Coexistence in GM and non-GM supply chains: public policy and private strategies. A theoretical model

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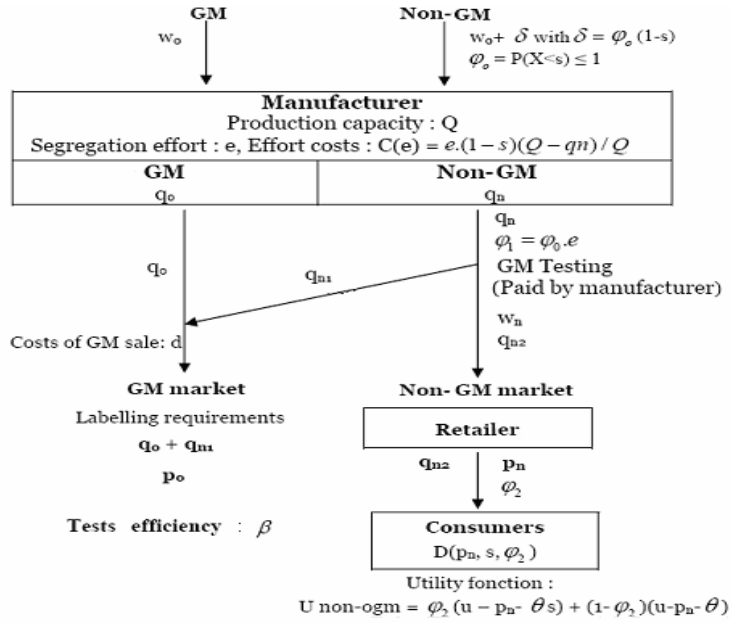
Abstract: In this paper we develop an analytical framework in order to assess the conditions of non-GM and GM products in chains. The model represents a vertical relationship with three stages in the supply chain: manufacturer, retailer and final consumers. Strategic games analysis is used to assess the impacts of private and public policies on stakeholders' trade-offs and on the GM/non-GM coexistence.

Introduction

In many works, coexistence between non-GM and GM products has been analysed at the producers' level. In our research project (integrated in the Co-Extra project), we try to assess the conditions of this coexistence at the processors' and retailers' level. A preliminary research based on empirical food chain analyses has been conducted and used to design of the following model.

1. Model of analysis

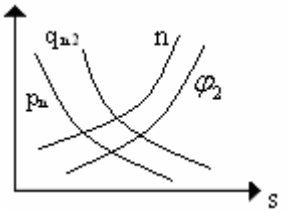
The **manufacturer** (M) is supposed to buy GM and non-GM raw materials. At this step, the non-GM product is supposed to comply with the labelling threshold *s* with a probability φ_0. As the manufacturer processes the two products inside the plant, he has to realize a segregation effort in order to reduce the "contamination" risk. The manufacturer sells the GM products on the GM market and the non-GM product to a retailer who only wants to supply the non-GM market. The retailer imposes a test before buying the non-GM product. We suppose that the test is not perfect and its efficiency depends on the sampling size. The greater this sampling size, the greater the cost of the test. The contaminated non-GM product is sold by the manufacturer on the GM market. The **retailer** (R) buys the non-GM product to the manufacturer by anticipating the demand on the non-GM final market, and sells them to the final consumers. The demand of the non-GM products by the **consumers** depends on the retail price, the labelling threshold *s* and the probability that the purity level of the marketed product is lower than *s*.

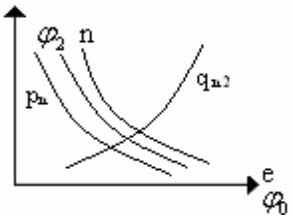


2. Results and analyses

First, at equilibrium, the quantity of non-GM products decreases in s, increases in e and φ_0; their price decreases in s, e and φ_0; the sampling size increases in s, decreases in e and φ_0.

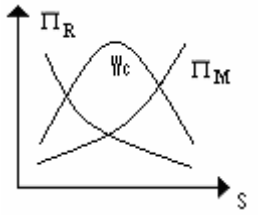
The quantity and the prices of the non-GM product depend on two mechanisms. On the one hand, when *s* increases, the non-GM demand decreases (quality effect). On the other hand, when s increases, lower production costs allow lower non-GM price and non-GM demand increases. Moreover, the retailer imposes more demanding tests which lead to a lower contamination rate and also increase the non-GM demand. As the quality effect dominates, the relation between the labelling threshold and the sold quantities is decreasing. On the contrary, when e or φ_0 decreases, the sampling size increases in order to obtain low contamination rate: non-GM demand increases. At the same time, testing costs increase: the price and demand of non-GM product decrease. As the price effect dominates, the non-GM sold quantities falls when e or φ_0 decreases.

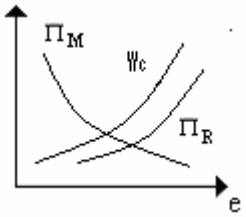


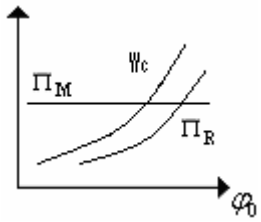


Second, at equilibrium, manufacturer's profit increases in s, decreases in e; retailer's profit decreases in s, increases in e & φ_0; and final consumer's welfares is convex in s, increase in e & φ_0.

The ***manufacturer***'s profit increases in *s* and decreases in *e* because of the increase in the effort costs and the fall of production costs given by the increase in *s*. The ***retailer***'s profit decreases in *s* because of the decrease in the non-GM price and demand. The profit is maximum for high values of *e or* φ_0: when e is high, the non-GM products price is low, but the low contamination rate has a positive effect on the consumers' demand and *vice versa*. The ***consumers***' surplus is convex in *s* because of the domination of positive effect given by the decrease in the contamination rate and the price when s is not too high and the domination of the negative effect given by the quality reduction when s is greater. The ***consumers***' surplus decreases when *e* or φ_0 decreases: the negative effect of higher price dominates the positive effect of higher contamination rate.







Conclusion

The model can highlight the opposite interests between the stakeholders regarding the labelling threshold s, the level of effort e and the purity of the raw material φ_0. The retailer and the consumers prefer strict or average labelling threshold, high effort, high φ_0 while the manufacturer prefers a slackened labelling threshold and small segregation effort.