How to Promote Quality Perception in Wine Markets: Brand Advertising or Geographic Indication?

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Abstract: In the context of the wine industry, we investigate sellers' choice between geographic indications and brand advertising to convey information to consumers. Sellers also decide whether or not to select an effort level for improving the quality of their products. We show that if this effort is selected, a seller will prefer to rely on brand advertising for promoting its products and set up its own reputation. Despite the sharing of the promotion cost, a geographic indication does not sufficiently reward the effort for improving quality. Finally, the selection of both instruments by sellers is examined.

Key words: Geographic indication, brand advertising, an effort, quality.

Introduction

Wine promotion has been recently modified with the emergence of "new-world" wine from Australia, California, and Chile. Wineries from these countries mainly use brand advertising (BA) to promote quality perception, while more traditional European wineries mainly rely on geographic indications (GI) for signaling the quality of their products. Foreign consumers in Europe are often baffled by the profusion of wine GIs. Reliance on GI to promote food product is widespread in Europe not only for wine but also for cheese, meat etc. For instance, nearly seven hundred products are registered under the European designations system, either under the so-called Protected Designation of Origin and Protected Geographical Indication (EC, 2006). Those facts raise the issue of the efficiency of the GI system for promoting food products.

We analyze the complex interaction between BA and GI, and rewards to quality improvements. We identify the relative effectiveness of GI and BA to reward sellers[1] for improvements in quality of their products, using a stylized framework linking product promotion and quality effort. In a two-period model, GI and BA enhance the quality perception and the willingness to pay of consumers. The BA allows a seller to develop an individual reputation. The GI allows sellers to share the promotion cost and to develop a common reputation. Besides the choice of GI or BA, sellers choose whether or not to make an effort to improve the overall quality level that affects the consumers' purchase decision in second period. Both signal and an effort strategies influence the sellers' profits.

We show that if the effort for improving quality is selected, a seller will prefer to rely on BA for promoting its products and set up its own reputation. Despite the sharing of the promotion cost, a GI does not sufficiently reward the effort for improving quality because of the common reputation. Conversely, when the seller avoids the effort, the GI is selected.

[1]We use the word sellers to denote firms, producers, wineries, and designate wine suppliers faced by consumers.

Sellers take advantage of sharing of the promotion cost under collective reputation.

The present paper is linked to two separate strands of the literature. The first strand includes numerous papers on quality signaling. The latter mainly considers prices (e.g., Mahenc, 2004) or advertising (e.g., Fluet and Garella, 2002) to signal higher quality. Our framework differs since we simplify the consumers' belief by considering GI and BA as persuasive tools that change consumers' preferences. The second and more recent strand focuses on GI and collective reputation (e.g., Marette and Crespi, 2003; Zago and Pick, 2004; and Winfree and McCluskey, 2005). In this literature, sellers' coordination or even price collusion via a GI may be necessary to improve quality when the fixed costs of certification or quality improvements are large. Our framework differs since we abstract from any price collusion linked to the GI and we introduce the possibility to use brand for sellers. Indeed, our paper try to address the question of the relative efficiency of collective reputation compared to that of a private brand.

The next section fleshes out our contention of the emergence of "new-world" wine relying on BA in contrast the reliance of European wine on GIs. Then we introduce the model in the third section. The main results are presented in the fourth, while the fifth provides some extensions, and the final section concludes. An appendix provides detailed derivations of results presented in the text.

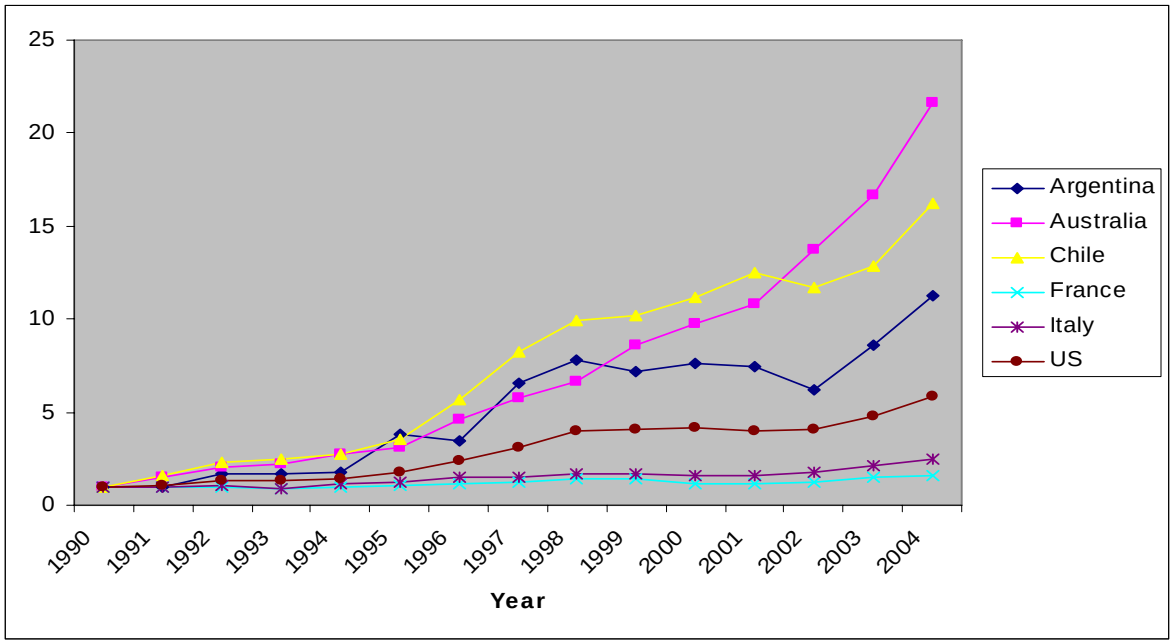
Promotion Strategies in the Wine Market

In the last 15 years, globalization and trade liberalization have entailed a new context of competition. While the consumption of wine in the whole world has been increasing (WHO, 2005), wine exports of European countries like France or Italy have leveled off. Conversely, the exports of Australia, Chile, Argentina and the United States have steadily gained grounds as shown in Figure 1, and markedly so in recent years.[2] The European domination is being

[2] Note that this figure exhibits aggregated volumes that neglect segmentation and quality heterogeneity.

challenged by these new sellers coming from Chile or Australia. This new competition has modified strategies of signaling and promotion in the wine market (BA versus GI), accompanied by differences in cost structure, industry structure, and wine technology. The intellectual challenge is to elucidate the individual effect of these various elements. We focus on the noticeable efforts of these emerging competitors to improve quality and the crucial role of their marketing strategies. The following stylized facts allow us to understand the differences between Europe and the emergent countries.[3]

Figure 1.Wine Exports Value (Basis 100 in 1990)



Basis Data Source: UN Commodity Trade Statistics Database.

