Consumer behavior under unverifiable information provided by interested parties: implications for consumer protection policies

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1. Introduction

As food products become more complex, involving key credence attributes or advanced technologies, the problem of consumer information (and choice) is becoming a key issue in the agrifood system. In the absence of perfect information or the ability to process complex information, consumers might achieve sub-optimal decisions and market failure might arise. Consequently, a public interest exists that consumers are provided with enough information to take rational decision. To this purpose, policy makers have adopted several policy tools to increase consumers' information set, such as education campaigns, banning of misleading information or labeling.

Despite of the regulator's efforts, incomplete information in food consumption is a relevant and current issue in the agrofood supply chain and a key topic in agricultural economics (e.g., Verberke 2005). This paper contributes to the extensive literature with a theoretical model describing consumer behavior, market equilibrium and public intervention in an industry where consumers must rely on the information of interested parties such as producers or associations.

The majority of the contributions in the field of incomplete information focus on the presence of unobservable characteristics (e.g., Nelson 1970; McCluskey 2000; Hobbs and Plunkett 1999). Instead, our model describes an industry with incomplete information concerning the effects of consumption. The consumers knows what product is buying, but have imperfect information regardless the consequences of such choice. A typical example of this class of products is labeled food containing genetically modified organism (GMO): their long-term effects were controversial and consumer were exposed to massive and conflicting information campaigns by life-science companies and environmental/farmer associations. Other examples can be found in the beef-hormones controversy or in the debate about nutritional properties of organic food.

The study question is relevant because of the increasing consumer awareness about the long-term impact of food consumption on health, environment and society (e.g., Wandel and Bugge 1997; Grunert, 2005; Aertens *et al*. 2009). Quite often, consumers lack the competences and the knowledge that are required to a complete assessment of such complex

issues, and they must take their consumption decisions based on information (claims) provided by heterogeneous, conflicting and interested sources. Our model shows that in this circumstance market may fail to achieve social optimum and public intervention may be socially desirable.

Labeling regulation cannot solve this class of problems, as there is no uncertainty regarding the content of the product (e.g., the presence of GMO's or hormones, fat), but consumers lack information about the consequences of consumption (on health, environment, society, ethical issues, etc.). Using the contract-theory jargon, labeling can solve *hidden type* problems (the food content) but not *hidden action* problems (the effects of consumption) (Salanié 1997).

Our theoretical model describes market equilibrium under the incomplete information assumption and it assesses the efficiency of two policy options that are available to regulators: funding education programs and supporting claims that are considered true.

2. Modeling consumer problem.

Consider an innovative product L that is a close substitute for a conventional product C. Assume that information regarding C is complete, whilst consumers cannot fully evaluate the effects of consumption of L and must rely – in this regard – on the information provided by competing, heterogeneous, and interested sources.

In this context, firms may have incentive to use information strategically. Each interested party releases information to consumers (claims) to influence consumption and increase own profits (e.g., *Rosou et. al*. 2004). Milgrom and Roberts (1986) showed that the market mechanisms are able to prevent false claims, if information is verifiable. We argue that such hypothesis in not always true, because in many cases consumers have no means to assess the truthfulness of competing claims by interested parties.

Our analysis is organized in three sections: consumer behavior, market equilibrium and policy implications. The model demonstrates that this class of incomplete information problems may lead to suboptimal consumption allocations and market failure. In section three we provide a discussion of the effects of public intervention.

