A simple model of voluntary vs mandatory labelling of GMOs*

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Abstract

We consider the welfare impact of the mandatory and voluntary labelling to infor consumers on GMOs content in foods. With a model of vertical differentiation in competitive markets, we evaluate the effects on price equilibrium and welfare levels. We find that the mandatory labelling scheme would be optimal in those countries with more GMO-averse consumers and no-GMOs practices producers. Voluntary labelling would instead optimally be chosen in those countries where producers are using GMOs and consumers are more concerned about the costs savings resulting in this technology adoption.

1 Introduction

In recent years, there has been a substantial amount of public discussion and concern, both at national and international level, about issues of food safety and the environmental impacts of consumer goods. One example for all exemplify the amount of attention drawn among consumers, firms, and policy-makers alike by these concerns, and that is the controversy on genetically manipulated products (GMOs). These are agricultural products in which some forms of gene splicing has occurred. Indeed genetic engineering involves the transfer of genetic information from one organism to the other to ensure traits such as insect or herbicide resistance, to improve potential yields, and to enhance nutritional or other characteristics.

Opponents of these products are concerned about the possibility that some pest-resistant traits may be spread to other less valuable plant varieties in the environment. Or that the transfer of some allergens or carcinogens may pose unknown risks to human health (Economist, 1999). Some are also worried that the use of marker genes to identify plants resistance to ampicillin may lead to antibiotic resistance (Kinsey, 1999). In addition, there are concerns about the consolidation in the control of GMOs by a small number of big patent-owners and the possible implications for consumers and family-farms (Falck-Zepeda et al., 1999).

An important aspect of the issue is that the products of concern are indistinguishable to consumers. More often that not the nutritional content is indeed not significantly different

from traditional products, and the only difference is in the technology adopted. Even when nutritional contents is indeed different, consumers may be unable to discern it. In other words, these products or production characteristics are unobservable to consumers and hence are considered credence goods (Caswell & Mojduszka, 1996).

As a consequence, there has been a lot of discussion on the appropriate forms of regulation for the production and trade of these products, and in particular on the best way to allow firms and consumers to make informed choices. In some cases opponents are even proposing a ban on these products, and the controversies span form national to international markets. Indeed, some are concerned that these disputes, away from being of relevance only to agricultural interests, may threat food security and disruptions of the global trading system as a whole (Runge & Jackson, 2000).

One aspect that has caused particular controversy is whether labelling of potential GMO products should be mandatory or voluntary. Mandatory labelling usually implies that all producers of goods presumed to be "unsound" or "unsafe" (e.g., genetically manipulated products) are requested to declare themselves as such through product labels. Some call this option "positive" labeling, since is informing consumers that a product contains GMOs ingredients. On the other hand, under voluntary labelling schemes, firms can voluntarily label their products as "sound" or "safe" (e.g., not genetically manipulated). In both cases the labelling system requires some degree of random monitoring by the government or some labelling agency in order to be credible to consumers.

The choice of mandatory vs. voluntary labelling is hence subject to considerable contro-

versy. In the case of genetically manipulated organisms, the United States has generally been in favor of voluntary labelling and recently the FDA reiterated this position. The European Union, on the other hand, together with other countries, has taken the stand for mandatory labelling. In addition, in general one may argue that consumers often favor mandatory systems, while producers prefer voluntary systems.

Related to this controversy, several questions arise. Which system is preferable under what conditions? What is the difference in effects of the two systems on the affected parties, including firms and consumers? How do the benefits or costs from the two labelling systems depend on the type of consumers (e.g., their degree of concern over product safety) and the type of firm (e.g., whether it prefers to use the "unsafe" practice or not)? What is the effect of monitoring costs?

In this paper we present a simple model which contributes to answering these questions. The model incorporates the prevailing information asymmetry between producers and consumers and we show the differences between a voluntary and a mandatory scheme. The impacts of the alternative systems on consumers and producers of different types are discussed and used to explain the observed preferences for a particular system by different groups or countries.

We then proceed to endogenize the choice of the two systems by letting it be chosen by a social-welfare maximizing government. The results are used to derive the conditions under which mandatory labeling is socially preferable over voluntary labeling and vice versa. We show that (and how) the answers to the research questions posed above depend on consumer

preferences, firms' cost structure, monitoring and labeling costs. Note that while the focus here is on GMOs, the same considerations apply to other settings, including the concern over mad cow disease in Europe, the impact of shrimp production on local mangrove ecosystems, and many more.