First, several types of information such as the winery, the grape, or the origin are usually mentioned on most bottles. However for a buyer, the most visible information in France is the GI for medium-quality wines, and cumulative GI (appellation, grand cru, etc) combined with winery ("Chateau") for high-quality wines. Conversely, the brand is the most visible information for the Australian wines (e.g., Jacob's Creek, 2005). Wine promotion in Australia, Chile and the United States favors BA, which facilitate the good reputation and the

[3] The stylized facts mainly concerned consumption wines that differ from collectible wines reserved to experts (Costanigro, 2005).

recognition by buyers.

Second, the profusion and proliferation of GIs in Europe lead to some risks of confusion for consumers (Marette and Zago, 2003). Peri and Gaeta (1999) count more than 400 official appellations in the wine sector in Italy, 450 appellations in France, and 1,397 in the wine sector in Europe. Such profusion assures product diversity but certainly increases buyer confusion (*Consumer Reports,* 1997). The recognition of quality labels by French consumers is only 12% for Appellations d'Origine Contrôlée, the French GI system for high-quality products (Loisel and Couvreur, 2001). Recently, Berthomeau (2002) discusses the difficulty that some French GIs have in entering new export markets because of the absence of any clear specification of the label that distinguishes one appellation from another in consumers' minds.[4] In sharp contrast, Jacobs-Creek and Kendall-Jackson wines can be found in most U.S. grocery stores.

Third, many European GIs impose numerous restrictions that often stifle the search for commercial efficiency and innovations in quality. The grape production is regulated, with a maximum yield allowed per unit of land. The excess of regulation for linking origin and quality seems problematic when the international competition is intense (Zago and Pick, 2004; and Ribaut, 2005). Conversely, the main features of regulations in the United States, Chile, and Australia are the lack of detailed rules, that is, the freedom to experiment with new techniques; the production and marketing of wines according to single varieties of grapes, sometimes associated with a relatively large production region; and an intense use of marketing investments.[5]

[4] The collective reputation of French wines plummeted during the last decade (Conan, 2005; Echikson, 2005; and Ribaut, 2005). Giraud-Heraud et al. (2002) and Ribaut (2005) mentioned the needs of wineries consolidation and/or reforms of French GI system.

[5] In September 2005, the United States and the EU reached a wine-trade agreement which makes some U.S. practices such as adding wood chips to wine barrels legitimate in the EU. U.S. companies will stop using some GIs such as Champagne, Sherry and Port. Some EU lawmakers are not satisfied with this agreement. The conflict arises because Europe wine industry is strictly regulated and emphasizes on traditional practices, while the U.S. wine industry is much younger and emphasizes new technology (Locke, 2005).

Fourth, wineries in Australia are much bigger than the ones in Europe. The average vineyard size in France is less than 2 hectares versus 111 hectares in Australia. Four sellers are dominating the Australian market, namely, Foster, Southcorp, Hardy, and Orlando Wyndham. The combined production share of the four largest sellers in New Zealand is 85%, while the combined production share of the two largest sellers in South Africa is 80%. Unlike the industry in Australia or Chile, the wine industry in Europe is fragmented. Indeed, apart from some notable exceptions, e.g., the Champagne (*Economist*, 2003), the wine industry in Europe is made up of many small sellers, which may lack adequate capital for the necessary investments in new technologies and marketing policies. In other words, small wineries are unable to reach the minimum-efficient scale since the quality improvement implies relatively large fixed costs.

Beyond these empirical facts, the effects of the origin and the role of the GI are tricky to evaluate. Despite all the limits previously mentioned, GI also indicates natural conditions such as the soils and the climate specific to a certain geographic area (Barham, 2003). Origins of products matters for consumers' purchase decisions. Orth et al. (2005) show that the origin of a bottle does affect the U.S. consumers' preference as shown in Table 1.[6]

Table 1. Consumers' Preference for Wine Origin

Origin	Mean rank	Standard Deviation
California	3.03	1.95
France	3.88	2.49
Italy	4.38	2.18
Australia	4.67	2.51
Oregon	4.78	2.55
Chile	5.75	2.32
Spain	5.87	1.98
Washington	6.02	2.42
New Zealand	6.51	1.89

Note: Scale from 1 = most preferred to 9 = least preferred
Source: Table 1 in Orth, Wolf and Dodd (2005).

However, GIs can be an efficient tool to signal collective reputation. The Champagne

[6] It should be noted that the origin in table 1 corresponds to countries or U.S. states, as GI in France or Italy often

GI is an example in which the combination of famous brands (with large vineyard size and enough capital for advertising) and a prestigious GI matters for consumers ready to pay a large premium (Combris et al., 2003). An "efficient" combination of brands and GI also characterizes the Napa Valley appellation, which generates a significant price premium compared to an equivalent-quality bottle with a different appellation (Bombrun and Sumner, 2003). The efficiency of GI compared to that of a private brand is an open question. Some empirical studies of wine have shown consumers' attitude towards GIs and brands. With a parametric hedonic approach, Steiner (2004) shows that the decline of French wine in British market is partly due to the consumers' low valuation of geographical appellation. Riley et al. (1999) show a positive correlation between consumers' attitude (and perception) and relative brand size in British wine market.

The debate about the strategies of sellers and the appropriate regulation will likely gain momentum. This last point directly leads to the focus of our paper. Although the choice among tools for improving quality raises many questions, we focus on the central link between an effort for improving quality and different tools for quality signaling (BA versus GI, a combination of both)). A stylized model is used to isolate the impact of alternative ways to signal quality with and without effort to improve quality.

The Model

Wee assume purchases occur in two periods ($t=1, 2$) with two sellers i and j who may offer products of high-quality or low quality. In the first period, sellers i and j choose whether or not to promote their products and/or whether or not to improve the quality of their products. The cost of promotion is A. If the sellers choose the GI, each seller incurs the cost $A/2$ since they share the cost. If a seller individually chooses to use BA, it incurs the cost A. The cost of product improvement is F. It is assumed that other costs of production are zero. For

concerned sub-regions or small areas.

simplicity, it is also assumed that $A = \gamma F$, with $\gamma \leq 1$.

Each consumer only purchases one unit of the good per period *t* (Mussa and Rosen, 1978). A consumer who buys one unit of the product from seller *i* at a price p_i^t has an expected indirect utility equal to $\theta E(q_i^t) - p_i^t$, where $E(q_i^t)$ is the expected quality. The mass of those consumers is normalized at 1, with a uniformly distributed parameter $\theta \in [0, 1]$. For simplicity, we assume that the consumers only want to get high-quality q_H and they get no satisfaction from getting low-quality ($q_\ell = 0$).

Consumers have a limited knowledge on the quality and the probability of producing high quality goods. In the first period (*t=1),* the consumer has a belief about the probability of getting high-quality from seller *i* equal to $\overline{\lambda} + I_i^\alpha \alpha$, with $0 \leq \overline{\lambda} + I_i^\alpha \alpha \leq 1$. $\overline{\lambda}$ is the initial belief in the absence of promotion and I_i^α is an indicator linked to the promotion strategy. I_i^α=1 means that the seller *i* invests in promotion (GI or BA) for enhancing the consumer's perception of quality in the first period, while I_i^α=0 means the seller *i* avoids investing in promotion.