In order to simplify our model we assume that consumers buy exactly one unit of either good L or C and – in the absence of public intervention – there are only two information providers: the producer of good L (FL) and the producer of good C (FC). Each firm release a strategic claim supporting its own product: FL claims that $U(L)>U(C)$ and FC claims that $U(C)>U(L)$, where $U(i)$ is the utility that a representative consumer can obtain

from consuming a unit of good *i*, with *i=L,C*. We assume that the content of the claim is exogenously determined and that only one claim is true. For simplicity, we assume that claims concern U(*L*) only, and U(C) is perfectly known. Consumers are perfectly aware of which products are buying (*C* or *L*) but they have no mean to know for sure which claim is true. We model this as an uncertainty problem, where consumers must estimate the expected utility of value of U(*L*), E(U_L). To this purpose they estimate a subjective probability that a claim *i* is true ($\hat{s}_i$) based on available information (which is provided by *FL* and *FC*) and their exogenous 'trust' in each source. Therefore consumer's expected utility from good *L* can be written as:

$$E(U_L) = \hat{s}_L U(L \mid T_L = 1) + (1 - \hat{s})_L U(L \mid T_L = 0),$$

where T_L is a binary variable that is equal to 1 if *CL* - the claim sustained by *FL* - is true and zero if *CC* – the claim by *FC* – is true. A consume choses *L* if $E(U_L) > U_C$ and *C* otherwise.

The subjective probability $\hat{s}_i = f(I, \Theta)$ is a function of *I*, the vector of available information provided by *FC* and *FL*, and Θ a measure of the exogenous trust level in each information provider, respectively.

3. Modeling market equilibrium

In order to simplify algebra and focus on the effect of information we assume that the aggregate demand for good *L* and *C* are:

(1a) $Q_c = a + \theta_c i_c - \theta_l i_l - b \cdot p_c + b \cdot p_l$

(1b) $Q_l = a - \theta_c i_c + \theta_l i_i + b \cdot p_c - b \cdot p_l$,

where *Q* are quantities, *p* are prices, *θ* are constant parameters representing the "firm trustworthiness", *i is* a measure of information such that $i = \sqrt{I}$ and the subscripts *c* and *l* refer to the conventional and innovative goods, respectively. The intercept *a* is defined as:

$$a = \frac{R_l + R_c}{2},$$

where R_l and R_c are the demand intercepts for products *L* and *C* if consumers were perfectly informed. If providing information is costly, the socially desirable allocation of information is:

$i_F = 0$ and $i_T \leq R_T/\theta_T$,

where the suffix F and T refers to the false or the true claim, respectively. The condition implies that the firm supporting the false claim does not provide information, and the firm supporting the true claim does not overprovide information.

We assume that firms' production functions exhibit constant returns to scale. Without further loss of generality we normalize firm *C* marginal cost of production to 0. The profit functions for the conventional and innovative firms are, respectively:

(2a) $\pi_c = p_c Q_c - \gamma_c i_c^2$

(2b) $\pi_l = (p_l - \Delta c) Q_l - \gamma_l i_l^2$

where γ is a parameter representing the firm's cost of providing information, and Δc is the difference in the marginal cost of production between firm C and L.

Under these assumptions, we develop a two-stage model to obtain the equilibrium prices for good *L* and *C* and the equilibrium information levels i_l and i_c. In the first stage firms compete in information, in the second stage they compete in prices. The solution of the model can be derived by backward induction.[1]

Stage 2 solution is a typical differentiated Bertrand equilibrium. Prices are strategic complements and the equilibrium prices are:

(3a) $p_l = \dfrac{3a + 2b\Delta c - \theta_c i_c + \theta_l i_l}{3b}$

(3b) $p_c = \dfrac{3a + b\Delta c + \theta_c i_c - \theta_l i_i}{3b}$

Equations (3a) and (3b) describe the optimal pricing for any given level of information i_c, i_l.

In stage 1, firms compete in information. Solving the profit maximization problem, given the pricing rules (3a) and (3b) and taking the competitor's information level as given, we obtain the following reaction functions:

(4a) $i_l^R = \dfrac{\theta_c \theta_l}{\theta_l^2 - 9b\gamma_l} i_c - \dfrac{3a\theta_l - b\Delta c\theta_l}{\theta_l^2 - 9b\gamma_l}$

(4b) $i_c^R = \dfrac{\theta_c \theta_l}{\theta_c^2 - 9b\gamma_c} i_l - \dfrac{3a\theta_c + b\Delta c\theta_c}{\theta_c^2 - 9b\gamma_c}$

[1] To simplify the model and focus our attention to the relevant issues, we assume that the model has always interior solution. This assumption implies that the range of model parameters must be defined accordingly.

