obtaining a bottle of superior quality for the price of a basic bottle.

The average quality of each class is worth: $\begin{aligned} \bar{q}_s &= p\left(q_1 / i=s\right) q_1+p\left(q_2 / i=s\right) q_2 \\ \bar{q}_0 &= p\left(q_1 / i=o\right) q_1+p\left(q_2 / i=o\right) q_2 \end{aligned}$

The utility function supposes that the consumer is risk neutral; indeed, the expected utility of a wine labelled superior is worth:

$$\begin{aligned} & E\left[U / i=s\right]=\left(\theta q_1-p_2\right) pr\left(q_1 / i=s\right)+\left(\theta q_2-p_2\right) pr\left(q_2 / i=s\right) \\ & =\theta\left[pr\left(q_1 / i=s\right) q_1+pr\left(q_2 / i=s\right) q_2\right]-p_2 \\ & =\theta \bar{q}_S-p_2 \end{aligned}$$

In the same way, it is very easy to check that the expected utility of an ordinary labelled wine is equal to: $E\left[U / i=o\right]=\theta \bar{q}_O-p_1$

[5] In this paper we concentrate on the information asymmetry about quality and do not consider information asymmetry about the characteristics of the signal.

The expected utility depends only on the average quality of each class. However, to model the utility of a risk adverse agent, it would not only be necessary to take account of the average quality, but also of the dispersion of quality inside each class. If the agents are risk averse, it is immediate to show that the selection committee imperfection decreases their expected utility.

The difference in expected utility between the classes is worth:

$$E[U / i = s] - E[U / i = s] = \theta(\overline{q}_S - \overline{q}_O) + p_2 - p_1$$

The value of the parameter of taste separating the consumers of wine labelled superior from the consumers of wine labelled basic, thus depends on the deviation of average quality between the wines labelled as basic and the wines labelled as superior. The trigger value is:

$$\theta_I^* = \frac{p_2 - p_1}{\overline{q}_S - \overline{q}_O}$$

As the selection committee is imperfect, the difference between average qualities is lower than the difference between intrinsic qualities ($\overline{q}_S - \overline{q}_O < q_2 - q_1$). For part of the consumers, the price spread is not justified any more by the variation of quality, they thus prefer to consume ordinary labelled wine rather than the wine labelled superior ($\theta_I^* > \theta^*$). In short, the committee imperfection reduces the deviation of average quality between the wines labelled superior and ordinary what leads, if the consumers are informed of it, to a reduction of the consumption of the wine labelled superior.

To maintain demand on its former level, the price of the bottles labelled superior must drop (or the price of the wine labelled basic must increase). Let us seek the price spread between the higher and ordinary labelled wines such that the trigger value with imperfection, θ_I^*, is equal to θ*:

$$\theta_I^* = \theta^* \Leftrightarrow \frac{p_2^I - p_1}{\overline{q}_S - \overline{q}_O} = \frac{p_2 - p_1}{q_2 - q_1} \Leftrightarrow p_2^I - p_1 = (p_2 - p_1)\frac{\overline{q}_S - \overline{q}_O}{q_2 - q_1}$$

From the second equality we deduce that the price spread must be equal to the quality spread. The third equality says that the price spread is equal to the product of the price spread for a perfect signal by the ratio of the quality spreads for a disturbed signal and a signal without noise. The price spread decreases with the deviation of average quality between the classes.

The committee imperfection leads, either to the decrease in demand, or to the fall of the relative price of the higher quality wine. Or, if a more positive presentation is wished, the improvement of the signal reliability makes it possible to increase the price or the demand of the wine of higher quality.

In the next paragraph we analyze the impact of the characteristics of the committee errors on the deviation of average quality. In effect, most people think that selection committees are more reluctant to label ordinary a superior wine than to label superior an ordinary wine. We first propose a formalization of this behaviour and then investigate the consequences for consumers and producers.

1.3. IMPERFECTION WITH SYMMETRICAL ERRORS

We define a selection committee as impartial if it makes symmetrical errors. The probability that the committee declares superior a basic bottle is the same as the probability to declare basic a superior one. Impartiality conditions are thus:

$$\begin{array}{l} pr(i = o / q_1) = pr(i = s / q_2) \\ pr(i = s / q_1) = pr(i = o / q_2) \end{array} \quad \text{or, to simplify notations:} \quad \begin{array}{l} p(o / q_1) = p(s / q_2) \\ p(s / q_1) = p(o / q_2) \end{array}$$

By using the Bayes theorem, expected utility becomes:

$$E[U / i = o] = (\theta q_1 - p_1)\frac{p(o / q_1)p(q_1)}{p(o)} + (\theta q_2 - p_1)\frac{p(o / q_2)p(q_2)}{p(o)}$$

$$E[U / i = s] = (\theta q_1 - p_2)\frac{p(s / q_1)p(q_1)}{p(s)} + (\theta q_2 - p_2)\frac{p(s / q_2)p(q_2)}{p(s)}$$

Let us calculate the expected utility deviation between wines labelled superior and basic:

$$E[U/i=s]-E[U/i=o]=\theta q_1\left[\frac{p(s/q_1)p(q_1)}{p(s)}-\frac{p(o/q_1)p(q_1)}{p(o)}\right]$$
$$+\theta q_2\left[\frac{p(s/q_2)p(q_2)}{p(s)}-\frac{p(o/q_2)p(q_2)}{p(o)}\right]-p_2+p_1$$

As in the preceding paragraph (1-2), we search the value of θ which separates the consumers in 2 groups: those which consume superior labelled wines and those which consume ordinary labelled wines.

1.3.1. Calculation of the trigger value of the quality parameter

We seek to express the value of θ, according to the degree of imperfection of the committee.

We show in appendix 1 that the trigger value of θ is:

$$\theta_{II}^{*}=\frac{p_2-p_1}{(q_2-q_1)[p(o/q_1)-p(o/q_2)]}\times\frac{p(o)p(s)}{p(q_1)p(q_2)}$$

θ_{II}^{*} : trigger value of θ, for an imperfect and impartial committee.

Let us note that if the committee is perfect; $pr(o/q_1)=1$ $pr(s/q_1)=0$ $\frac{p(o)p(s)}{p(q_1)p(q_2)}=1$

the value of θ is strictly equal to the one obtained for a perfect committee. The imperfection of the committee intervenes on two different ways:

- directly through the quality of the signal: $p(o/q_1)-p(o/q_2)$
- indirectly through the ratio of the product of the probabilities of the signals on the product of the probabilities of qualities: $\frac{p(o)p(s)}{p(q_1)p(q_2)}$.

1.3.2. Interpretation of θ_{II}^{*}

We will start by analyzing the significance of θ_{II}^{*} when the two wine classes have identical size ($p(q_1)=p(q_2)$), then we will study the impact of the difference in size between the classes.

When classes are of identical size, the expression of θ is simpler ([6]):

$$\theta_{II}^{*} = \frac{(p_2 - p_1)}{(q_2 - q_1)[p(o/q_1) - p(o/q_2)]} = \frac{(p_2 - p_1)}{(q_2 - q_1)[2p(o/q_1) - 1]}$$

The committee imperfection intervenes only through the quality of the signal and not through the relative frequency of the unconditional signals.

When the committee is imperfect, $[2p(o/q_1) - 1] < 1$ one thus has: $\theta_{II}^{*} > \theta^{*}$

One finds the results of paragraph 1-2, uncertainty on quality reduces the proportion of consumers which buys wine labelled superior. If the signal does not bring any information ($p(o/q_1) = 0,5$), no consumer buys wine labelled superior. Indeed, the difference between average qualities of the two classes is null, it is thus useless to pay a higher price for a wine of the same average quality.