In the second period (*t=2*), the consumers repeat their purchases by learning the average quality of the products because of an imperfect experience. Consumers can communicate with each other after the first period, so that a common knowledge is formed regarding the average quality of the products among consumers.[7] Their belief regarding the probability of getting high quality depends on the seller's decision for improving quality at a cost *F* and on the promotion strategies. The cost *F* implies an improvement of the probability of having high-quality equal to *e*. Under BA, consumers are able to identify each seller's improvement since promotion is individual. If the seller *i* chose BA, the probability of having

[7] We assume that consumers learn about the probability via their own experience and they use complementary

high-quality products is $\lambda + I_i^e e$ (with $0 < \lambda + I_i^e e \leq 1$), where λ is the real probability to get high-quality in the absence of an effort. I_i^e is an indicator of the probability improvement (I_i^e=1 when *F* is incurred and zero otherwise). If both sellers chose GI, consumers are not able to precisely distinguish the quality of both sellers since the promotion is collective. As GI leads to a collective reputation, the probability for consumers to get high quality in the absence of distinction between both sellers is $(\lambda + I_i^e e)/2 + (\lambda + I_j^e e)/2 = \lambda + (I_i^e + I_j^e)e/2$, with $i \neq j$.

We summarize all the cases faced by sellers and consumer in table 2. Recall that the low quality is q_L=0, so that the expected quality for consumers is equal to their belief regarding the probability of getting high quality multiplied by the quality level, q_H.

Table 2. Sellers' Strategy and Consumers' Expectation of Seller *i*'s quality (q_L=0)

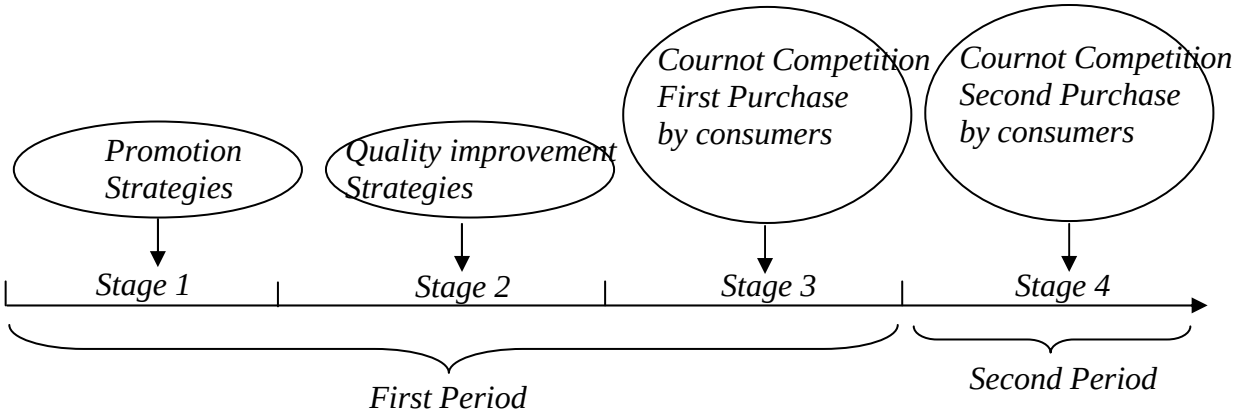
First Period			Second Period
Seller *i*'s Strategy (Seller *j*'s Strategy)	Cost incurred by seller i	Consumer's expected quality of seller i	Consumer's expected quality of seller i
No signal (No signal)	$I_i^e F$	$\overline{\lambda}\ q_H$	$(\lambda + 0.5(I_i^e + I_j^e)e)\ q_H$
GI (GI)	$I_i^e F$+0.5*A*	$(\overline{\lambda} + \alpha)\, q_H$	$(\lambda + 0.5(I_i^e + I_j^e)e)\ q_H$
BA (BA)	$I_i^e F$+*A*	$(\overline{\lambda} + \alpha)\, q_H$	$(\lambda + I_i^e e)\ q_H$
BA (No signal)	$I_i^e F$+*A*	$(\overline{\lambda} + \alpha)\, q_H$	$(\lambda + I_i^e e)\ q_H$
No signal (BA)	$I_i^e F$	$\overline{\lambda}\ q_H$	$(\lambda + I_i^e e)\ q_H$

The game proceeds in three stages in the first period. At the first stage, the sellers make their decisions for promoting their products, namely GI, BA or no signal. In the second stage, each seller decides whether or not to make an effort to improve the probability of

information (communication among the consumers, newspaper and so on).

producing high quality goods. In the third stage of the first period, each seller selects a quantity (Cournot competition), and consumers decides on their consumption levels. They learn partial information via the consumption. The stage 4 corresponds to the second period, where the consumers repeat their purchase and each seller selects a quantity (Cournot competition). The time line of the stages is shown in the following graph:

Figure 2. Time Line of the Game



We now turn to the presentation of the sellers' choices.

The sellers' choices

When the sellers choose the information strategy (in stage 1) and the effort strategies (in stage 2) that maximize their profits, they take into account the quantity choices in stages 3 and 4. The subgame perfect equilibrium is detailed in the appendix.

The incentive for a seller to select promotion and/or an effort balances two opposite effects. An information/effort strategy leads to a higher demand for its products by increasing the consumer's willingness to pay. However, this positive effect may be offset by the fixed cost induced by these strategies or by the strategic interaction with the other seller. The sellers' choices depend on the efficiency of both promotion (represented by parameters $\overline{\lambda}, \alpha$ and γ) and an effort (represented by the parameter *e*).

For sake of simplicity, we characterize the equilibrium strategies for alternative values of some parameters, representing the relative cost of promotion compared to the cost of an

effort for improving quality. We consider the configurations with high level (relative high α/γ compared with *e*), medium level (α/γ is close to *e*), and low level (α/γ is low compared to *e*) of promotion cost compared to the cost of an effort (recall that $A=\gamma F$). Let

$$\gamma_1 = \frac{\alpha(4e+3\lambda)^2(36\alpha^2+56\alpha\overline{\lambda}+21\overline{\lambda}^2)}{e(4\alpha+3\overline{\lambda})^2(36e^2+56e\lambda+21\lambda^2)} \quad (1)$$

$$\gamma_2 = \frac{4\alpha^2(80e^3+81\alpha\lambda^2+24e\lambda(9\alpha+\lambda)+4e^2(36\alpha+25\lambda))}{e(4\alpha+3\overline{\lambda})^2(16e^2+31e\lambda+15\lambda^2)} + \frac{(8\alpha\overline{\lambda}+3\overline{\lambda}^2)(60e^3+63\alpha\lambda^2+6e\lambda(28\alpha+3\lambda)+e^2(112\alpha+75\lambda))}{e(4\alpha+3\overline{\lambda})^2(16e^2+31e\lambda+15\lambda^2)} \quad (2)$$

$$\gamma_3 = Max\left\{Min\left\{\frac{4\alpha-2e}{e},1\right\},0\right\} \quad (3)$$

and we have $\gamma_1 < \gamma_2$. Figures 3 to 4 illustrate the market equilibrium detailed in the propositions, where the X-axis represents the quality level, q_H , and the Y-axis represents the fixed cost, *F*. The relative values of q_H and *F* determine the sellers' optimal strategy and define the limits of different areas (the frontiers of these regions are detailed in the appendix). Below, we present the propositions and provide an intuitive interpretation, leaving the mathematical proof in the appendix.