Information are strategic complements if $\theta_a > 9b\gamma_a$ and strategic substitutes if $\theta_a < 9b\gamma_a$ (for a = *l, c*). For $\theta_a = 9b\gamma_a$, the equation is undefined. Equations (4a) and (4b) shows that the strategic behavior in information depends on the value of trust level (θ) relative to the information cost parameter (γ). If the firm is "trustworthy" (i.e., $\theta_a > 9b\gamma_a$), they have an aggressive information strategy (information are strategic complement), matching an increase in the competitor information level with an increase on its own. If consumers do not trust the firm (i.e., $\theta_a < 9b\gamma_a$), then they adopt an accommodating strategy and information is a strategic substitute. Noticeably, it is possible that one of the firm competes aggressively and the other is accommodating, depending on the individual values of the trust parameters.

Solving the system composed of Equations (4a) and (4b) for the two unknown i_l and i_c, we obtain the equilibrium information level, as a function of the model parameters alone:

(5a) $$i_l^* = \frac{\theta_l\left(9a\gamma_c b - 3\Delta c\gamma_c b^2 - 2a\theta_c^2\right)}{3b\left(9b\gamma_c\gamma_l - \gamma_c\theta_l^2 - \gamma_l\theta_c^2\right)}$$

(5b) $$i_c^* = \frac{\theta_c\left(3\Delta c\gamma_l b^2 + 9a\gamma_l b - 2a\theta_l^2\right)}{3b\left(9b\gamma_l\gamma_c - \gamma_c\theta_l^2 - \gamma_c\theta_c^2\right)}$$

Equations (5a) and (5b) suggest that the equilibrium information levels are determined by the demand parameters (*a* and *b*) the firms' cost structure (Δc) and by their trustworthiness (θ_c and θ_l). The trueness of the claims does not affect the result. Consequently, market incentives are not sufficient to select the true claims, consumption might be allocated differently than in the case of consumers' perfect information, and market failure may arise.

Substituting equations (5a) and (5b) into equations (3a) and (3b), we obtain the equilibrium prices:

(6a) $$p_l^{**} = \frac{\gamma_l\left(6\Delta c\gamma_c b^2 + 9a\gamma_c b - 2a\theta_c^2\right) - \Delta cb\left(\theta_c^2\gamma_l + \theta_l^2\gamma_c\right)}{b\left(9\gamma_l\gamma_c b - \theta_c^2\gamma_l - \theta_l^2\gamma_c\right)}$$

(6b) $$p_c^{**} = \frac{\gamma_c\left(3\Delta c\gamma_l b^2 + 9a\gamma_l b - 2a\theta_l^2\right)}{b\left(9b\gamma_c\gamma_l - \gamma_c\theta_1^2 - \gamma_l\theta_c^2\right)}$$

Equation (6a) and (6b) suggest that the price equilibrium is jointly determined with the equilibrium in information. The outcome of information competition has a direct impact on price and quantities and it determines the welfare distribution. If the information market fails to identify the false claim, the product market fails as well.

4. Public policies and consumer protection

The results from section 3 suggest that it exists a public interest in regulating the information market. Consumers exposed to false claims might implement sub-optimal purchasing decisions and deceiving firms might earn a rent. In this section we discuss the effect of three possible consumer-protection actions: ban on false information, subsidies on information campaign, and public statements in favor of a claim.

4.1 Ban of false information.

Assume that the government knows which of the claims is true. The obvious line of action is to ban false claims; so that consumers are exposed only to true information. Advertising and labeling regulations follow this approach. Our model suggests that such policy does not necessarily avoid market failure.

Firstly, in many instances, the government cannot exert a direct control on all information sources that are available to consumers. Thus, consumers can still be exposed to false claims and banning might not be sufficient to prevent market failure.

