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Consumer confusion and multiple equilibria

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Abstract

This paper focuses on consumer confusion when firms may choose between credible and non-credible certification systems for signalling quality. It is shown that the presence of confused consumers leads to the emergence of multiple stable equilibria, in which either all firms select the credible certification or all firms select the non-credible certification. A situation with numerous confused consumers is characterized by the complete absence of credible certification.

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1. Introduction

As consumers face different types of certification, they may be confused over the significance of claims. Eco-labels with various claims provide an interesting example of possible confusion among consumers. So many green claims have emerged that eco-labels have proliferated. Just a few of the more well-known labels are the German "Blue Angel", the "Nordic Swan", dozens of organic certification labels, "Dolphin Safe," "California Clean," "Bird Friendly," "Shade Grown," "Green Seal". In fact, the Eco-labels Center, a US-based consumer advocacy group, lists over 200 US eco-labels across various products on its web site (Eco-labels Center, 2008). Among these 200 or so eco-labels that were monitored, many make unsubstantiated claims that do not help consumers clarify their opinions. Moreover, these "poor" labels often tarnish the credibility of "serious" labels. The different seals linked to labels are often very similar, which does not help consumers' recognition before purchasing goods.

This paper explores the consequences of consumer confusion over certification systems or labels. In a very simple model, two firms choose whether or not to select a costly credible certification making a substantiated claim for quality. Under the alternative choice, the non-credible certification makes unsubstantiated claim for quality. Different certification choices by both firms induce consumers' confusion over the offered quality under each certification system.

It is shown that the presence of confused consumers when different choices are made by firms leads to the emergence of multiple stable equilibria, in which either all firms select the credible certification or all firms select the non-credible certification. In comparison, a situation without confusion would lead to a unique equilibrium. Moreover, a situation with numerous confused consumers is characterized by the complete absence of credible certification that is a unique equilibrium.

The results of this paper differ from previous papers that overlooked confusion despite their focus on certification (Lizzeri,1999, Albano and Lizzeri, 2001) or labels (Amacher et al. 2004, Bonroy and Constantatos, 2008). Lizzeri (1999) and Albano and Lizzeri (2001) show that competition among the certification intermediaries can lead to information revelation compared to a monopoly situation. This result is unlikely in our framework since consumer confusion cripples the revelation process. The present paper also differs from the Wilson's (1980) paper, showing that markets may be characterized by multiple equilibria because of imperfect information for all consumers and adverse selection about quality. The present paper differs since a situation with only confused consumers is characterized by a unique equilibrium. Confusion by only a part of consumers explains the emergence of multiple equilibria.

The paper is organized as follows. The next section introduces the stylized model. Following that, the market equilibrium is detailed. The last section presents some conclusions.

2. The Model

In order to focus on the main economic mechanisms and to keep the mathematical aspects as simple as possible, the analytical framework is admittedly simple. In this stylized framework, trade occurs in a single stage, with two firms able to produce the good. Each firm offers either high- or low-quality products. High quality, $s_h > 0$, implies a (sunk) cost *F>0* for a firm and low quality $s_L = 0$ costs zero for simplicity.

Under perfect information about quality, each consumer has the following utility function:

$$U(x_1, x_2) = (a + s_1)x_1 + (a + s_2)x_2 - (x_1^2 + x_2^2 + 2\gamma x_1 x_2)/2 + v, \quad (1)$$

where x_i is the consumer's consumption of good offered by firms i=1, 2 and v is the quantity of a composite good (Garella and Petrakis, 2008). s_i represents the quality parameter for firm i' s good. The parameter γ measures the degree of substitutability between the two goods and is restricted to lie in the interval [0,1]. Let p_i denote the unit price for good i, while the price of the composite good is normalized to equal one. After normalizing the population of consumers to one (for simplicity), maximization of utility defined by (1) with respect to x_1 and x_2 gives the (inverse) consumer demand functions $p_i = a + s_i - x_i - \gamma x_j$. Simultaneously solving these inverse demands for x_i gives the demand functions,

$$x_i(p_i, p_j, s_i, s_j) = \frac{a(1-\gamma) + (s_i - \gamma s_j) - p_i + \gamma p_j}{1-\gamma^2}, \text{ for } i, j = 1,2 \text{ and } i \neq j. \quad (2)$$

In our model each consumer may buy both goods in variable quantities including low-quality goods with $s_\ell = 0$ since $a>0$.