Proposition 1*: When the cost of signaling is low with* $\gamma \le \gamma_1$*, the sellers' strategies are as follows (see Figure 3):*

(a) both sellers choose no signal and no seller makes an effort in area 1,

(b) one seller chooses BA and no seller makes an effort in area 2,

(c) one seller chooses BA and makes an effort in area 3,

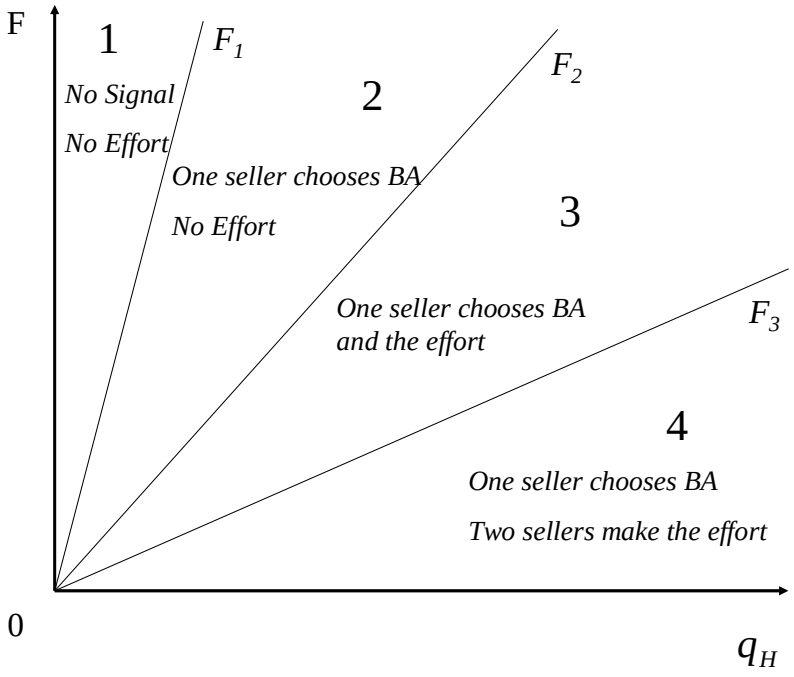
(d) one seller chooses BA and both seller make an effort in area 4.

Proof is given in the appendix.

In area 1, making the effort or using a signal is too costly, since the respective costs represented by *F* (and γF) are relatively large. When *F* decreases in areas 2, 3 and 4, the different strategies of an effort and signal become affordable for the seller(s). When the cost of signaling is low with $\gamma \le \gamma_1$, each seller will try to use the BA alone, since it increases the

perception differentiation and the profit via the parameter α in the first period and the individual reputation in the second period. This market mechanism leads one seller to choose BA instead of cooperating with the other seller to select a GI since the cost of signaling is relatively small.

Figure 3. The strategies with low cost of signaling ($\gamma \leq \gamma_1$)



In area 2, one seller chooses BA because of the low cost of signaling (small γ), and no seller make an effort because of the relative high cost of the effort compared with the signal cost. When F further decreases (area 3), the seller choosing the BA chooses to make an effort. In area 3, the fixed cost is still quite high for the other seller to select a signal or an effort. When F is relatively small (area 4), both sellers make an effort. Only one seller chooses the BA that allows to increase the perception differentiation in period 1. We now turn to a situation where the cost of promotion increases.

Proposition 2*: For a medium cost of signaling with $\gamma_1 < \gamma \leq \gamma_2$, the sellers' strategies are as follows (see Figure 3):*

(a) both sellers choose no signal and no seller makes an effort in area 1,

(b) one seller choose BA and make an effort in area 3,

(c) one seller chooses BA and both seller make an effort in area 4.

Proof is given in the appendix.

Since signaling is more costly, no seller selects the BA without making the effort. In other words, the BA is valuable only if an effort is made. Indeed compared to proposition 1, the area 2 disappeared when γ increased. We now turn to a situation where the cost of promotion keeps increasing with $\gamma_2 < \gamma_3$[8]. Let

$$\alpha_1 = \frac{3\bar{\lambda}}{4} \qquad (4)$$

Proposition 3*: When the cost of signaling is medium with $\gamma_2 < \gamma \leq \gamma_3$, the sellers' strategies are as follows (see Figure 4):*

(a) both sellers choose no signal and no seller makes an effort in area 1,

(b) both sellers choose GI but no seller makes an effort in area 5,

(c) both sellers make no signal but make an effort in area 6,

(d) both sellers make an effort ; one seller chooses BA if $\alpha > \alpha_1$ and both of them choose GI if $\alpha < \alpha_1$ in area 7.

Proof is given in the appendix.

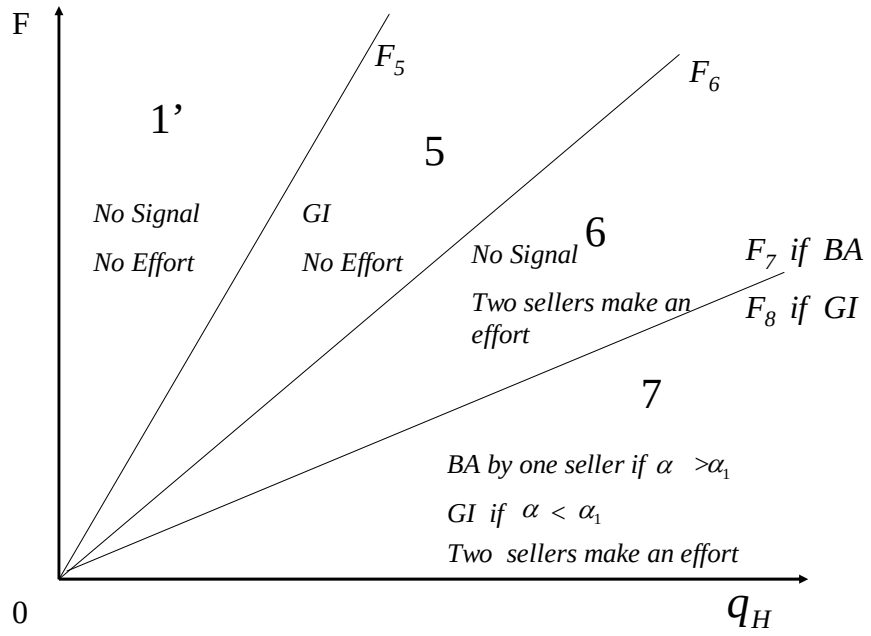
When the cost of promotion keeps increasing, the GI becomes more attractive compared to the BA because the sellers share the cost of promotion. The areas 3 and 4 from Figure 3 disappear, since the cost of doing BA is too high to afford for a single seller. In Figure 4, the sellers lean towards the GI rather than doing BA individually. Some new equilibrium appears in Figure 4.