The price spread is equal to the product of the price spread for a perfect signal by the quality of the signal (the term between hooks) $p_2^{II} - p_1 = (p_2 - p_1)[2p(o/q_1) - 1]$. The price spread decreases with the signal quality or, knowing that if the signal is perfect $[2p(o/q_1) - 1] = 1$, the ratio of the price spreads is equal to the ratio of signal quality. Improvement of the committee competence makes it possible to better capture the consumers' willingness to pay.

To measure the effect of the difference in size on the choice of consumers, it is necessary to be able to interpret the ratio $\frac{p(o)p(s)}{p(q_1)p(q_2)}$.

We show in appendix 1 that this ratio is equal to:

$$\frac{p(o)p(s)}{p(q_1)p(q_2)} = 1 + p(o/q_1)(1 - p(o/q_1))\frac{(p(q_1) - p(q_2))^2}{p(q_1)p(q_2)}$$

The term $p(o/q_1)(1 - p(o/q_1)) \geq 0$ represents the variance of the pure signal, i.e. a Bernoulli random variable $\begin{matrix} X = 1 \;\; avec\; p(o/q_1) \\ X = 0 \;\; avec\, 1 - p(o/q_1) \end{matrix}$.

[6] Cf. appendix 1.

The term $\frac{(p(q_1)-p(q_2))^2}{p(q_1)p(q_2)} \geq 0$ depends only on the difference in size between the two classes [7].

The ratio $\frac{p(o)p(s)}{p(q_1)p(q_2)}$ is thus superior or equal to 1.

That means that the difference in size between the wine classes reduces the proportion of consumers willing to buy the wine labelled superior (the difference in size increases θ).

In short, the proportion of consumers of wine labelled superior is a decreasing function of the deviation of size between the two classes. To minimize the impact of the errors of the committee on the consumer behaviour, the best solution is to separate the wines around the medium quality so as to obtain two classes of about identical size.

We can rewrite the expression of θ_{II}^* in the following form [8]:

$$\theta_{II}^* = \frac{(p_2-p_1)}{(q_2-q_1)}\frac{1}{[2p(o/q_1)-1]}\left[1+p(o/q_1)(1-p(o/q_1))\frac{(2p(q_1)-1)^2}{p(q_1)(1-p(q_1))}\right]$$

$$\theta_{II}^* = \theta_P^* \frac{1}{-V'(p(o/q_1))}\left[1+V(p(o/q_1))D\right]$$

θ_P^* : value of θ for a perfect signal,

$V(p(o/q_1)), V'(p(o/q_1))$: variance of the pure signal, and derivative of the variance according to $p(o/q_1)$,

D: indicator of the deviation of size between classes.

We can thus summarize the results obtained in the following way:

Perfect committee: $p(o/q_1)=1, V=0\ V'=-1 \Rightarrow \theta_{II}^* = \theta_P^*$

Imperfect committee, classes of identical size:

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[7] Cf. appendix 1.

[8] In appendix 2 we demonstrate that the approach using mean quality spread and the approch using the signal characteristics are coherent.

$$0{,}5 < p(o/q_1) < 1, V > 0, V' > -1,\ D = 0 \Rightarrow \theta^*_{II0} = \theta^*_P \frac{1}{-V'(p(o/q_1))} > \theta^*_P$$

Imperfect committee, classes of different size:

$$0{,}5 < p(o/q_1) < 1,\ V > 0,\ V' > -1,\ D > 0 \Rightarrow \theta^*_{IID} > \theta^*_{II0} > \theta^*_P$$

The choice of the number of labels and of the quality spread between labels is complex. The idea of multiplying the number of labels to better capture the consumer willingness to pay reaches its limits quickly because of the cost of the quality levels separation procedure and also because the reliability decreases when the number of classes increases. The risk of this approach is to spread confusion in the consumer mind.

The level of quality chosen to separate the classes of quality has also effects on quality signalling. The higher this level is and the more unequal the classes are what amplifies the impact of the errors of the selection committee on the consumer behaviour. However this result must be moderated, because there is undoubtedly a link between the level of quality separating the two wine classes and the degree of competence of the committee. One can indeed imagine that it is more difficult to decide between wines around an average quality than to decide between the wines of very high quality of the other wines. In short, the division in classes of unequal sizes decreases the probability of misclassification but increases the consequence of the errors of classification on consumers. The consequences are reversed for the division in classes of equal sizes.

1.4. NON SYMMETRICAL ERRORS

Until now we studied symmetrical errors, but in fact, it seems that selection committees more often let pass basic wines in the superior quality category than they reject superior wines in the category of basic wines. We try to model this behaviour and to analyze its impact on consumers.

In a tautological way one can say that the selection committee is not impartial if the conditions of impartiality are not checked:

$$p(o/q_1) \neq p(s/q_2)$$
$$p(s/q_1) \neq p(o/q_2)$$

As we want to dissociate the analysis of the effects of the imperfection of those of partiality, it is necessary for us to be able to compare committees with the same degree of imperfection.

A committee is imperfect at the level C if: $p(s/q_1) + p(o/q_2) = C$. Constant C thus represents the sum of the errors of the committee.

An impartial committee, of level of imperfection C checks: $p(s/q_1) = p(o/q_2) = C/2$

A partial committee, of level of imperfection C is such as:

$$p(s/q_1) = \frac{C}{2} + B_1 \qquad p(o/q_2) = \frac{C}{2} + B_2$$

Skews of partiality B_1 and B_2 are connected by: $p(s/q_1) + p(o/q_2) = C \Leftrightarrow B_1 = -B_2$

We can thus write more simply the conditional probabilities of errors:

$$p(s/q_1) = \frac{C}{2} + B \qquad p(o/q_2) = \frac{C}{2} - B$$

As the sum of the probabilities conditional to a given quality is equal to 1, we get:

$$p(o/q_1) = 1 - \frac{C}{2} - B \qquad p(s/q_2) = 1 - \frac{C}{2} + B$$

We will say that a committee of level of imperfection C is lax if B > 0 hard if B < 0. If the committee is lax (respectively hard), it increases (decreases) the probability that a bottle labelled superior (respectively basic) contains ordinary wine (respectively superior wine) and decreases (increases) the probability that a basic labelled bottle (respectively superior) contains superior wine (respectively ordinary) ([9]). In short, a lax committee lets pass relatively more bottles of ordinary wine than it rejects bottles of superior wine, a hard committee makes the opposite.

[9] Demonstration in appendix 4.

In appendix 3, we show that the value of θ takes the same general form than for an impartial committee:

$$\theta_{NI}^{*} = \frac{p_2 - p_1}{(q_2 - q_1)[p(o/q_1) - p(o/q_2)]} \times \frac{p(o)p(s)}{p(q_1)p(q_2)} = \frac{p_2 - p_1}{(q_2 - q_1)[1 - C]} \times \frac{p(o)p(s)}{p(q_1)p(q_2)}$$

The probabilities of the signals depend on skew:

$$\frac{p(o)p(s)}{p(q_1)p(q_2)} = 1 + \frac{C}{2}\left(1 - \frac{C}{2}\right)\frac{(p(q_1) - p(q_2))^2}{p(q_1)p(q_2)} + \frac{B(1-C)(p(q_1) - p(q_2)) - B^2}{p(q_1)p(q_2)}$$

from where

$$\theta_{NI}^{*} = \frac{p_2 - p_1}{(q_2 - q_1)[1 - C]}\left[1 + \frac{C}{2}\left(1 - \frac{C}{2}\right)\frac{(p(q_1) - p(q_2))^2}{p(q_1)p(q_2)} + \frac{B(1-C)(p(q_1) - p(q_2)) - B^2}{p(q_1)p(q_2)}\right]$$

The effect of skew on the value of θ is not simple, it depends on:

- the size of the deviation between classes $p(q_1) - p(q_2)$,
- the degree of perfection of the committee (1-C),
- and the size of the skew itself, B.