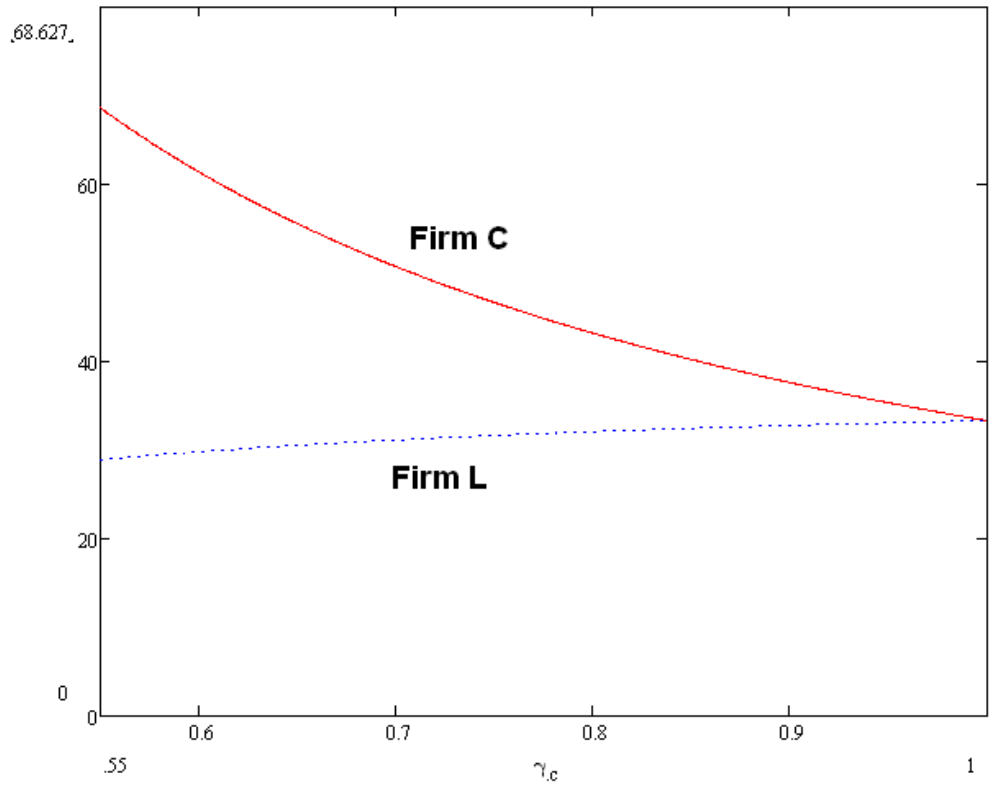
Secondly, a perfect ban on false claims does not necessarily ensure that interested parties provide correct information. Assume that the ban constrains the firm providing the false claim to set the information level to zero, meaning that the consumers are not exposed to the false claim. The market incentives are such that the competitor provides an information level that maximizes own profits regardless of the true information. Equations (4.a) and (4.b) show that the information level provided by the firm that is allowed to make a claim is not necessarily equal to $E=\frac{R_x - R_y}{2\theta_x}$, where x indicates the firm that is allowed to provide information, y indicates the firm promoting the banned claim. E is the level of information released by firm x allowing consumers to make the same consumption choice as if they were perfectly informed.

Firm *x*'s strategy is driven by an egoistic profit maximization principle. Banning the competitor in the information market simply gives firm *x* monopolistic power. Because it in not necessarily true that firm x's private optimum coincides with the social optimum, the ban does not necessarily prevents market failure.

4.2 Subsidizing information campaigns

Consider a public regulator who knows that the claim of one of the firms (say C) is true and wants to reduce the distortions due to misinformation. A possible approach is to subsidize firm C's information campaign, so that the false information is crowded out. We model this policy as an exogenous drop in the cost of providing information for the subsidized firm (γ_C).

Figure 1: Information levels as a function of the information cost of firm C (γ_c). Information supplies are strategic substitutes.