In area 4, GI replaces BA of Figure 3 for large values of *F*. As the cost of making an effort keeps decreasing, sellers would choose to make an effort instead of signaling in area 6. In reality, this corresponds to as new technology which decreases the fixed cost of making investment in quality improvements. The story in area 7 is the following: if signaling is not

[8] The relative value of γ_2 and γ_3 depends on the relative values of $\lambda, \bar{\lambda}, e$ and α. If $\gamma_2 > \gamma_3$, Proposition 3

persuasive to a certain level ($\alpha < \alpha_1$), the sellers would choose to cooperate with each other and do GI to share the fixed cost. However, if signaling is effective and α is greater than some certain level α_1, one seller would do BA to distinguish itself from the other in the first period to gain higher profit.

Figure 4. The strategies with medium cost of signaling ($\gamma_2 < \gamma \leq \gamma_3$)



Proposition 4*: When the cost of signaling is high ($\gamma > \max\{\gamma_2, \gamma_3\}$) the sellers' strategies are as follows (see Figure 4):*

(a) no seller chooses any signal strategy and no seller makes an effort in area 1',

(b) both sellers make no signal but both sellers make an effort in area 6, and

(b) both sellers make an effort ; one seller chooses BA if $\alpha > \alpha_1$ and both of them choose GI if $\alpha < \alpha_1$ in area 7.

Proof is given in the appendix.

Proposition 4 is illustrated in Figure 4. In this case, the cost of signaling is so large that even the effect of cost sharing of GI does not work well. Therefore, the area 5 in Figure 4 disappears. And the sellers choose to make an effort instead of signaling in area 6.

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does not exist.

From the 4 propositions above we can conclude that the strategies of the sellers depend on the relative effectiveness of making an effort and signaling. When signaling is more effective and the fixed cost of making an effort is large, sellers tend not to make an effort; when making an effort is more effective and the fixed cost of signaling is large, sellers tend not to signal. We also conclude that BA provides sellers with a higher incentive to make an effort than GI does, since GI is a collective reputation. If the effort for improving quality is selected, a seller will prefer to rely on BA for promoting its wine and set up its own reputation. Despite the sharing of the promotion cost, a geographic indication does not sufficiently reward the effort for improving quality due to the common reputation. On the contrary, when the seller avoids making the effort, GI is selected to be the promotion strategy. In this case, sellers take advantage of sharing of the promotion cost and collective reputation.

Extensions

In defining then analytical framework, restrictive assumptions were made for simplicity. Some of the results of the model are robust if we consider the following extensions.

(i) In our model we abstract from the combination of GI and BA. One extension could be the incorporation of this combination. The following assumption could be made: In the first period, GI enhances the consumer's expectation by α and costs sellers $\frac{A}{2}$, BA enhances the consumer's expectation by α as well but costs sellers A, and the combination of the two enhances the consumer's expectation by $c\alpha$ and costs sellers $\frac{3A}{2}$. When the combination of these two are effective (high $c\alpha$ compared with the cost $\frac{3A}{2}$), the sellers would choose the combination, if the combination are not effective enough, the sellers would choose GI or BA individually that goes back to the propositions of this paper. Let

$$c_1 = \min\{1, \frac{32\alpha^4 + 24\alpha^3\overline{\lambda} - 19\alpha^2\overline{\lambda}^2 - 14\alpha\overline{\lambda}^3 - 14\alpha\overline{\lambda}^3}{3(16\alpha^4 + 24\alpha^3\overline{\lambda} + 9\alpha^2\overline{\lambda}^2)}\}$$

and when $c < c_1$, the combination of GI and BA is dominated by GI or BA in equilibrium and it never emerges. (See proof of Lemma (*viii*)).

(ii) In our model signaling only have effect on the first period. One extension could be that the introduction of effect of signaling on the consumers' expectation in the second period. That is, the second period's expectation of consumers is the combination of the expectation of the first period and the real probability. For example, when the sellers choose GI, the consumers' expectation in the second period is $[\varphi(\lambda + 0.5(I_i^e + I_j^e)e) + (1-\varphi)(\overline{\lambda} + \alpha)]\, q_H$, where $0 \le \varphi \le 1$. The higher the effectiveness of signals in the second period, the closer the consumers' expectation to the real probability. By doing this, we introduce an interaction effect of signaling and making an effort. We expect that sellers' incentive of making an effort is lower when the second period effectiveness of signaling is lower.

(iii) Our model abstract from the discount of the second period profit of the consumers. If there is a discount of the second period, the larger the discount, the lower the sellers' incentive to make an effort.

(iv) In the model, we abstracted from a context with numerous sellers. When there are more than 2 sellers, a seller with higher probability of producing a high-quality good has incentives to signal quality to distinguish itself from the rest of the sellers.

(v) We only considered one region. One extension of our model is the introduction of several regions. Probabilities of producing high quality goods are different across different regions. We expect that sellers in a region with high probability have more incentive to do GI.

(vi) We assumed vertical differentiation. An alternative solution is to introduce horizontal differentiation. In this context with *m* consumers and perfect information, m_1 consumers prefer goods from seller 1 and (m-m_1) consumers prefer goods from seller 2. Using our model we expect that as m_1 increases, seller 1's incentive of signaling and making an effort increases.

Conclusions

We explore sellers' choice between promotions strategies (GI and BA) and quality improvement strategies and how these strategic choices affect consumers' purchase decision in the wine market. We show that sellers' choice depends on the relative efficiency of promotion strategies compared with that of making an effort to improve quality. Another result is that if the effort for improving quality is selected, a seller would like to use BA for promoting its wine and set up its own reputation. In spite of its advantage that the sellers can share the promotion cost, a GI does not sufficiently reward the effort for improving quality since it promotes a collective reputation. However, when the seller chooses not to make an effort to improve the quality, a GI is selected to be the promotion strategy. In the latter case by using a GI, sellers can take advantage of the sharing of the promotion cost and collective reputation.

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APPENDIX

The consumer's demand and sellers' profits are presented before detailing the proof of propositions, with the characterization of the sub-game perfect Nash equilibrium of this four-stage game (solved by backward induction).