If the two classes are of the same size, the value of θ is simpler:

$$\theta_{NI}^{*} = \frac{p_2 - p_1}{(q_2 - q_1)[1 - C]}\left[1 - \frac{B^2}{p(q_1)p(q_2)}\right]$$

The skew of the committee (whatever its sign) decreases the value of θ_{NI}^{*}, which means that, for a given level of imperfection, the proportion of consumers of wine labelled superior increases. The difference between average qualities is minimum for a null skew, it increases with the absolute value of skew [(10)].

If the class of the basic wines is larger than that of the superior wines, a hard committee decreases θ_{NI}^{*}, in general a lax committee increases θ_{NI}^{*}, but there are

[10] Demonstration in appendix 4.

exceptions ([11]). If the class of the superior wines is larger than that of basic wines, a lax committee decreases θ^*_{NI}, a hard committee increases θ^*_{NI}, and there are also exceptions.

1.5. IMPACT OF ERRORS CHARACTERISTICS ON PRODUCERS

After having analyzed the impact of error characteristics on consumers, we will study their impact on the wine industry profit. Selection committees are often close to the producers (their members are producers themselves, or they belong to organizations representative or defending the interests of producers) or are sensitive to direct or indirect pressures of producers. We can understand these pressures when we know that a quality label refusal often means the economic death for the affected producer. One can wonder whether this proximity between producers and committees leads the latter to adopt behaviours which are systematically favourable to the first. To answer this question, we will study the consequences of error characteristics on the producers' profit.

1.5.1. Perfect selection committee

The unit production cost of each quality of wine is noted c_1 and c_2. If N represents the total number of bottles produced, the cost for the producers taken as a whole is: $N(c_1 p(q_1) + c_2 p(q_2))$. We will suppose that each consumer buys only one bottle and that θ follows a uniform distribution function on [0, 1]. With these assumptions, the turnover of the profession is given by the following expression: $N(\theta^* p_1 + (1-\theta^*)p_2)$.

The total profit is thus equal to: $\Pi = N\{\theta^* p_1 + (1-\theta^*)p_2 - (c_1 p(q_1) + c_2 p(q_2))\}$

From the market equilibrium equations for the wines labelled superior and basic, one can deduce the inverse demand functions:

$$\theta^* = p(q_1) \Leftrightarrow \frac{p_2 - p_1}{q_2 - q_1} = p(q_1) \Leftrightarrow p_2 = p_1 + p(q_1)(q_2 - q_1) \Leftrightarrow p_2 - p_1 = (1 - p(q_2))(q_2 - q_1)$$

[11] Cf. appendix 3 for a detailed presentation of these cases.

As one could expect, the price spread decreases when the supply of the wine labelled superior increases. If everyone makes superior wine, the price of this wine falls to the level of price of ordinary wine.
While replacing, θ^* and p_2 by their values in the equation of the profit, one obtains:

$$\Pi = N\left\{-p(q_1)^2(q_2-q_1)+p(q_1)(q_2-q_1)+p_1-c_2+p(q_1)(c_2-c_1)\right\}$$

Let us seek the quantities which maximize the profit, taking into account the prices reaction:

$$\frac{d\Pi}{dp(q_1)}=0 \Leftrightarrow p^*(q_1)=\frac{1}{2}\left[\frac{c_2-c_1}{q_2-q_1}+1\right]$$

The optimal production depends on the cost quality spreads ratio. The production of basic (superior) wine increases (decreases) with the cost deviation and decreases (increases) with the quality spread.

The equilibrium price spread is worth: $p_2^* - p_1^* = \frac{1}{2}\left[(c_2-c_1)+(q_2-q_1)\right]$

As $p^*(q_1)\leq 1 \Leftrightarrow c_2-c_1 \leq q_2-q_1$, the equilibrium price spread is between the cost spread and the quality spread.

The maximum profit is:
$$\Pi^* = N\left\{(1-p^*(q_1))(p_2-c_2)+p^*(q_1)\right\}$$
$$\Pi^* = \frac{N}{2}\left\{(p_2-c_2)+(p_1-c_1)+\frac{(c_2-c_1)}{(q_2-q_1)}\left[(p_1-c_1)-(p_2-c_2)\right]\right\}$$

And, if we replace in the maximum profit equation the price of the superior wine by its value given in the equilibrium equation, we obtain:

$$\Pi^* = \frac{N}{2}\left\{\left(p_1^* + \frac{1}{2}[(c_2 - c_1) + (q_2 - q_1)] - c_2 \right) + \left(p_1^* - c_1\right) + \frac{(c_2 - c_1)}{(q_2 - q_1)}\left[-\frac{1}{2}(c_2 - c_1) - \frac{1}{2}(q_2 - q_1) + (c_2 - c_1)\right]\right\}$$

$$\Pi^* = \frac{N}{2}\left\{\left(p_1^* - c_2\right) + \left(p_1^* - c_1\right) + \frac{1}{2}[(c_2 - c_1) + (q_2 - q_1)] + \frac{(c_2 - c_1)^2}{2(q_2 - q_1)} - \frac{1}{2}(c_2 - c_1)\right\}$$

$$\Pi^* = \frac{N}{2}\left\{\left(p_1^* - c_2\right) + \left(p_1^* - c_1\right) + \frac{1}{2}(q_2 - q_1) + \frac{(c_2 - c_1)^2}{2(q_2 - q_1)}\right\}$$

It is easy to check that the optimal profit of the profession is a decreasing function of the cost spread.

1.5.2. Imperfect selection committee

The expression of the average profit is the same as that of the preceding paragraph in which θ_{ni}^* replaces θ.

The equation which describes market equilibrium is slightly modified because it is now the supply of wine **labelled** of a certain quality which must be equal to the demand for this same quality label. The equation is written then:

$$\theta_{ni}^* = \frac{p_2 - p_1}{q_2 - q_1}\frac{1}{1-C}\frac{p(o)(1-p(o))}{p(q_1)(1-p(q_1))} = p(o)$$

The price spread which ensures markets equilibrium is equal to:

$$p_2^* - p_1^* = (q_2 - q_1)(1-C)\frac{p(q_1)(1-p(q_1))}{(1-p(o))}$$

For a production and a given imperfection level, a hard committee increases the number of ordinary labelled bottles (it increases p(o)), it thus increases the price spread between wines labelled superior and ordinary. A lax committee decreases the price spread, the superior labelled wine is thus relatively more abundant and thus relatively less expensive.