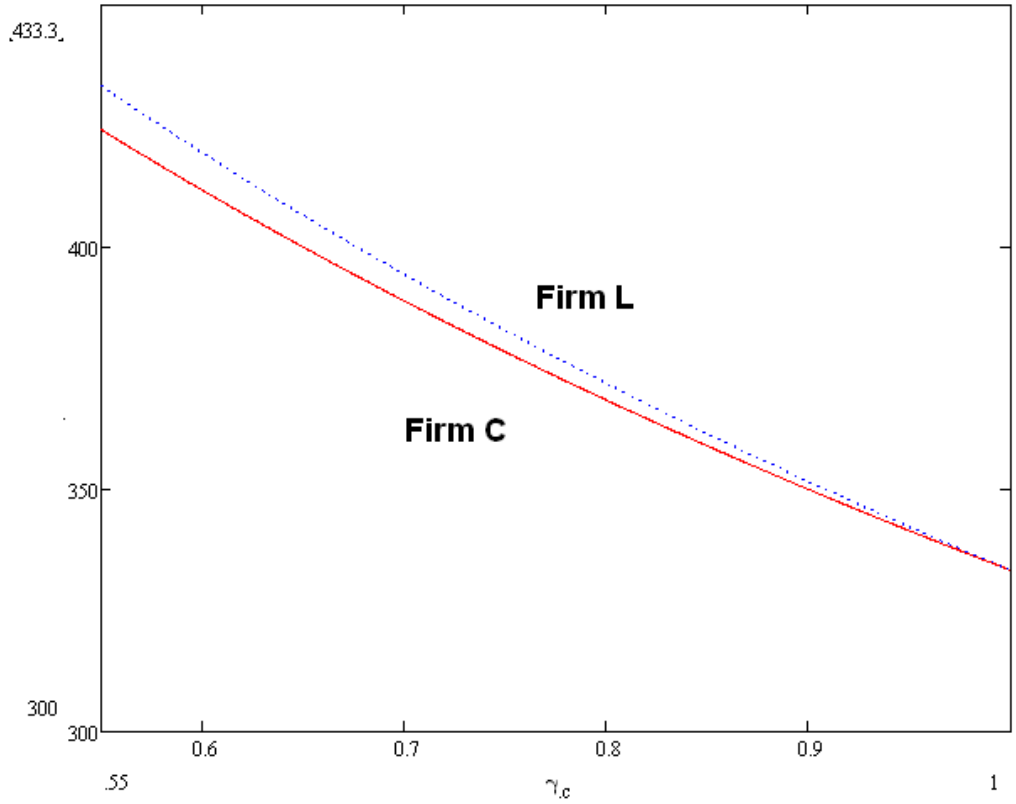
The theoretical model suggests that there are combinations of parameters such that the government intervention might have unintended consequences. We use a

numerical simulation to illustrate this point.[2] We conclude that a subsidy can reduce the release of false claims only if information are strategic substitutes (i.e., if $\theta_a<9b\gamma_a$).

Figure 1 provides an illustrative example of the effects of exogenous reductions of γ_c, under the assumption that information are strategic substitutes. In this case, firm C increases the information supply and firm L decreases it.

If information supplies are strategic complements, the outcome of the policy might be quite opposite. Figure 2 shows that firm L reacts to C's increased information supply by increasing their own information level. The final outcome of the policy is that both firms act aggressively in the information market and the false information in not necessarily crowded off. Under extreme conditions (such as in Figure 2), it is possible that firm L increases the information supply more than firm C.

Figure 2: Information levels as a function of the information cost of firm C (γ_c) . Information supplies are strategic complements.