We turn to the situation under imperfect information, where consumers may receive some knowledge about qualities for firms 1 and 2 via certification. There are two types of possible certification. Each firm may select a costly credible certification making a substantiated claim about the quality of products at a (sunk) cost C, covering the monitoring process and the quality inspection. High-quality is signaled by a seal. Low-quality is detected and receives no seal that is clearly interpreted as a low-quality signal by consumers. Under the alternative choice, the non-credible certification makes a poor claim about quality at zero cost. As this cost is zero, a firm with low-quality products has an incentive to post this certification, if some consumers are confused and wrongfully believe that the firm offer high-quality products. For non-confused consumer, this non-credible certification is linked to the low-quality choice.

Information about certification choices are received by all consumers at the end of stage 1. However, when consumers really purchase the good in stage 3, some of them may be confused if different certification systems are selected by competing firms. There is a proportion ρ of non-confused consumers who clearly identify both types of certification systems. There is a proportion $(1-\rho)$ of confused consumers when different certification systems are selected. This confusion over the certification definition may come from (*i*) a lack of knowledge/understanding by consumers, (*ii*) a lack of recall regarding labels between stage 1 (when the information is received) and stage 3 (when the good is purchased), (*iii*) a seals (logos) similarity. These confused consumers involuntarily switch the significance of certification, which means that the product with the non-credible certification is wrongfully perceived as a product with the credible certification and vice versa. When both firms select the same type of certification, there is no confusion since consumers perfectly identify a single type of certification used by both firms.[1]

[1] This assumption is made for simplicity. Extensions could easily consider the consumers' inability to recall or interpret the information when one type of certification is selected and sent by both firms.

The timing of this game is divided into three stages. In stage 1, each firm selects its quality level and incurs the sunk cost F if the high quality is selected. Each firm also chooses the certification, namely the credible one or the non-credible one. If the credible one is selected, the sunk cost C is incurred. At the end of stage 1, information about certification is provided to consumers. In stage 2, both firms choose a price. In stage 3, trade occurs with confused and non-confused consumers who purchase the goods.

3. The Firm's Decisions

The game is solved by backward induction (i.e., subgame Nash equilibrium). When purchases are made in stage 3, consumers' perception about qualities $s_1^{\,p}$ and $s_2^{\,p}$ respectively offered by firms 1 and 2 depends on the certification decisions in stage 1. In stage 2, for perceived qualities $s_1^{\,p}$ and $s_2^{\,p}$, each firm determines its level of price by taking into account other firm's best reply. The gross profit (without taking into account sunk costs) of a firm i is $p_i x_i(p_i, p_j, s_i^{\,p}, s_j^{\,p})$ for i, j =1,2; $i \neq j$. The first order conditions are such that $x_i(p_i^*, p_j^*, s_i^{\,p}, s_j^{\,p}) + p_i^* \partial x_i(p_i^*, p_j^*, s_i^{\,p}, s_j^{\,p}) / \partial p_i = 0$ for i, j =1,2; $i \neq j$, leading to equilibrium prices $p_i^* = \left[a(2-\gamma-\gamma^2) + (2-\gamma^2)s_i^{\,p} - \gamma s_j^{\,p} \right] / \left(4-\gamma^2\right)$. Substituting the equilibrium prices in gross profit gives the equilibrium gross profit for the firm i equal to

$$\pi_i(s_i^{\,p}, s_j^{\,p}) = \frac{\left[a(2-\gamma-\gamma^2) + (2-\gamma^2)s_i^{\,p} - \gamma s_j^{\,p} \right]^2}{\left(4-\gamma^2\right)^2 \left(1-\gamma^2\right)}, \text{ for } i, j = 1,2 \text{ and } i \neq j \qquad (3)$$