The average profit becomes:

$$E(\Pi) = N\{p_1 - c_2 + (q_2 - q_1)(1-C)p(q_1)(1-p(q_1)) + (c_2 - c_1)p(q_1)\}$$

Profit depends on the level of incompetence C, but does not depend on the skew. For a given skew, price and volume effects compensate exactly. Thus a lax committee increases the volume of superior labelled wine, but as the price of this quality drops consequently, the effect on the total profit is null.
The first order condition gives the optimal quantities of basic wines:

$$\frac{dE(\Pi)}{dp(q_1)} = N\{(q_2 - q_1)(1-C)(1-2p(q_1)) + (c_2 - c_1)\} = 0$$
$$\Leftrightarrow p^*(q_1) = \frac{1}{2}\left[\frac{c_2 - c_1}{q_2 - q_1}\frac{1}{1-C} + 1\right]$$

Committee imperfection leads producers to increase the ordinary wine supply. In this case, the price effect (price difference between the wines labelled superior and basic drops) is higher than the volume effect (part of the ordinary wine sold at superior labelled price and part of the superior wine sold with the price of the ordinary labelled wine).

The expression of the optimal profit becomes ([12]):

$$E(\Pi^*) = \frac{N}{2}\left\{(p_1^* - c_2) + (p_1^* - c_1) + \frac{1}{2}(q_2 - q_1)(1-C) + \frac{(c_2 - c_1)^2}{2(q_2 - q_1)(1-C)}\right\}$$

The profit is a decreasing function of the committee imperfection. In spite of the optimal reaction of producers, an imperfect committee thus degrades the global economic situation of the producers. The superior wine producers are the great losers because a part of their wine is not labelled as superior and because the price of the wines labelled superior drops. The basic wine producers benefit from the imperfection of the committee because part of their wine is labelled by error as superior.

[12] Cf. appendix 5.

Skew has a neutral effect on the global economic situation of the producers. However the sign of the skew has a contrasted impact on the various producers.

A hard committee will strongly degrade the situation of the superior wine producers it fails to recognize. On the other hand, the situation of the other superior wine producers will improve because of the rise in prices due to the scarcity of the superior labelled bottles. As for basic wine producers, they have few chances to obtain a bonus by obtaining the superior label. Moreover, the price of the wine labelled ordinary falls because of relative supply abundance. So their expected profit must fall.

A lax committee will downgrade only very little superior wine. But the profits of the superior wine producers will be degraded. In effect, the price of the superior labelled wine will fall due to the increase in supply. The basic wine producers are more likely to see their wine labelled as superior. Their situation improves even more because in parallel, the price of the basic labelled wine increases thanks to the relative scarcity of this label. So their expected profit increases.

In short, a hard committee is favourable to the superior wine producers; a lax committee is favourable to ordinary wine producers who are more fragile economically. Moreover, one hard committee will generate a greater feeling of injustice because of the more significant superior wine rejection. On the whole, a lax committee will be more easily accepted by producers (advantages for ordinary wine producers and diffuse losses for the superior wine producers) and by the authorities because of the support brought to the producers more in difficulties.

2. COMPETITION BETWEEN SELECTION COMMITTEES

We will consider successively two types of competition:

- an indirect competition: different committees evaluate different wines, but these wines are in competition,
- a direct competition: different committees evaluate the same wine and each committee delivers its own label ([13]).

[13] The case where different committees evaluate the same wine to deliver only one label (double checking process) is beyond the scope of this paper. It is a way to improve the reliability of the certification process and the paper focus on the nature and consequences of the lack of reliability.

2.1. INDIRECT COMPETITION BETWEEN COMMITTEES

As we indicated in introduction, international competition puts in competition the various systems of labels and certification. It seemed to us interesting to study the impact of the characteristics of the selection committee (competence and partiality) on the competitive position of the wines which it is charged to evaluate.

Let us suppose two types of wine A and B which have the same levels of quality, i.e.:

$$\begin{cases} q_1^A = q_1^B \\ q_2^A = q_2^B \end{cases}$$

Two different committees, A and B, are charged to evaluate the wines of the type A and of type B. If the committees have different competences, the analysis of the preceding section shows that the consumers will prefer the superior labelled wine evaluated by the most qualified committee and ordinary labelled wine classified by the less qualified committee. Competition between wines induced thus a competition between committees. If the committees have the same qualification level, but A is harder than B, at identical price, $p_1^A = p_1^B p_2^A = p_2^B$, the consumers will prefer the wine of the type A which offers a higher average quality in the two classes. So competition pushes the committees to become harder.

If the committees are in indirect competition, with equal competence, it can be judicious to replace committees related to the producers (with a lax skew), by committees related to the consumers (with a hard skew).

This analysis can, to a certain extent, explain the success of the wines of the new world. The vertical differentiation of these wines is often carried out by the firms which produce them. Because of their control of the production process, it is reasonable to think that their capacity to evaluate the wine according to quality is strong. Moreover, they can choose the degree of severity which gives a competitive advantage to their products. On the whole, for a given price, they are able to offer to consumers a wine which has a more reliable signal on quality than the wines evaluated by a system of certification which suffers of more information asymmetry between producers and committees and is often induced to be lax.

If the competence of the committee decreases when the complexity of the product increases, the simpler wines will be classified better than the complex wines. There still the strategy of the wines of the new world is coherent since by producing varieties wines the firms offer wines whose quality is easier to judge than that of traditional zones of production. These wines thus are better evaluated what increases consumers satisfaction and producers profit.
However, one can imagine that quality increases with the degree of complexity of the wine. Under this assumption, the strategy of the wines of the new world reaches a limit for the wines of very high quality.

A contrario, for the European producers several strategies are possible:

- to produce wines of sufficiently high complexity so that no competitor wine can be evaluated with a better competence,
- to increase the competence and the severity of the committees so as to improve the signal reliability and therefore the average quality of the wines,
- to simplify the wines so as to be able to signal them in a more reliable way.

The first strategy can be conceived only for the products of top-of-the-range. The third strategy appears dangerous because it removes the specificity of the European wines. In other words, it improves vertical differentiation signalling with depends on horizontal differentiation. Nothing indicates that the net effect on competitiveness of these wines is positive. The second strategy thus appears to us to be the best for wines of intermediate quality. But, owing to the fact that it leads to a greater selectivity of the wines and to a stronger rejection of the wines potentially of good quality, it can put in danger some of the firms which currently profit from the superior quality label. The increase in the severity of the committees must thus be accompanied by measures which make it possible for the firms to limit its economic consequences.

2.2. DIRECT COMPETITION BETWEEN COMMITTEES

Two selection committees are charged to evaluate the same wine, each committee delivers its own label. Consumer thus profits from the information provided by the signals delivered by both committees. His expected utility thus takes the following form:

$$E(U/i_1,i_2)=\theta(q_1 p(q_1/i_1,i_2)+q_2 p(q_2/i_1,i_2))-p_{i_1,i_2}$$

i_1: information provided by the first committee,

i_2: information provided by the second committee,

p_{i_1,i_2} : price of the bottles having the signals i_1, i_2.