The consumer utility is $\sum_{t=1}^{2} \theta E(q_i^t) - p_i^t$ by consuming the product by seller i (i=1 or 2). In period t (t=1 or 2), if the two sellers choose the same strategy, then $E(q_1^t) = E(q_2^t) = \bar{q}^t$ and $p_1^t = p_1^t = \bar{p}^t$. When $\theta \bar{q}^t - \bar{p}^t = 0$, the consumer is indifferent between buying and not buying a product in period t, implying that her taste parameter $\bar{\theta}^t = \frac{\bar{p}^t}{\bar{q}^t}$. As the distribution of preference is uniform, the demand for the product is $\bar{x}^t = 1 - \frac{\bar{p}^t}{\bar{q}^t}$ and $\bar{p}^t = (1 - \bar{x}^t)\bar{q}^t$. In period t, if the two sellers choose different strategies, then the expected quality of the products from two sellers are different, $E(q_1^t) = \bar{q}_1^t$ and $E(q_2^t) = \bar{q}_2^t$. Suppose $\bar{q}_1^t > \bar{q}_1^t$ (indicating $p_1^t > p_2^t$) the consumer's demand for seller 1's product is $x_1^t = 1 - \frac{p_1^t - p_2^t}{\bar{q}_1^t - \bar{q}_2^t}$. And the demand for seller 2's product is $x_2^t = \frac{p_1^t - p_2^t}{\bar{q}_1^t - \bar{q}_2^t} - \frac{p_2^t}{\bar{q}_2^t}$. By solving the system of equations of $x_1^t = 1 - \frac{p_1^t - p_2^t}{\bar{q}_1^t - \bar{q}_2^t}$ and $x_2^t = \frac{p_1^t - p_2^t}{\bar{q}_1^t - \bar{q}_2^t} - \frac{p_2^t}{\bar{q}_2^t}$ for p_1^t and p_2^t, we get $p_1^t = \bar{q}_1^t(1 - x_1^t) - \bar{q}_2^t x_2^t$ and $p_2^t = \bar{q}_2^t(1 - x_1^t - x_2^t)$.

In stage 2, each seller chooses a level of quantity, taking into account the quantity of the other seller. For the case that the two sellers' strategies are different, the profit for the higher expected quality seller is

$\pi_1 = \sum_{t=1}^{2} p_1^t \bar{q}_1^t - I_1^e F - I_1^\alpha A' = \sum_{t=1}^{2} (\bar{q}_1^t (1 - x_1^t) - \bar{q}_2^t x_2^t) x_1^t - I_1^e F - I_1^\alpha A'$ and the profit for the lower expected quality seller is

$\pi_2 = \sum_{t=1}^{2} p_2^t \bar{q}_2^t - I_2^e F - I_2^\alpha A' = \sum_{t=1}^{2} \bar{q}_2^t (1 - x_1^t - x_2^t) x_2^t - I_2^e F - I_2^\alpha A'$. A' is the fixed cost associated with information strategies: $A' = A$ if BA is chosen and $A' = \frac{A}{2}$ if GI is chosen. The first order conditions for the maximization of π_1 with respect to x_1^t (namely, $\frac{\partial \pi_1}{\partial x_1^t} = 0$) and π_2 with respect to x_2^t (namely $\frac{\partial \pi_2}{\partial x_2^t} = 0$) lead to equilibrium prices x_1^{t*} and x_2^{t*}. The substitution of these equilibrium quantities into π_1 and π_2 leads to the following respective profits for the seller 1 and seller 2:

$$\pi_1^* = \sum_{t=1}^{2} \frac{\bar{q}_1^t (2\bar{q}_1^t - \bar{q}_2^t)^2}{(4\bar{q}_1^t - \bar{q}_2^t)^2} - I_1^e F - I_1^\alpha A' \quad \text{(A1.1)}$$

$$\pi_2^* = \sum_{t=1}^{2} \frac{\bar{q}_2^t \bar{q}_1^{t\,2}}{(4\bar{q}_1^t - \bar{q}_2^t)^2} - I_2^e F - I_2^\alpha A' \quad \text{(A1.2)}$$

A particular case of (A1.1) and (A1.2) is when both sellers choose the same strategies in both periods (which leads to $\bar{q}_1^t = \bar{q}_2^t = \bar{q}^t$):

$$\bar{\pi}_i^* = \sum_{t=1}^{2} \frac{\bar{q}^t}{9} - I_i^e F - I_i^\alpha A' \quad i\text{=1 or 2} \quad \text{(A2)}$$

The decision on the choice of strategies in stage 1 depends on these profits, which in turn depends on the expected quality and fixed costs listed in Table 2 of the main text. In stage 1, each seller faces the choices of strategies listed in the first column of Table 2. The decision depends on the comparison among the profits. Table 2 list all the cases of the expected qualities and associated costs by choosing different strategies for the two sellers. If the

expected qualities for the two sellers are the same, substitute them in (A2) and get the profits for the two sellers. If the expected qualities for the two sellers are different, substitute them in (A1.1) and (A1.2) and get the profits for the two sellers. Since there are two periods, the sellers' profit would be the first period profit plus a discount parameter δ times the profit of the second period.

We use $\pi^{i}_{strategy1(I_1^e)+strategy2(I_2^e)}$ to denote seller i's profit with seller 1 choosing strategy 1 and seller 2 choosing strategy 2 and an effort making decision ($I_i^e = 1$ means an effort making, $I_i^e = 0$ means avoid making an effort). Among the strategies no signal is denoted by n, GI is denoted by GI and BA is denoted by BA. For example, $\pi^{2}_{BA(1)+n(1)}$ denotes seller 2's profit when seller 1 chooses BA and making an effort and seller 2 chooses no signal and but makes an effort.

The following equilibria are dominated:

(i) both sellers choose no signal, and one of them chooses to make an effort,

(ii) both sellers choose GI, and one of them chooses to make an effort,

(iii) both sellers choose BA,

(iv) one seller chooses BA and makes no effort, and the other one chooses no signal but makes an effort,

(v) Both sellers choose GI and makes no effort, if one seller could choose BA and makes no effort conditional on the other seller choosing no signal and no effort,

(vi) both sellers choose GI and make an effort if an equilibrium arises in which one seller chooses BA and both make an effort, and vice versa,

(vii) Both sellers choose GI and make an effort, or both sellers choose no signal but make an effort if one of them could choose BA and make an effort conditional on the other seller not deviating from choosing no signal and no effort.

(viii) One seller chooses the combination of GI and BA, another seller chooses GI alone; both of the sellers choose the combination of GI and BA.

Proof of previous points (i) & (ii):

Both sellers choose no signal and seller 1 also chooses to make an effort and seller 2 does not make an effort is not dominated when the following necessary (but not sufficient) conditions are satisfied: seller 1 does not deviate to make no effort and seller 2 does not deviate to make an effort. That is:

$$\pi^1_{n(1)+n(0)} > \pi^1_{n(0)+n(0)} \quad \text{(A3.1)}$$

$$\pi^2_{n(1)+n(0)} > \pi^2_{n(1)+n(1)} \quad \text{(A3.2)}$$

(A1.1) is satisfied by $F < \frac{e}{18} q_H$ and A(1.2) is satisfied by $F > \frac{e}{18} q_H$, these two can not be satisfied at the same time, so the equilibrium is dominated. Similar proof applies to *(ii)* of Lemma.