In the next section we review the literature on the regulation of GMOs. We then proceed to describe the model and then show the effects of the regulation on different agents. We end with the choice of the optimal system and conclude with some of the questions that are still open and need to be investigated.

2 The regulation and related literature

The issues on GMOs are sometimes overlapping with those regarding food safety in general, a topic that in the last years has gained prominence in the scientific community and policy arena. The problems and their relative analysis can be summarized in those points which concern producers, consumers, international trade and the optimal regulation.

Some studies have investigated the impact on economic welfare of the adoption of GMOs. Producers do not appear to be the only beneficiaries from their adoption, even though their expected profits increase because either plants become resistant to pests - being them insects, weeds, diseases, etc. - and hence need less chemicals or other inputs, or because they increase yields. Hence the main incentive for producers to adopt a GMOs technology would be related to the possible increased profits. But the costs savings or yields increases for producers would also translate in an increase of efficiency in the system, i.e., a reduction in market prices,

which would benefit consumers alike.

Assuming a homogeneous set of commodities, these studies consider how the distribution of benefits and costs vary among different agents - consumers, producers and GMO-patent firms - and different countries, according to the rate of technology adoption and protection of intellectual property rights. As it is emerging, GMOs crops are cultivated mainly in the US, Canada and Argentina, with the lion's share for soybeans, corn and cotton. In a situation with protected property rights, most of the benefits would go to the innovator, to consumers and to producers (Moschini, 2001)

But these studies consider a simplified setting, that is a world where there are no risks, informational asymmetries, etc. But the reality is that consumers in many countries have strongly manifested their opposition to GMOs products. The fact is that consumers are worried by health risks, such as allergies to new proteins and antibiotic resistance. They oppose GMOs on ethical principles, arguing against unnatural genetic manipulation. A strong case is also made by those who fear unknown long-term health impacts (Hobbs & Plunkett, 2000). In other words, consumers demand to be protected based on their right to know and governments try to deliver on it.

Few would argue that markets are efficient in ensuring optimal resource allocation in the case of GMOs products, as they are recognized as being an example of credence goods, goods whose quality is difficult to ascertain by consumers both before and after consumption. As such they would need some forms of intervention in order to correct market failures due to information asymmetry.

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The relevant question is in fact which is the optimal regulation of GMOs products use and trade. The positions and the solutions proposed are very different. For example, some firms are voluntarily certifying that their products are GMO-free. Some retailers are banning all food items with any GMO-based ingredient and selecting suppliers accordingly. Many countries are thinking about restricting or banning imports of GMOs commodities. The European Union has already enforced a mandatory labeling regime, soon to be followed by other major countries. Indeed, the dimension of the problem is now international, with the GMOs products being seen as an example of the risks associated with globalization and the controversy about their trade as an opportunity to oppose trade liberalization.

The main controversy is now regarding the use of labeling, and in particular whether it should be mandatory or instead on a voluntary basis. One can easily summarize the literature by noting that in the majority of studies emerge that voluntary labelling would be better for economic welfare. The main argument is "let the market decide" (Sheldon, 2000). And this would be right both in a country-by-country case and for international trade.

The need to enforce labelling or minimum safety standards emerges when one consider food safety problems in a situation of asymmetric information and credence goods. Using a two-period model and a monopolistic market, Marette et al (2000) show that the optimal regulation is represented by voluntary labelling together with third party monitoring. Crespi & Marette (2000), studying how food safety should be financed in a single period model, find the advantage of a voluntary labeling financed with a per-unit fee that maintains competition among safe sellers. Indeed, a voluntary scheme would be sufficient, i.e., better, when there

is more than one seller, whilst a mandatory scheme would be needed with a monopolist.

A parallel but less formal strand of literature argues against mandatory labelling enforced in the international arena. One reason, for example, is that the costs of mandatory labeling would be higher because of the need to segregate, when the benefits of it would be similar to those of voluntary labeling and only for part of consumers (Caswell, 1998). But costs would come after what governments perceive as the rights of consumers to know, at least in those countries where concerned consumers are numerous. For this reason one should expect in the future to see both countries with mandatory and voluntary labeling (Caswell, 2000).

Arguing that voluntary (referred as negative, in the sense that it says that "this product contains no-GMOs") labelling is to be preferred, Runge & Jackson (2000) recognize that the information provision through labelling is a form of public good and governments ought to share responsibility for its implementation. In addition, they argue for an harmonization effort by supranational bodies, e.g., FAO, to ensure a common system of labelling to be enforced at the WTO level.