Whatever the quality of the wine, the theorem of Bayes makes it possible to write:

$$p(q_j/i_1,i_2)=\frac{p(i_1\cap i_2/q_j)p(q_j)}{p(i_1\cap i_2)}$$

We will suppose the conditional independence of the committees, i.e.:

$$p(i_1\cap i_2/q_j)=p(i_1/q_j)p(i_2/q_j)$$

The probability of the joined signal becomes:

$$p(i_1\cap i_2)=p(i_1/q_1)p(i_2/q_1)p(q_1)+p(i_1/q_2)p(i_2/q_2)p(q_2)$$

Let us calculate the price spread, if the committees have different opinions:

$$E(U/s_1,o_2)-E(U/o_1,s_2)=0\Leftrightarrow$$
$$p_{S_1O_2}-p_{O_1S_2}=\theta[q_1(p(q_1/s_1,o_2)-p(q_1/o_1,s_2))+q_2(p(q_2/s_1,o_2)-p(q_2/o_1,s_2))]$$

By replacing the conditional probabilities by their values and by supposing that committees have identical competence, the equation becomes ([14]):

$$p_{S_1O_2}-p_{O_1S_2}=\theta\left[\frac{p(q_1)p(q_2)(1-C)(q_2-q_1)(B_1{}^2-B_2{}^2)}{p(s_1\cap o_2)p(o_1\cap s_2)}\right]$$

The price spread depends on the difference between the squares of skews. The direction of skews (hard or lax) does not intervene. What means that at identical

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[14] Cf. appendix 6.

price, the consumer must choose the bottle evaluated higher by the committee with the greater skew (in absolute value), even if this skew is positive (the committee is lax). Indeed $p(q_2 / s_1, o_2) > p(q_2 / o_1, s_2)$ if $B_1^2 > B_2^2$, which means that the probability of obtaining a bottle of superior wine is stronger when it was evaluated such by the jury with the greater skew (in absolute value). This result reinforces the analysis of the section 1-5. As there is a pressure so that the committees show lax skew and, that in the event of conflict of appreciation, it is the laxer committee who sees his opinion most often validated, competition between committees should thus lead to a lax drift.

CONCLUSION

We explored the consequences of the imperfection and the skew of selection committees charged to evaluate and certify the quality of the wines. The imperfection of committees:

- reduces the proportion of superior labelled wine consumers and the price difference between various qualities of wine,
- reduces the average profit of the industry, and weaken the competitive position of the superior wines it is charged to certify.

The effects of skew on the consumers are more complex than those of the imperfection. A positive (negative) skew degrades (improves) the average quality of each wine class, the impact on the difference between averages quality is thus not systematic. However, skew modifies the frequency of each signal: positive skew decreases the frequency of the superior quality signal what must raise the price of the superior labelled wines, *a contrario*, a negative skew lowers the price of the superior labelled wine.

Skew does not have impact on the average profit of the industry, a negative skew is favourable to the superior wine producers, a positive skew is favourable to the common beverage wine producers.

Finally a lax committee (positive skew) systematically deteriorates the competitive position of the wine it evaluates, while a hard committee (negative skew) improves it.

We also showed that in the event of conflict between the committees on the quality of a wine, it is the opinion of the committee with the greater (in absolute value) skew which has the most chances to be validated *ex post*. The search for a greater reputation on behalf of the committees can thus lead them to be laxer or harder. Let us note that our results are obtained by supposing that all the economic agents (producers and consumers) know the exact significance of the signal delivered by committees as well as the exact characteristics of their reliability (degree of imperfection and skew). It is clear that without these assumptions would the above conclusions will be substantially modified.

It will not be easy to test empirically the various propositions of the paper because it will be difficult to measure the different aspects of the selection committee behaviour. However we can imagine methods to detect this behaviour. One is to compare the selection of an existing committee with the results obtained by a scientific independent committee. A less demanding method is to use objective characteristics as proxies of the committee behaviour. The number of bottles checked, the time used to check, the money spent by the committee to make tests… could be proxies for competence. The rejection rate could be a proxy for its skew.
Another difficulty is to measure the impact of the committee behaviour on various price spreads. First, if they don't exist, it is necessary to construct price indexes associated with each existing label. Second we must be able to isolate the effect of the committee behaviour on price indexes spreads. So we must be able to control the effects of other variables on price spreads.

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APPENDIX 1 CALCULATION OF THE VALUE OF θ FOR AN IMPARTIAL JURY

A1.1. Calculation of the value of θ in the general case

$$E[U/i=s]-E[U/i=o]=0 \Leftrightarrow$$
$$\theta q_1\left[\frac{p(s/q_1)p(q_1)}{p(s)}-\frac{p(o/q_1)p(q_1)}{p(o)}\right]+\theta q_2\left[\frac{p(s/q_2)p(q_2)}{p(s)}-\frac{p(o/q_2)p(q_2)}{p(o)}\right]-p_2+p_1=0$$

By using the impartiality conditions, one can write:

$$\frac{p(s/q_1)p(q_1)}{p(s)}-\frac{p(o/q_1)p(q_1)}{p(o)}=\frac{p(o/q_2)p(q_1)}{p(s)}-\frac{p(o/q_1)p(q_1)}{p(o)}$$

thus

$$\frac{p(o/q_2)p(q_1)}{p(s)}-\frac{p(o/q_1)p(q_1)}{p(o)}=\frac{p(q_1)p(o)-p(o/q_1)p(q_1)p(o)-p(o/q_1)p(q_1)p(s)}{p(o)p(s)}$$
$$=\frac{p(q_1)p(o)-p(o/q_1)p(q_1)[p(o)+p(s)]}{p(o)p(s)}=\frac{p(q_1)[p(o)-p(o/q_1)]}{p(o)p(s)}$$

and by using the theorem of total probabilities:

$$\frac{p(q_1)[p(o)-p(o/q_1)]}{p(o)p(s)}=\frac{p(q_1)[p(o/q_1)p(q_1)+p(o/q_2)p(q_2)-p(o/q_1)]}{p(o)p(s)}$$
$$=\frac{p(q_1)p(q_2)}{p(o)p(s)}[p(o/q_2)-p(o/q_1)]$$

Same manner one shows as:

$$\frac{p(s/q_2)p(q_2)}{p(s)}-\frac{p(o/q_2)p(q_2)}{p(o)}=\frac{p(q_2)p(q_1)}{p(o)p(s)}[p(o/q_1)-p(o/q_2)]$$

The equation becomes:

$$\frac{p(q_2)p(q_1)}{p(o)p(s)}\{\theta q_1[p(o/q_2)-p(o/q_1)]+\theta q_2[p(o/q_1)-p(o/q_2)]\}=p_2-p_1$$
$$\frac{p(q_2)p(q_1)}{p(o)p(s)}(q_2-q_1)\theta[p(o/q_2)-p(o/q_1)]=p_2-p_1$$

The value of θ is thus: $\theta_{II}^{*}=\frac{(p_2-p_1)}{(q_2-q_1)[p(o/q_1)-p(o/q_2)]}\times\frac{p(o)p(s)}{p(q_1)p(q_2)}$

A1.2. Interpretation of the value of the value of θ when the classes are of identical size

$\begin{cases} p(o/q_1)+p(s/q_1)=1 \\ p(o/q_2)+p(s/q_2)=1 \end{cases}$,so, according to the conditions of impartiality one can write that:

$$\begin{cases} p(o/q_1)+p(o/q_2)=1 \\ p(s/q_1)+p(s/q_2)=1 \end{cases}$$

Let us pose $p(q_1)=p(q_2)\times F$, F thus represents the size ratio. The theorem of the total probabilities makes it possible to write:

$$\begin{cases} p(o)=p(o/q_1)p(q_2)F+p(o/q_2)p(q_2)=p(q_2)[p(o/q_1)F+p(o/q_2)] \\ p(s)=p(s/q_1)p(q_1)+p(s/q_2)(p(q_1)/F)=p(q_2)[p(s/q_1)+p(s/q_2)/F] \end{cases}$$