Proof of point (iii):

$\pi^i_{BA(1)+BA(1)} = \frac{(\bar{\lambda}+\alpha)+(\lambda+e)}{9} q_H - A - F$ which is always less than

$\pi^i_{GI(1)+GI(1)} = \frac{(\bar{\lambda}+\alpha)+(\lambda+e)}{9} q_H - \frac{A}{2} - F$, *i*=1,2. So the sellers would rather choose GI and make an effort to achieve the same profit with a lower cost.

Proof of point (iv):

Seller 1 choosing BA and making no effort and seller 2 making no signal but making an effort is not dominated when the following necessary conditions are satisfied: seller 1 does not deviate to make an effort and seller 2 does not deviate to make no effort. That is:

$$\pi^1_{BA(0)+n(1)} > \pi^1_{BA(1)+n(1)} \quad \text{(A4.1)}$$

$$\pi^2_{BA(0)+n(1)} > \pi^2_{BA(0)+n(0)} \text{ (A4.2)}$$

A(4.1) is satisfied by F> $f_1 = \frac{e(16e^2 + 31e\lambda + 15\lambda^2)}{9(4e+3\lambda)^2} q_H$ and (A4.2) is satisfied by F< $f_2 = \frac{e^2 + e\lambda}{4e+3\lambda} q_H$, but $f_1 - f_2 = -\frac{4e(5e^2 + 8e\lambda + 3\lambda^2)}{9(4e+3\lambda)^2} q_H$ <0, so the necessary conditions cannot be satisfied.

Proof of point (v):

Seller 1 choosing GI and making no effort is not dominated when the following necessary conditions are satisfied: seller 1 does not deviate to make no signal and make no effort, and seller 1 doesn't deviate to do BA conditional on seller 2 making no signal and no effort. That is:

$$\pi^1_{GI(0)+GI(0)} > \pi^1_{n(0)+n(0)} \text{ (A5.1)}$$

$$\pi^1_{GI(0)+GI(0)} > \pi^1_{BA(0)+n(0)} \text{ (A5.2)}$$

(A5.1) is satisfied by $F < f_3 = \frac{2\alpha}{9\gamma} q_H$, and (A5.2) is satisfied by

F> $f_4 = \frac{2}{\gamma}\left(\frac{(\bar{\lambda}+\alpha)(\bar{\lambda}+2\alpha)^2}{(3\bar{\lambda}+4\alpha)^2} - \frac{\bar{\lambda}+\alpha}{9}\right) q_H$, but $f_3 < f_4$, which can not satisfied.

Proof of point (vi):

Seller 1 choosing BA and making an effort and seller 2 making no signal but making an effort is not dominated when the following necessary conditions are satisfied: seller 1 does not deviate to choose GI and make an effort and seller 2 does not deviate to choose GI make an effort. That is:

$$\pi^1_{BA(1)+n(1)} > \pi^1_{GI(1)+GI(1)} \text{ (A6.1)}$$

$$\pi^2_{BA(1)+n(1)} > \pi^2_{GI(1)+GI(1)} \text{ (A6.2)}$$

(A6.1) is satisfied by $F < f_4 = \frac{2}{\gamma}\left(\frac{(\bar{\lambda}+\alpha)(\bar{\lambda}+2\alpha)^2}{(3\bar{\lambda}+4\alpha)^2} - \frac{\bar{\lambda}+\alpha}{9}\right)q_H$ and (A6.2) is satisfied by $F > f_5 = \frac{2}{\gamma}\left(\frac{\bar{\lambda}+\alpha}{9} - \frac{\bar{\lambda}(\bar{\lambda}+\alpha)^2}{(3\bar{\lambda}+4\alpha)^2}\right)q_H$. When $f_4 < f_5$ (which indicates $\alpha > \alpha_1 = \frac{3\bar{\lambda}}{4}$), Seller 1 choosing BA and making an effort and seller 2 making no signal but making an effort is not dominated, but both choosing GI and making an effort is dominated. When $f_4 > f_5$ (which indicates $\alpha < \alpha_1 = \frac{3\bar{\lambda}}{4}$), the equilibrium that seller 1 choosing BA and making an effort and seller 2 making no signal but making an effort is dominated, but both choosing GI and making an effort is not dominated.

Proof of point (vii):

Both sellers choose GI and make an effort when the following necessary conditions are satisfied: sellers do not deviate to make no effort and one of the sellers does not deviate to choose BA and make an effort conditional on the other seller choose no signal and make no effort. That is:

$$\pi^1_{GI(1)+GI(1)} > \pi^1_{BA(1)+n(0)} \quad \text{(A7.1)}$$

$$\pi^1_{GI(1)+GI(1)} > \pi^1_{GI(0)+GI(1)} \quad \text{(A7.2)}$$

(A7.1) is satisfied by

$F > f_6 = \frac{2}{\gamma}\left(\frac{(\bar{\lambda}+\alpha)(\bar{\lambda}+2\alpha)^2}{(3\bar{\lambda}+4\alpha)^2} - \frac{\bar{\lambda}+\alpha}{9} + \frac{(\lambda+e)(\lambda+2e)^2}{(3\lambda+4e)^2} - \frac{\lambda+e}{9}\right)q_H$ and (A7.2) is satisfied by $F < f_7 = \frac{e}{18}q_H$. But

$f_6 - f_7 = \frac{16e^3(5-\gamma) + 45\alpha\lambda^2 + 8e^2(10\alpha + (16-3\gamma)\lambda) + 3e\lambda(40\alpha + (16-3\gamma)\lambda)}{18(3\lambda+4e)^2}q_H$ >0. So the necessary conditions cannot be satisfied. Similar proof could apply to the case that both

sellers make no signal but make an effort.

Proof of point (viii):

The necessary condition for seller 1 to choose the combination of GI and BA as the marketing strategy if it has no incentive to deviate to do BA alone, which means:

$$\pi^1_{GIBA(0)+GI(0)} > \pi^1_{BA(0)+n(0)} \quad \text{(A8.1)}$$

The condition above leads to the frontier below which the strategies that one seller choose the combination of GI and BA and another seller choose GI alone will emerge in equilibrium.

$$f_8 = \frac{2}{\gamma}\left(\frac{(\bar{\lambda}+c\alpha)((2c-1)\alpha+\bar{\lambda})^2}{((4c-1)\alpha+3\bar{\lambda})^2} - \frac{(\bar{\lambda}+\alpha)(2\alpha+\bar{\lambda})^2}{(4\alpha+3\bar{\lambda})^2}\right)q_H$$

When this frontier is below the horizontal axis in Figure 3 of the main text, the strategy that one seller chooses the combination of GI and BA, the other seller choose GI alone and none of them makes an effort is dominated by the strategy that one seller choose BA, the other seller makes no signal and none of them makes an effort. That is f_8 <0, which generates

c< $c_{11} \approx \frac{32\alpha^4 + 24\alpha^3\bar{\lambda} - 19\alpha^2\bar{\lambda}^2 - 14\alpha\bar{\lambda}^3 - 14\alpha\bar{\lambda}^3}{3(16\alpha^4 + 24\alpha^3\bar{\lambda} + 9\alpha^2\bar{\lambda}^2)}$. The exact value of c_{11} is rather complex, the expression above gives the approximate value by ignoring the smaller order of this value. Similarly, we could prove that the strategy both sellers choose the combination of GI and BA is dominated by both of the seller choose GI in equilibrium when c<1.