We now turn to the firms' decisions regarding the quality and certification choices in stage 1. For a firm i, the net profit depends on quality/certification choices implying sunk costs and quality perceptions $s_i^{\,p}, s_j^{\,p}$ by consumers. For i, j =1,2 and $i \neq j$, Y_i is an indicator variable taking the value of 1 if firm i chooses high-quality products and zero if low quality is chosen. Z_i is an indicator variable taking the value of 1 if firm i chooses the credible certification and zero if non-credible certification is chosen. The profit for a seller i is

$$\begin{aligned} &\Pi_i(Y_i, Z_i, Y_j, Z_j) = \pi_1(s_i^{\,p}, s_j^{\,p}) - Y_i F - Z_i C \\ &\textit{with} \quad s_i^{\,p} = Z_i Y_i Z_j s_h + Z_i Y_i (1-Z_j)\rho s_h + (1-Z_i) Y_j Z_j (1-\rho) s_h + 0 \\ &\textit{and} \quad s_j^{\,p} = Z_j Y_j Z_i s_h + Z_j Y_j (1-Z_i)\rho s_h + (1-Z_j) Y_i Z_i (1-\rho) s_h + 0 \end{aligned} \qquad (4)$$

A few details are now provided about quality perceptions. When firms have the same certification strategy $Z_i = Z_j$, there is no consumer confusion. The quality perception is $s_i^{\,p} = s_j^{\,p} = s_h$ if $Z_i = Z_j = 1$ and $Y_i = Y_j = 1$. The quality perception is $s_i^{\,p} = s_j^{\,p} = 0$ if $Z_i = Z_j = 0$ whatever Y_i, Y_j, because consumers believes the quality is low when all firms choose non-credible certification. With different certification strategies, let assume that firm 1 chooses high-quality s_h and a credible label ($Y_1 = 1$ and $Z_1 = 1$), while firm 2 chooses the non-credible certification ($Z_2 = 0$). A proportion ρ of non-confused consumers clearly identify the different

seals, and their demands are $x_1(p_1, p_2, s_h, 0)$ for firm 1 with high quality s_h and $x_2(p_2, p_1, 0, s_h)$ for firm 2 with low quality equal to zero (see equation (2) for details about demands). A proportion $(1-\rho)$ of confused consumers involuntarily switch the significance of certification, which means that the product with the non-credible certification is wrongfully perceived as a product with the credible certification and vice versa. For these confused consumers, the demands are $x_1(p_1, p_2, 0, s_h)$ for firm 1 (wrongfully perceived with low-quality equal to zero) and $x_2(p_2, p_1, s_h, 0)$ for firm 2 (wrongfully perceived with high-quality s_h). By using (2) and the proportions of non-confused and confused consumers, the expected demand q_1 for firm 1 (and similarly q_2 for firm 2 by using x_2) is $\rho x_1(p_1, p_2, s_h, 0) + (1-\rho)x_1(p_1, p_2, 0, s_h) = x_1(p_1, p_2, \rho s_h, (1-\rho)s_h)$. For firm 1, the overall profit is determined by (4) with $Z_1 = 1, Z_2 = 0$.

Various situations may emerge at the equilibrium depending on the parameters values. The subgame-perfect equilibrium is characterized by the absence of individual deviation by any firm. Figure 1 represents the game at stage 1 by reducing this stage to a 4×4 normal-form game, where two firms simultaneously choose one of 4 actions, namely (high quality, low quality)× (credible certification, non-credible certification).

Figure 1: 4×4 Normal-Form Game in Stage 1

High Quality $Y_2 = 1$

High Quality $Y_1 = 1$	Credible $Z_2 = 1$	Non-credible $Z_2 = 0$
Credible $Z_1 = 1$	$\Pi_1(1,1,1,1)$ $\Pi_2(1,1,1,1)$	$\Pi_1(1,1,1,0)$ $\Pi_2(1,0,1,1)$
Non-Credible $Z_1 = 0$	$\Pi_1(1,0,1,1)$ $\Pi_1(1,1,1,0)$	$\Pi_1(1,0,1,0)$ $\Pi_2(1,0,1,0)$

Low Quality $Y_2 = 0$

High Quality $Y_1 = 1$	Credible $Z_2 = 1$	Non-credible $Z_2 = 0$
Credible $Z_1 = 1$	$\Pi_1(1,1,0,1)$ $\Pi_2(0,1,1,1)$	$\Pi_1(1,1,0,0)$ $\Pi_2(0,0,1,1)$
Non-Credible $Z_1 = 0$	$\Pi_1(1,0,0,1)$ $\Pi_2(0,1,1,0)$	$\Pi_1(1,0,0,0)$ $\Pi_2(0,0,1,0)$