If, the two classes of wines are of identical size, F = 1, the preceding equalities become:

$$\begin{cases} p(o)=p(q_2)=p(q_1) \\ p(s)=p(q_2) \end{cases}$$

The value of θ is simplified in: $\theta_{II}^{*}=\frac{(p_2-p_1)}{(q_2-q_1)[p(o/q_1)-p(o/q_2)]}=\frac{(p_2-p_1)}{(q_2-q_1)[2p(o/q_1)-1]}$

A1. 2. Impact of the size difference between the classes

Calculation of $\frac{p(o)p(s)}{p(q_1)p(q_2)}$

Knowing that

$$\begin{cases} p(o) = p(q_2)[p(o/q_1)F + p(o/q_2)] = p(q_2)[F + p(o/q_2)(1-F)] \\ p(s) = p(q_2)[p(s/q_1)F + p(s/q_2)] = p(q_2)[F + p(s/q_2)(1-F)] = p(q_2)[F + (1-p(s/q_2))(1-F)] \end{cases}$$

the ratio becomes:

$$\frac{p(o)p(s)}{p(q_1)p(q_2)} = \frac{[F + p(o/q_2)(1-F)][F + (1-p(o/q_2))(1-F)]}{F}$$

$$= [F + p(o/q_2)(1-F)]\left[\frac{1}{F} + p(o/q_2)\left(1-\frac{1}{F}\right)\right]$$

The development of the two terms between hooks gives:

$$\frac{p(o)p(s)}{p(q_1)p(q_2)} = 1 + p(o/q_1)(1-p(o/q_1))\left(F - 2 + \frac{1}{F}\right)$$

By remembering that $F = \frac{1-p(q_2)}{p(q_2)}$, the ratio becomes:

$$\frac{p(o)p(s)}{p(q_1)p(q_2)} = 1 + p(o/q_1)(1-p(o/q_1))\frac{(p(q_1)-p(q_2))^2}{p(q_1)p(q_2)}$$

The term $\frac{(p(q_1)-p(q_2))^2}{p(q_1)p(q_2)}$ depends only on the difference in size between the classes.

To check it we calculate the derivative of: $\frac{(p(q_1)-p(q_2))^2}{p(q_1)p(q_2)} = \frac{(2p(q_1)-1)^2}{p(q_1)(1-p(q_1))}$

$$\left(\frac{(2p(q_1)-1)^2}{p(q_1)(1-p(q_1))}\right)'_{p(q_1)} = \frac{(2p(q_1)-1)}{(p(q_1)(1-p(q_1)))^2}$$

The derivative is null when the two classes are of the same size $p(q_1) = 1/2$, it is negative if $p(q_1) < 1/2$ and positive if $p(q_1) > 1/2$.

APPENDIX 2 SIGNAL QUALITY AND DIFFERENCE IN QUALITY BETWEEN CLASSES

The average quality of the superior labelled wines and the ordinary labelled wines is worth:

$$\bar{q}_S = p(q_1 / s)q_1 + p(q_2 / s)q_2$$
$$\bar{q}_O = p(q_1 / o)q_1 + p(q_2 / o)q_2$$

The difference between average qualities is worth:

$$\bar{q}_S - \bar{q}_O = [p(q_1 / s) - p(q_1 / o)]q_1 + [p(q_2 / s) - p(q_2 / o)]q_2$$

by using the theorem of Bayes:

$$\bar{q}_S - \bar{q}_O = \left[\frac{p(s / q_1)p(o) - p(o / q_1)p(s)}{p(o)p(s)}\right]p(q_1)q_1 + \left[\frac{p(s / q_2)p(o) - p(o / q_2)p(s)}{p(o)p(s)}\right]p(q_2)q_2$$

The use of impartiality conditions makes it possible to obtain:

$$\bar{q}_S - \bar{q}_O = \left[\frac{[1 - p(o / q_1)]p(o) - p(o / q_1)p(s)}{p(o)p(s)}\right]p(q_1)q_1 + \left[\frac{p(o / q_1)p(o) - [1 - p(o / q_1)]p(s)}{p(o)p(s)}\right]p(q_2)q_2$$

and after simplification:

$$\bar{q}_S - \bar{q}_O = \left[\frac{p(o) - p(o / q_1)}{p(o)p(s)}\right]p(q_1)q_1 - \left[\frac{p(s) - p(o / q_1)}{p(o)p(s)}\right]p(q_2)q_2$$

The theorem of the total probabilities makes it possible to write:

$$\overline{q}_S - \overline{q}_O = \left[\frac{p(o/q_1)p(q_1) + p(o/q_2)p(q_2) - p(o/q_1)}{p(o)p(s)}\right]p(q_1)q_1$$
$$-\left[\frac{p(o/q_1)p(q_2) + p(o/q_2)p(q_1) - p(o/q_1)}{p(o)p(s)}\right]p(q_2)q_2$$
$$= \left[\frac{[p(o/q_2) - p(o/q_1)]p(q_2)}{p(o)p(s)}\right]p(q_1)q_1 - \left[\frac{[p(o/q_2) - p(o/q_1)]p(q_1)}{p(o)p(s)}\right]p(q_2)q_2$$
$$= \frac{p(q_1)p(q_2)}{p(o)p(s)}[p(o/q_1) - p(o/q_2)][q_2 - q_1]$$

However, we showed that: $\theta_{II}^* = \frac{(p_2 - p_1)}{(q_2 - q_1)[p(o/q_1) - p(o/q_2)]} \times \frac{p(o)p(s)}{p(q_1)p(q_2)}$

Thus $\theta_{II}^* = \frac{(p_2 - p_1)}{(\overline{q}_S - \overline{q}_O)}$

APPENDIX 3 IMPACT OF SKEW ON θ

A3.2. Calculation of the value of θ

The expression of the difference between the hopes of utility becomes:

$$E(U/s) - E(U/o) = 0 \Leftrightarrow$$
$$\theta q_1\left[\frac{(C/2 + B)p(q_1)}{p(s)} - \frac{(1 - C/2 - B)p(q_1)}{p(o)}\right] + \theta q_2\left[\frac{(1 - C/2 + B)p(q_2)}{p(s)} - \frac{(C/2 - B)p(q_2)}{p(o)}\right] = p_2 - p_1$$

$$\theta q_1\left[\frac{C/2 + B - p(s)}{p(s)p(o)}\right] + \theta q_2\left[\frac{-C/2 + B + p(o)}{p(s)p(o)}\right] = p_2 - p_1$$

By using the theorem of the total probabilities one obtains:

$$\theta q_1\left[\frac{p(q_2)(C-1)}{p(s)p(o)}\right] + \theta q_2\left[\frac{(1-C)p(q_1)}{p(s)p(o)}\right] = p_2 - p_1$$

from where: $\theta_{NI}^* = \frac{p_2 - p_1}{q_2 - q_1}\frac{1}{1-C}\frac{p(s)p(o)}{p(q_1)p(q_2)}$

A3.2. Impact of skew on the probability of the signals

The product of signals unconditional probabilities is worth:

$$p(o)p(s)=\left[\left(1-\frac{C}{2}-B\right)p(q_1)+\left(\frac{C}{2}-B\right)p(q_2)\right]\left[\left(\frac{C}{2}+B\right)p(q_1)+\left(1-\frac{C}{2}+B\right)p(q_2)\right]$$

The development of the terms inside the hooks makes it possible to write:

$$p(o)p(s)=\left[p(q_1)+\frac{C}{2}(p(q_2)-p(q_1))-B\right]\left[p(q_2)-\frac{C}{2}(p(q_2)-p(q_1))+B\right]$$

The product of the terms between hook gives:

$$p(o)p(s)=p(q_2)p(q_1)-\frac{C}{2}(p(q_2)-p(q_1))^2-B(p(q_2)-p(q_1))$$
$$+BC\frac{C}{2}(p(q_2)-p(q_1))-B^2-\left(\frac{C}{2}\right)^2(p(q_2)-p(q_1))^2$$
$$=p(q_2)p(q_1)+\left[\frac{C}{2}-\left(\frac{C}{2}\right)^2\right](p(q_2)-p(q_1))^2+B(1-C)(p(q_2)-p(q_1))-B^2$$

While dividing by $p(q_2)p(q_1)$, one obtains the result given in the text.