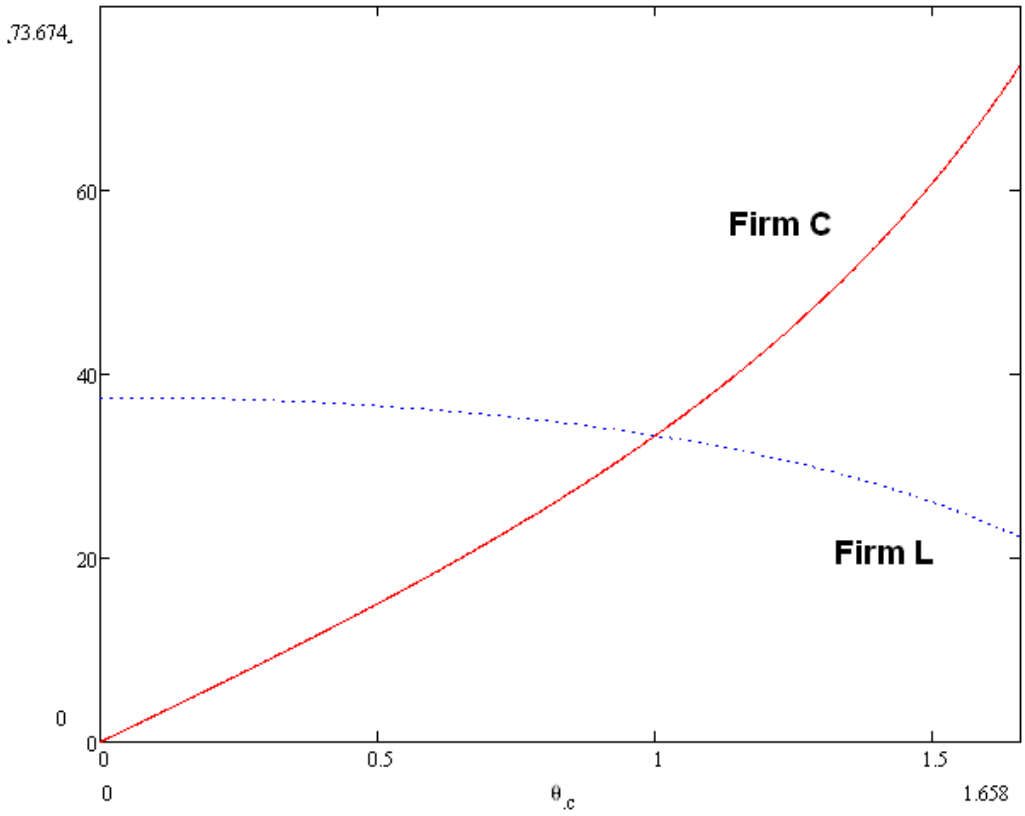
[2] Unless otherwise specified, the simulation parameters are Δc =0, b = 1, a = 100, $\gamma_c=\gamma_l$= 1, $\theta_c=\theta_l$ =1, when information are strategic substitutes or $\theta_c=\theta_l$ =10 when strategic complements. In the comparative analysis, the range of the parameters has been restricted to ensure an interior solution.

Summarizing, subsidizing information campaign reduces the quantity of false claims only if the agents have an accommodating behavior when competing in information.

4.2 Publicly supporting a claim

Public authorities can affect the outcome of information competition by supporting a claim explicitly (so that – for example – the firm can boost the claim as "approved by"). We modeled this approach as an exogenous increase in the trust parameter θ for the firm who benefits of the public support.

Figure 3: Information levels as a function of consumer trust in firm C (θ_c) . Information supplies are strategic substitutes.