High Quality $Y_2 = 1$

Low Quality $Y_1 = 0$	Credible $Z_2 = 1$	Non-credible $Z_2 = 0$
Credible $Z_1 = 1$	$\Pi_1(0,1,1,1)$ $\Pi_2(1,1,0,1)$	$\Pi_1(0,1,1,0)$ $\Pi_2(1,0,0,1)$
Non-Credible $Z_1 = 0$	$\Pi_1(0,0,1,1)$ $\Pi_2(1,1,0,0)$	$\Pi_1(0,0,1,0)$ $\Pi_2(1,0,0,0)$

Low Quality $Y_2 = 0$

Low Quality $Y_1 = 0$	Credible $Z_2 = 1$	Non-credible $Z_2 = 0$
Credible $Z_1 = 1$	$\Pi_1(0,1,0,1)$ $\Pi_2(0,1,0,1)$	$\Pi_1(0,1,0,0)$ $\Pi_2(0,0,0,1)$
Non-Credible $Z_1 = 0$	$\Pi_1(0,0,0,1)$ $\Pi_2(0,1,0,0)$	$\Pi_1(0,0,0,0)$ $\Pi_2(0,0,0,0)$

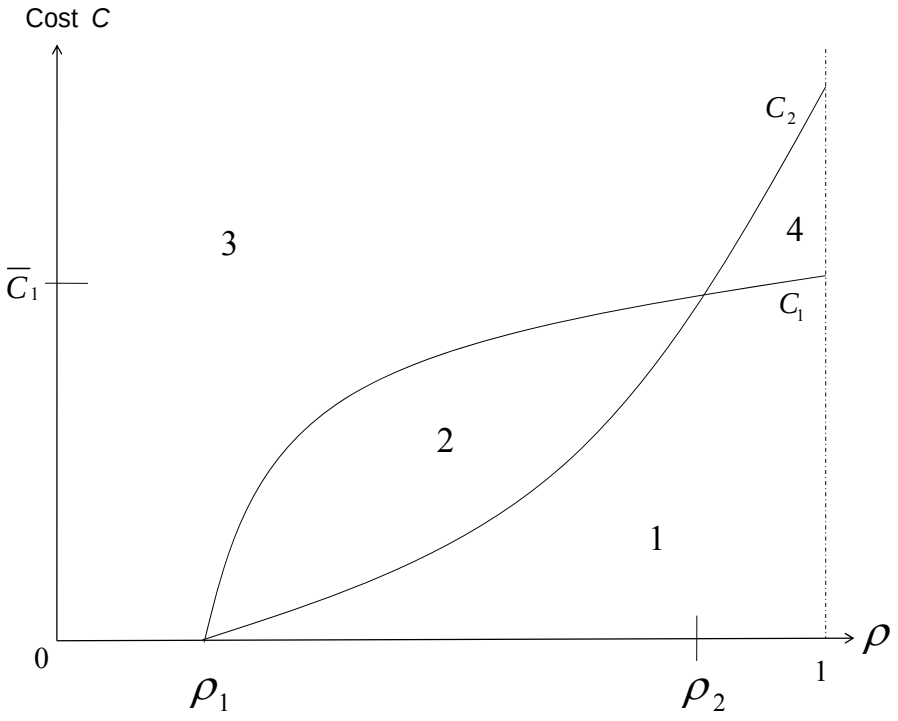
The row player is the firm 1 with the profit $\Pi_1(Y_1, Z_1, Y_2, Z_2)$ in the cell corresponding to

strategies Y_1, Z_1, Y_2, Z_2, and the column player is the firm 2 with the profit $\Pi_2(Y_2, Z_2, Y_1, Z_1)$ in the cell corresponding to strategies Y_2, Z_2, Y_1, Z_1. The quality choice (Y_i) determines the choice among matrixes and the certification choice (Z_i) determines the choice inside each matrix.