A3.3. Study of the term $B[(1-C)(p(q_1)-p(q_2))-B]$

If the jury has a minimum of competence, one must have

$$p(s/q_1)=\frac{C}{2}+B<0{,}5\Leftrightarrow B<\frac{1-C}{2}$$
$$p(o/q_2)=\frac{C}{2}-B<0{,}5\Leftrightarrow B>\frac{C-1}{2}$$

1st case: the size of the ordinary wine class is higher than that of the superior wine $p(q_1)>p(q_2)$

The term between hook is null if $(1-C)(p(q_1)-p(q_2))=B$. There are values of B ranging between $\left[(1-C)(p(q_1)-p(q_2)) \quad \frac{1-C}{2}\right]$ if $p(q_1)<\frac{3}{4}$

B	$-\infty,0$	$0,(1-C)(p(q_1)-p(q_2))$	$(1-C)(p(q_1)-p(q_2)),$ $\frac{1-C}{2}$
B	-	+	+
$[(1-C)(p(q_1)-p(q_2))-B]$	+	+	-
$B[(1-C)(p(q_1)-p(q_2))-B]$	-	+	-

A hard committee decreases the value of θ. A lax committee increases θ, except if skew is strong and $p(q_1)<\frac{3}{4}$.

2nd case: the size of the first class is lower than that of the second $p(q_1)<p(q_2)$

It exists values of B ranging between $\left[\frac{C-1}{2} \quad (1-C)(p(q_1)-p(q_2))\right]$ if $p(q_2)>\frac{3}{4}$

B	$\frac{C-1}{2},(1-C)(p(q_1)-p(q_2))$	$(1-C)(p(q_1)-p(q_2)),0$	0, $+\infty$
B	-	-	+
$[(1-C)(p(q_1)-p(q_2))-B]$	+	-	-
$B[(1-C)(p(q_1)-p(q_2))-B]$	-	+	-

A lax committee decreases the value of θ. A hard committee increases θ, except if skew is strong and $p(q_2)>\frac{3}{4}$.

APPENDIX 4 IMPACT OF IMPERFECTION AND SKEW ON QUALITY OF THE CLASSES

A4.1. Impact of skew on the probabilities

The probability of finding a good bottle among those labelled superior is worth:

$$p(q_2 / s) = \frac{(1 - C/2 + B)p(q_2)}{p(q_2) - \frac{C}{2}(p(q_2) - p(q_1)) + B}$$

Let us calculate the derivative of this probability:

$$\frac{dp(q_2 / s)}{dB} = \frac{p(q_2)\left[p(q_2) - \frac{C}{2}(p(q_2) - p(q_1)) + B\right] - (1 - C/2 + B)p(q_2)}{\left[p(q_2) - \frac{C}{2}(p(q_2) - p(q_1)) + B\right]^2}$$

and after simplification: $\frac{dp(q_2 / s)}{dB} = \frac{p(q_1)p(q_2)[C - 1]}{\left[p(q_2) - \frac{C}{2}(p(q_2) - p(q_1)) + B\right]^2} < 0$

The probability of finding a good bottle in wines labelled superior decreases when skew increases.

The probability of finding an ordinary bottle among those labelled basic is given by:

$$p(q_1 / o) = \frac{(1 - C/2 - B)p(q_1)}{p(q_1) + \frac{C}{2}(p(q_2) - p(q_1)) - B}$$

Let us calculate the derivative of this probability:

$$\frac{dp(q_1 / o)}{dB} = \frac{-p(q_1)\left[p(q_1) + \frac{C}{2}(p(q_2) - p(q_1)) - B\right] + (1 - C/2 - B)p(q_1)}{\left[p(q_1) + \frac{C}{2}(p(q_2) - p(q_1)) - B\right]^2}$$

and after simplification: $\frac{dp(q_1 / o)}{dB} = \frac{p(q_1)p(q_2)[1 - C]}{\left[p(q_2) - \frac{C}{2}(p(q_2) - p(q_1)) + B\right]^2} > 0$

The probability of finding an ordinary bottle in the basic class increases with B.

The increase in skew thus degrades the average quality of the two classes as one can check it by calculation.

A4.2. Impact of skew on average qualities

$$\overline{q}_S = \frac{(1 - C/2 + B)p(q_2)q_2 + (C/2 + B)p(q_1)q_1}{p(q_2) - \frac{C}{2}(p(q_2) - p(q_1)) + B}$$

After simplification, the derivative compared to skew is worth:

$$\frac{d\overline{q}_S}{dB} = \frac{p(q_1)p(q_2)(q_1 - q_2)[1 - C]}{\left[p(q_2) - \frac{C}{2}(p(q_2) - p(q_1)) + B\right]^2} < 0$$

In the same way:

$$\overline{q}_O = \frac{(1 - C/2 - B)p(q_1)q_1 + (C/2 - B)p(q_2)q_2}{p(q_1) + \frac{C}{2}(p(q_2) - p(q_1)) - B}$$

$$\frac{d\overline{q}_O}{dB} = \frac{p(q_1)p(q_2)(q_1 - q_2)[1 - C]}{\left[p(q_1) + \frac{C}{2}(p(q_2) - p(q_1)) - B\right]^2} < 0$$

A4.3. Impact of skew on the difference between average qualities

The derivative of the difference between average qualities can be calculated in the following way:

$$\frac{d(\overline{q}_S - \overline{q}_O)}{dB} = \left(\frac{N_S}{D_S} - \frac{N_O}{D_O}\right)_B' = \frac{N_S' D_S - N_S D_S'}{D_S^2} - \frac{N_O' D_O - N_O D_O'}{D_O^2}$$

As we have just shown that: $N_S^{'}D_S - N_S D_S^{'} = N_O^{'}D_O - N_O D_O^{'}$

The sign of the derivative is given by the sign of:

$$D_O^2 - D_S^2 = (D_O + D_S)(D_O - D_S) = (p(q_1) - p(q_2))(1-C) - 2B$$

However this sign is unspecified, which means that skew can increase or reduce the difference between average qualities.

On the other hand, when the classes have the same sizes, $D_O^2 - D_S^2 = -2B$. As we know $N_S^{'}D_S - N_S D_S^{'} = N_O^{'}D_O - N_O D_O^{'} < 0$, the difference between average qualities grows with the absolute value of B. It reaches its minimum for B = 0, value for which the derivative is null.