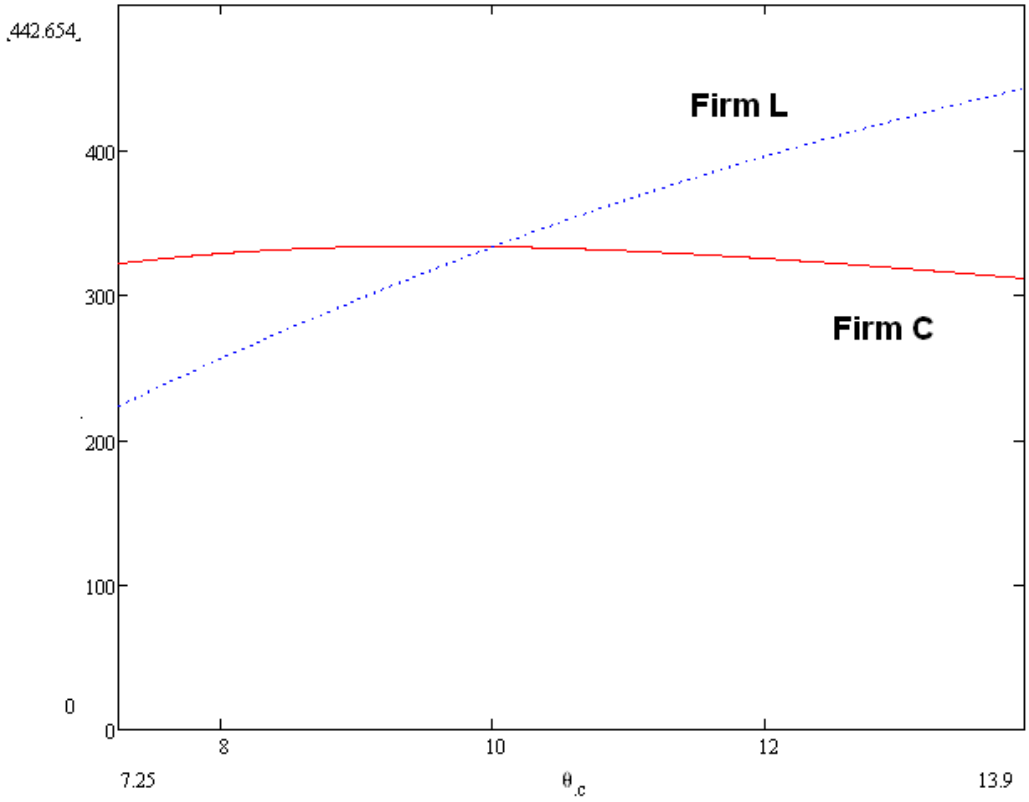


Figures 3 and 4 illustrate the outcome of the policy when information supplies are strategic substitutes or complements, respectively. In the first case, the policy successfully reduces the supply of the false claim. In the case of strategic complements, instead, it reinforces the aggressive behavior in information competition. This because it is profitable for firm L to boost the information supply to overcome the disadvantage

of the competitor's increased reputation. This result predicts massive campaigning by firm L following a public statement, in the attempt to preserve market shares.

Under extreme circumstances (such as the one represented in figure 4), firm C might find profitable to reduce the information supply, taking full advantage of the increased reputation. Our analysis supports the conclusion that is more effective to take a stance against the false claim (reducing the trust of the consumer) rather than support the true one.

Figure 4: Information levels as a function of consumer trust in firm C (θ_C). Information supplies are strategic complements.



The theoretical model shows that the outcome of information competition and public intervention is driven by the strategic behavior of the agents (aggressive or accommodating). In turn, the stance is determined by the relative value of the trust parameter θ, compared to the cost of providing information (γ). This result explains why GMO companies have given-up campaigning in favor of their product, opting for long-term, trust-building initiatives. The model shows that, unless a sufficient level of trust is

achieved, flooding consumers with information might even be detrimental as it might trigger an information war.

5 Conclusions

We develop a simple theoretical model to analyze consumer behavior and market equilibrium in industries where consumers have incomplete information about the consequences of food consumption. Policy implications are discussed using comparative statics analysis.

Our first conclusion is that the type of incomplete information we addressed can cause substantial market failure and therefore need to be considered carefully by policy-makers. Market agents may exploit consumers' the lack of information strategically, making misleading claims to bend consumers' choices in their favor. The public sector has several options available to reduce the risk of market failure and our paper outlines the implication of three possible actions: ban of false claims, subsidizing information campaign and public statements supporting claims.

The analysis concludes that policy outcome depends on model parameters. Under specified conditions, public intervention may have unintended consequences, such as increasing the spread of false claims or reducing the diffusion of true information.

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