With figure 1, the elimination of dominated strategies can be made for firm 1 (and symmetrically for firm 2). We restrict our attention to the second column of the left matrixes for which the firm's 2 strategy ($Y_2 = 1, Z_2 = 1$) is given. Thus, for firm 1, the strategy ($Y_1 = 1, Z_1 = 0$) is strictly dominated by the strategy ($Y_1 = 0, Z_1 = 0$), since the profit $\Pi_1(1,0,1,1) = \pi_1((1-\rho)s_h, \rho s_h) - F - C$ is strictly lower than the profit $\Pi_1(0,0,1,1) = \pi_1((1-\rho)s_h, \rho s_h) - C$. Moreover, the strategy ($Y_1 = 0, Z_1 = 1$) fully revealing low quality because of the absence of seal under credible certification is strictly dominated by the strategy ($Y_1 = 0, Z_1 = 0$), since the profit $\Pi_1(0,1,1,1) = \pi_1(0, s_h) - C$ is strictly lower than the profit $\Pi_1(0,0,1,1) = \pi_1((1-\rho)s_h, \rho s_h)$. The strategies ($Y_1 = 1, Z_1 = 1$) and ($Y_1 = 0, Z_1 = 0$) are non-dominated and the ranking between $\Pi_1(0,0,1,1)$ and $\Pi_1(1,1,1,1)$ depends on parameter values *F, C* and ρ.

The previous demonstration can be replicated for other columns and for other rows when deviations of firms 2 are considered. In figure 1, the profits linked to non-dominated strategies are circled with dashed lines. The comparison of these profits delineates the emergence of equilibrium. Figure 2 is useful for illustrating the choices by firm(s) at the equilibrium among the strategies for which profits are circled in Figure 1. These choices are detailed in proposition 1. In figure 2, the proportion of non-confused consumers, ρ, is located along the horizontal axis, and the cost of the credible certification, *C*, is located along the vertical axis.

Figure 2: Firms' Choices



Proposition 1. *There is a unique equilibrium in the following regions:*

- *Both firms choose high-quality products with a credible certification in region 1.*
- *Both firms choose low-quality products with a non-credible certification in region 3.*
- *One firm chooses high-quality products with a credible certification and the other firm choose low-quality products with a non-credible certification in region 4.*

There are multiple equilibria in region 2, for which either both firms choose high-quality products with a credible certification or both firms choose low-quality products with a non-credible certification.

Proof: The profits linked to non-dominated strategies and circled with dashed lines in figure 1 are compared. The selection of high-quality products with a credible certification by both firms is a subgame perfect equilibrium, if $\Pi_1(1,1,1,1) > \Pi_1(0,0,1,1)$, which is equivalent to $C < C_1 = \pi_1(s_h, s_h) - F - \pi_1((1-\rho)s_h, \rho s_h)$. This constraint $C < C_1$ is similar for firm 2 with $\Pi_2(1,1,1,1) > \Pi_2(0,0,1,1)$. The constraint $C < C_1$ means that there is no profitable deviation for a firm that chooses high-quality when the competitor also chooses high-quality.

The selection of low-quality products with a non-credible certification by both firms is a subgame perfect equilibrium, if $\Pi_1(0,0,0,0) > \Pi_1(1,1,0,0)$, which is equivalent to $C > C_2 = \pi_1(\rho s_h, (1-\rho)s_h) - F - \pi_1(0,0)$. This constraint means that there is no profitable deviation (associated with both credible certification and high-quality products) for a firm that chooses low-quality when the competitor also chooses low-quality.

The regions of figure 1 are determined as following. For $\rho > \rho_2 = (2-\gamma^2)/(2+\gamma-\gamma^2)$, the relationship $C_2 > C_1$ is satisfied. Region 4 with strategies described in proposition 1 is defined by $C_1 < C < C_2$.

For $\rho_1 < \rho < \rho_2$ (with $\rho_1 = \gamma/(2+\gamma-\gamma^2)$), the relationship $C_2 < C_1$ is satisfied. It means that for $C_2 < C < C_1$ in region 2, there are multiple equilibria, since both firms select high-quality products with credible certification if $C < C_1$ or both firms select low-quality products with non-credible certification if $C > C_2$.