A4.4 Impact of the imperfection on average qualities

$$\overline{q}_S = \frac{(1 - C/2 + B)p(q_2)q_2 + (C/2 + B)p(q_1)q_1}{p(q_2) - \frac{C}{2}(p(q_2) - p(q_1)) + B}$$

After simplification, the derivative compared to C is worth:

$$\frac{d\overline{q}_S}{d(C/2)} = \frac{p(q_1)p(q_2)(q_1 - q_2)[1 + 2B]}{\left[p(q_2) - \frac{C}{2}(p(q_2) - p(q_1)) + B\right]^2} < 0$$

In the same way:

$$\overline{q}_O = \frac{(1 - C/2 - B)p(q_1)q_1 + (C/2 - B)p(q_2)q_2}{p(q_1) + \frac{C}{2}(p(q_2) - p(q_1)) - B}$$

$$\frac{d\overline{q}_O}{d(C/2)} = \frac{p(q_1)p(q_2)(q_2 - q_1)[1 - C]}{\left[p(q_1) + \frac{C}{2}(p(q_2) - p(q_1)) - B\right]^2} > 0$$

The imperfection reduces the difference between average qualities.

APPENDIX 5 STUDY OF THE PROFIT OF THE INDUSTRY

The expression of the optimal profit is:

$$E(\Pi^*) = N\left\{ p_1 - c_2 + (q_2 - q_1)(1-C)\frac{1}{4}\left[\frac{c_2 - c_1}{q_2 - q_1}\frac{1}{1-C} + 1\right]\left[1 - \frac{c_2 - c_1}{q_2 - q_1}\frac{1}{1-C}\right] + (c_2 - c_1)\frac{1}{2}\left[\frac{c_2 - c_1}{q_2 - q_1}\frac{1}{1-C} + 1\right]\right\}$$

or by using the remarkable identity:

$$E(\Pi^*) = N\left\{ p_1 - c_2 + (q_2 - q_1)(1-C)\frac{1}{4}\left[1 - \left(\frac{c_2 - c_1}{q_2 - q_1}\frac{1}{1-C}\right)^2\right] + (c_2 - c_1)\frac{1}{2}\left[\frac{c_2 - c_1}{q_2 - q_1}\frac{1}{1-C} + 1\right]\right\}$$

after simplification:

$$E(\Pi^*) = N\left\{ p_1 - c_2 + \frac{1}{4}(q_2 - q_1)(1-C) + \frac{1}{2}(c_2 - c_1) + \frac{1}{4}\frac{(c_2 - c_1)^2}{q_2 - q_1}\frac{1}{1-C}\right\}$$

The derivative of the profit compared to C is worth:

$$\frac{dE(\Pi^*)}{dC} = \frac{N}{4}\left\{-(q_2 - q_1) + \frac{(c_2 - c_1)^2}{q_2 - q_1}\frac{1}{(1-C)^2}\right\} = \frac{N}{4}\left\{\frac{(c_2 - c_1)^2 - (1-C)^2(q_2 - q_1)^2}{(q_2 - q_1)(1-C)^2}\right\}$$

Like $p(q_1) \leq 1 \Leftrightarrow (c_2 - c_1) \leq (q_2 - q_1)(1-C)$, the derivative is negative.

APPENDIX 6 COMPETITION BETWEEN COMMITTEES

Expressions of the conditional probabilities are as follows:

$$p(q_1 / s_1, o_2) = \frac{p(s_1 / q_1)p(o_2 / q_1)p(q_1)}{p(s_1 / q_1)p(o_2 / q_1)p(q_1) + p(s_1 / q_2)p(o_2 / q_2)p(q_2)}$$

$$p(q_1 / o_1, s_2) = \frac{p(o_1 / q_1)p(s_2 / q_1)p(q_1)}{p(o_1 / q_1)p(s_2 / q_1)p(q_1) + p(o_1 / q_2)p(s_2 / q_2)p(q_2)}$$

$$p(q_2/s_1,o_2)=\frac{p(s_1/q_2)p(o_2/q_2)p(q_2)}{p(s_1/q_1)p(o_2/q_1)p(q_1)+p(s_1/q_2)p(o_2/q_2)p(q_2)}$$

$$p(q_2/o_1,s_2)=\frac{p(o_1/q_2)p(s_2/q_2)p(q_2)}{p(o_1/q_1)p(s_2/q_1)p(q_1)+p(o_1/q_2)p(s_2/q_2)p(q_2)}$$

By replacing the conditional probabilities by their expression according to competence and of skews one obtains:

$$p(q_1/s_1,o_2)=\frac{\left(\frac{C}{2}+B_1\right)\left(1-\frac{C}{2}-B_2\right)p(q_1)}{\left(\frac{C}{2}+B_1\right)\left(1-\frac{C}{2}-B_2\right)p(q_1)+\left(\frac{C}{2}-B_2\right)\left(1-\frac{C}{2}+B_1\right)p(q_2)}$$

$$p(q_1/o_1,s_2)=\frac{\left(\frac{C}{2}+B_2\right)\left(1-\frac{C}{2}-B_1\right)p(q_1)}{\left(\frac{C}{2}+B_2\right)\left(1-\frac{C}{2}-B_1\right)p(q_1)+\left(\frac{C}{2}-B_1\right)\left(1-\frac{C}{2}+B_2\right)p(q_2)}$$

$$p(q_2/s_1,o_2)=\frac{\left(\frac{C}{2}-B_2\right)\left(1-\frac{C}{2}+B_1\right)p(q_2)}{\left(\frac{C}{2}+B_1\right)\left(1-\frac{C}{2}-B_2\right)p(q_1)+\left(\frac{C}{2}-B_2\right)\left(1-\frac{C}{2}+B_1\right)p(q_2)}$$

$$p(q_2/s_1,o_2)=\frac{\left(\frac{C}{2}-B_1\right)\left(1-\frac{C}{2}+B_2\right)p(q_2)}{\left(\frac{C}{2}+B_2\right)\left(1-\frac{C}{2}-B_1\right)p(q_1)+\left(\frac{C}{2}-B_1\right)\left(1-\frac{C}{2}+B_2\right)p(q_2)}$$

After reduction with the same denominator and simplification, the numerator of the term in q_1 becomes:

$$N(q_1)=q_1p(q_1)p(q_2)\left\{\left(\left(\frac{C}{2}\right)^2-B_1^{\,2}\right)\left(\left(1-\frac{C}{2}\right)^2-B_2^{\,2}\right)-\left(\left(\frac{C}{2}\right)^2-B_2^{\,2}\right)\left(\left(1-\frac{C}{2}\right)^2-B_1^{\,2}\right)\right\}$$

$$N(q_1)=q_1p(q_1)p(q_2)\left(B_1^{\,2}-B_2^{\,2}\right)(C-1)$$

In the same way, the numerator of the term in q_2 is worth:

$$N(q_2) = q_2 p(q_1) p(q_2) \left\{ \left(\left(\frac{C}{2} \right)^2 - B_2^{\,2} \right) \left(\left(1 - \frac{C}{2} \right)^2 - B_1^{\,2} \right) - \left(\left(\frac{C}{2} \right)^2 - B_1^{\,2} \right) \left(\left(1 - \frac{C}{2} \right)^2 - B_2^{\,2} \right) \right\}$$

$$N(q_2) = q_2 p(q_1) p(q_2) \left(B_2^{\,2} - B_1^{\,2} \right)(C - 1)$$

The numerator of the whole of the expression is worth:

$$N(q_1) + N(q_2) = p(q_1) p(q_2)(1 - C)(q_2 - q_1)\left(B_1^{\,2} - B_2^{\,2} \right)$$

As by assumption $q_2 > q_1$, the numerator is of the sign of $\left(B_1^{\,2} - B_2^{\,2} \right)$. The denominator is positive, the price spread is thus also of the sign of $\left(B_1^{\,2} - B_2^{\,2} \right)$.