Therefore, we can $c_1 = \min\{1, \frac{32\alpha^4 + 24\alpha^3\bar{\lambda} - 19\alpha^2\bar{\lambda}^2 - 14\alpha\bar{\lambda}^3 - 14\alpha\bar{\lambda}^3}{3(16\alpha^4 + 24\alpha^3\bar{\lambda} + 9\alpha^2\bar{\lambda}^2)}\}$.

The frontiers determination and proof of propositions

We now turn to the equilibrium strategies that lead to proposition 1, 2 3,and 4.

The Nash equilibrium is that a seller will choose a strategy that leads to a higher profit than all other available strategies given the other seller's strategy. Due to the page limitation of this paper, we only give an example on how to derive some of the frontiers in

proposition 1. The lower limit of area 1 in the proposition 1, which is also the frontier for area 2. If no signal and no effort is Nash equilibrium, applying *Lemma (v)* and *(vii)* the following conditions have to be satisfied:

$$\pi^1_{n(0)+n(0)} > \pi^1_{BA(0)+n(0)} \text{ and } \pi^2_{n(0)+n(0)} > \pi^2_{BA(0)+n(0)}\text{; (A9.1)}$$

$$\pi^1_{n(0)+n(0)} > \pi^1_{BA(1)+n(0)} \text{ and } \pi^2_{n(0)+n(0)} > \pi^2_{BA(1)+n(0)}\text{; (A9.2)}$$

$$\pi^1_{n(0)+n(0)} > \pi^1_{BA(1)+n(1)} \text{ and } \pi^2_{n(0)+n(0)} > \pi^2_{BA(1)+n(1)}\text{; (A9.3)}$$

(A9.1) leads to

$$F > f_9 = \frac{1}{\gamma}\left(\frac{(\bar{\lambda}+\alpha)(\bar{\lambda}+2\alpha)^2}{(3\bar{\lambda}+4\alpha)^2} - \frac{\bar{\lambda}}{9}\right)q_H .$$

(A9.2) leads to

$$F > f_{10} = \frac{1}{\gamma+1}\left(\frac{(\bar{\lambda}+\alpha)(\bar{\lambda}+2\alpha)^2}{(3\bar{\lambda}+4\alpha)^2} + \frac{(\lambda+e)(\lambda+2e)^2}{(3\lambda+4e)^2} - \frac{\bar{\lambda}+\lambda}{9}\right)q_H .$$

(A9.3) Leads to

$$F > f_{11} = \left(\frac{(\bar{\lambda}+\alpha)(\bar{\lambda}+2\alpha)^2}{(3\bar{\lambda}+4\alpha)^2} + \frac{e-\bar{\lambda}}{9}\right)q_H \text{, and}$$

$$F > f_{12} = \left(\frac{\bar{\lambda}(\bar{\lambda}+\alpha)^2}{(3\bar{\lambda}+4\alpha)^2} + \frac{e-\bar{\lambda}}{9}\right)q_H .$$

When $\gamma \le \gamma_1$. $f_9 > f_{10} > f_{11} > f_{12}$, so we have

$$F_1 = \frac{1}{\gamma}\left(\frac{(\bar{\lambda}+\alpha)(\bar{\lambda}+2\alpha)^2}{(3\bar{\lambda}+4\alpha)^2} - \frac{\bar{\lambda}}{9}\right)q_H .$$

If seller 1 choose BA and no effort and the second seller making no signal and no effort is Nash equilibrium, applying *Lemma (iv)* the following conditions have to be satisfied*:*

$$\pi^1_{BA(0)+n(0)} > \pi^1_{n(0)+n(0)} \text{ (A10.1)}$$

$$\pi^1_{BA(0)+n(0)} > \pi^1_{BA(1)+n(0)} \text{ (A10.2)}$$

(A10.1) leads to

$$F< F_1 = \frac{1}{\gamma}\left(\frac{(\bar{\lambda}+\alpha)(\bar{\lambda}+2\alpha)^2}{(3\bar{\lambda}+4\alpha)^2} - \frac{\bar{\lambda}}{9} \right) q_H$$

(A10.2) leads to

$$F> f_{13} = \left(\frac{(\lambda+e)(\lambda+2e)^2}{(3\lambda+4e)^2} - \frac{\lambda}{9} \right) q_H .$$

So we get

$$F_2 = \frac{2}{\gamma}\left(\frac{(\bar{\lambda}+\alpha)(\bar{\lambda}+2\alpha)^2}{(3\bar{\lambda}+4\alpha)^2} - \frac{\bar{\lambda}+\alpha}{9} \right) q_H$$

And when $F_2 <F< F_1$, one seller choosing BA and making no effort and the other seller making no signal no effort is an equilibrium.

Similarly, we get other frontiers in the propositions. Let

$$\gamma_4 = \frac{4\alpha^2(4e^2(36\alpha-7\lambda)+24e(9\alpha-\lambda)\lambda+81\alpha\lambda^2)}{e(4\alpha+3\bar{\lambda})^2(16e^2+31e\lambda+15\lambda^2)} + \frac{(8\alpha\bar{\lambda}+3\bar{\lambda}^2)(7e^2(16\alpha-3\lambda)+6e(28\alpha-3\lambda)\lambda+63\alpha\lambda^2)}{e(4\alpha+3\bar{\lambda})^2(16e^2+31e\lambda+15\lambda^2)}$$

$$\gamma_5 = \frac{2\alpha}{e}$$

Then,

$$F_3 = \begin{cases} \left(\frac{\lambda+e}{9} - \frac{(\lambda+e)^2\lambda}{(3\lambda+4e)^2} \right) q_H & if \quad \gamma < \gamma_4 \\ \frac{1}{\gamma+1}\left(\frac{(\bar{\lambda}+\alpha)(\bar{\lambda}+2\alpha)^2}{(3\bar{\lambda}+4\alpha)^2} + \frac{e-\bar{\lambda}}{9} \right) q_H & if \quad \gamma > \gamma_4 \end{cases}$$

$$F_4 = \frac{1}{\gamma+1}\left(\frac{(\bar{\lambda}+\alpha)(\bar{\lambda}+2\alpha)^2}{(3\bar{\lambda}+4\alpha)^2} + \frac{(\lambda+e)(\lambda+2e)^2}{(3\lambda+4e)^2} - \frac{\bar{\lambda}+\lambda}{9} \right) q_H$$

$$F_5 = \frac{2\alpha}{9\gamma} q_H$$

$$F_6 = \frac{e}{18} q_H$$

$$F_8 = \begin{cases} \frac{2\alpha}{9\gamma} q_H & if \quad \gamma < \gamma_5 \\ \frac{2}{\gamma+2}\left(\frac{\alpha+e}{9} \right) q_H & if \quad \gamma > \gamma_5 \end{cases}$$