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Abdelhakim Hammoudi, Huong Hue Nguyen, Louis Georges Soler, Aurelie Trouillier, . Joint Research Center

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

H. Hammoudi, H-H. Nguyen, L-G. Soler, et A. Trouillier
Inra LORIA - Mai 2007

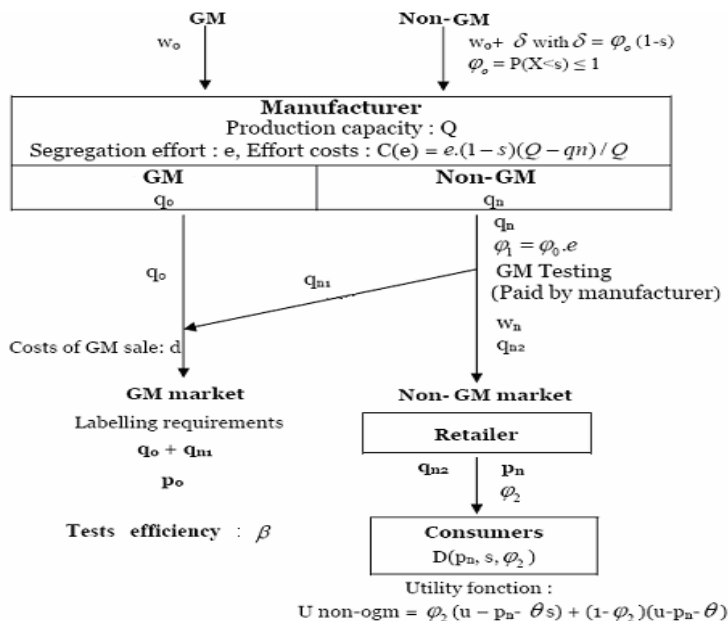
Abstract: In this paper we develop an analytical framework in order to assess the conditions of non-GM and GM products in chains. The model represents a vertical relationship with three stages in the supply chain: manufacturer, retailer and final consumers. Strategic games analysis is used to assess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



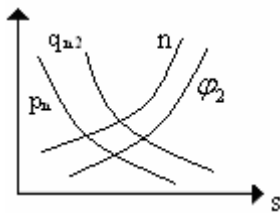
order to reduce the “contamination” risk. The manufacturer sells the GM products on the GM market and the non-GM product to a retailer who only wants to supply the non-GM market. The retailer imposes a test before buying the non-GM product. We suppose that the test is not perfect and its efficiency depends 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

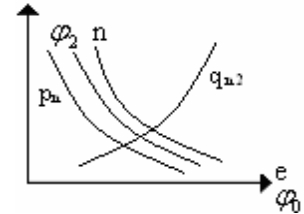
First, at equilibrium, the quantity of non-GM products decreases in s , increases in e and φ_0 ; their price decreases in s , e and φ_0 ; the sampling size increases in s , decreases in e and φ_0 .

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



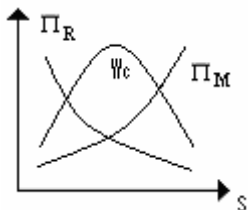
increases, lower production costs allow lower non-GM price and non-GM demand increases. Moreover, the retailer imposes more demanding tests which lead to a lower contamination rate and also increase the non-GM demand. As the quality effect dominates, the relation between the labelling threshold and the

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.

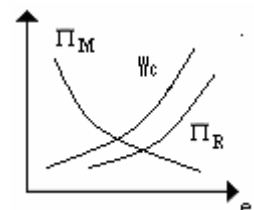


Second, at equilibrium, manufacturer's profit increases in s , decreases in e ; retailer's profit decreases in s , increases in e & ϕ_0 ; and final consumer's welfares is convex in s , increase in e & ϕ_0 .

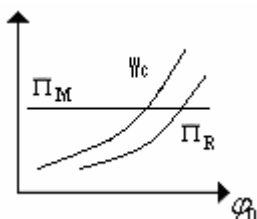
The **manufacturer's** profit increases in s and decreases in e because of the increase in the effort



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.