For $\rho > \rho_1$, region 1 is defined by $C < Min[C_1, C_2]$. For $0 \le \rho \le 1$, region 3 is defined by $C > Max[C_1, C_2, 0]$, with $C_1 < 0$ and $C_2 < 0$ for $\rho < \rho_1$.

□

The firms' choices depend on the cost of the credible certification. In region 1, for $C < Min[C_1, C_2]$, then the credible certification leading to high-quality products is selected by both sellers, because of a relatively low cost of credible certification. Conversely, a relatively high cost of credible certification deters firm(s) from using the credible certification. In region 4, namely for a cost, $C_1 < C < C_2$, then the credible certification is selected by only one seller with

the other one selecting the non-credible certification. With ρ close to one, only a few consumers are confused over the certification, which does not deter firms from differentiating the certification systems. In region 3, namely for a cost, $C > Max[C_1, C_2]$, then the credible certification is not selected and only the non credible certification leading to low-quality products is selected by both sellers. Numerous confused consumers ($\rho < \rho_1$) lead to the absence of credible certification

The confusion increases the incentive for the firm 2 to free ride the credible certification by avoiding the higher cost *C* of a credible certification compared to the non-credible certification. In region 2, there is a multiplicity of equilibria, in which either all firms select the credible certification or all firms select the non-credible certification. The related mechanism depends on the absence of individual deviation by one firm. For $C < C_1$, corresponding to $\Pi_1(1,1,1,1) > \Pi_1(0,0,1,1)$, then one firm individually chooses the credible certification when the other firm chooses the credible certification, which defines a stable equilibrium. For $C > C_2$, corresponding to $\Pi_1(0,0,0,0) > \Pi_1(1,1,0,0)$, one firm chooses the non-credible certification when the other firm chooses the non-credible certification, which defines a stable equilibrium. Thus for C such that $C_2 < C < C_1$ (in region 2), both equilibria may emerge.

This multiplicity comes from the change in the incentive to individually deviate from an equilibrium situation, because of the confusion with different choices regarding the certification. Indeed, when ρ decreases, the profits linked to the deviation move in an opposite direction since $\pi_1(\rho s_h, (1-\rho)s_h)$ decreases explaining the decrease of C_2 and $\pi_1((1-\rho)s_h, \rho s_h)$ increases explaining the decrease of C_1. In figure 1, the frontier C_2 becomes lower than C_1 since the variation of $\pi_1(\rho s_h, (1-\rho)s_h)$ in absolute value is larger than the variation of $\pi_1((1-\rho)s_h, \rho s_h)$. Note that the multiplicity only emerges because of the deviation profit that depends on the proportion $(1-\rho)$ of confused consumers. Under both equilibria in area 2, no individual deviation is profitable because of consumers' confusion.

In comparison to previous situations with confusion (for $\rho < 1$), a situation without confusion would lead to situations with a unique equilibrium (namely, for $\rho = 1$ represented by the dashed and vertical line in figure 2). For $C < \overline{C}_1$ (with $\overline{C}_1$ equal to C_1 when $\rho = 1$), the choice of high-quality with credible certification would be selected by both firms under the absence of confusion (with $\rho = 1$), while, with $\rho < 1$, the choice of low-quality products may be selected in region 2 and is selected in region 3. In such a context, there is a role for regulation that would consist to impede the non-credible certification system. Such a ban would impede the use of any certification by firms with low-quality products.

4. Conclusion

Using a very stylized framework, we showed the impact of consumers' confusion on market mechanisms.

In order to focus on the main economic mechanisms and to keep the mathematical

aspects as simple as possible, the analytical framework was admittedly simple. In order to fit different problems coming from various contexts, some extensions could be integrated into the model presented here. As the analysis was performed under duopoly, this paper can be a starting point for future research on the same issue in an oligopoly context with many firms and/or many labels possibilities reinforcing confusion and proliferation. The possibility of imperfect monitoring linked to the credible certification would reinforce the absence of high-quality as in region 3 of figure 2. The difficult/unlikely emergence of high levels of quality when numerous consumers are confused could be observed when firms may choose multiple quality levels. Eventually, the consumers' knowledge belief could be much more complex or the incentive of certifiers could be also studied.

However, despite limitations, this simple model suggests that it is especially imperative for firms or governments to examine consumers' confusion/knowledge when private or public certification systems are selected.

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