But while the economic analysis is relatively unanimous in arguing for the superiority of the voluntary approach to labelling, the fact is that in the policy arena the issue is controversial and only few countries, indeed those with the majority of GMOs planted acreage, are in fact enforcing voluntary labelling. One has to consider indeed differences in consumers and producers interests in different countries to explain these different positions.

In this regard, Giannakas & Fulton (2001), in a paper that is relatively close to the one we propose, takes explicitly into account the heterogeneity in consumers' preferences and the

different costs they may face with diverse policy options. In this fashion, they can rationalize the requests for a ban on GMO-based commodities when these are perceived as different. In addition, they can rank the no-labelling to the mandatory labelling policy according to the degree of aversion to GMO-food, the segregation costs, the share of GMO markets and the extent of mislabelling.

They do not consider though the choice of mandatory vs voluntary labelling. In this paper we tackle exactly this question, taking explicitly into consideration differences in consumers' preferences, costs of different policy options, and the distribution of benefits and costs to different interests in an international setting. Our purpose in indeed to show a model that can explain the different positions in the policy arena and be the basis for some welfare comparisons and policy evaluations.

3 The model

Suppose that a given agricultural commodity, e.g., soybeans, can be produced either with Genetically Modified Organisms (GMOs) or with a more traditional technology, i.e., GMO-free seeds and agronomic practices. There are two types of firms, with each type corresponding to these two options and having different production costs. The GMO-based firms have unit costs of production equal to c_u, whilst the GMO-free firms have unit costs of production of c_s. [1] We assume that the use of GMOs allows producers to reduce their production costs, i.e., $c_s > c_u$.

[1] Here s stands for "sound" or "safe" to indicate also that this model is more general and applies to a whole range of issues other than GMOs, such as environmental labelling, child labour-free clothing, etc.

We also assume that within each group of firms there is perfect competition, so that the market price will be determined only by marginal costs. With these latter - as we will see below - we include production costs as well as labelling costs and segregating costs. Although under this assumption profits are zero, firms prefer higher to lower market shares.

There is a continuum of consumers, each of which buys one unit of the good. They all value the basic utility from the good as a, and for simplicity we assume that $a = c_u$. However, consumers also value - to varying degrees - the fact that a product is GMO-free. Let this valuation be given by θ and let θ be uniformly distributed across consumers within the interval $[0, \overline{\theta}]$.

Let P_s^i denote the price of sound, i.e., GMO-free, products, where $i \in \{m, v\}$ and "m" denotes a mandatory labelling system, whilst "v" a voluntary labelling regimen. Similarly, P_u^i denotes the price of GMO-based products. Consumers' utility, in monetary terms, from buying a GMO-based product is thus $U_u^i = a - P_u^i$, and that from buying a GMO-free product is $U_s^i = a + \theta - P_s^i$.

Thus, for given prices, consumers buy GMO-free products if $U_s^i = a + \theta - P_s^i \geq a - P_u^i = U_u^i$ and they buy GMO-based products otherwise. Hence, we have that consumers with $\theta \geq P_s^i - P_u^i$ buy the GMO-free good and those with $\theta < P_s^i - P_u^i$ buy the GMO-based good. Note however that in the absence of a credible labelling system, the two types of products are indistinguishable to consumers.

4 Creating a labelling system

4.1 Voluntary labelling

With voluntary labelling, GMO-free firms can distinguish themselves from GMO-based firms through labelling. However, the labelling has to be credible to consumers. Therefore, the GMO-free firms have to build up or support a third-party labelling Agency which monitors those firms which use the "GMO-free" label. In this simple model, it is assumed that the system is structured in such a way that monitoring and fines ensure perfect compliance.

We assume that the labelling, i.e., monitoring costs, are borne by the firms which use the label. The amount is C per unit of labeled product, that is we use the optimal financing method (Crespi & Marette, 2000). The new prices in the resulting market equilibrium are then the following: $P_u^v = c_u$ and $P_s^v = c_s + C$.

With voluntary labelling, consumers with $\theta \geq \widehat{\theta}$, where $\widehat{\theta} = P_s^v - P_u^v = c_s - c_u + C$ buy the GMO-free product. Their utility is $U_s^v = a + \theta - c_s - C$. On the other hand, consumers with $\theta < \widehat{\theta}$ buy the unlabeled or GMO-based product receiving an utility of $U_u^v = a - c_u$.

4.2 Mandatory labelling

In the case of mandatory labelling, the government requires all GMO-based products to be labelled as such. To make the system credible, the government has to set up a system composed of monitoring and fines to assure compliance. Assume that the total cost of this system is the same as under the voluntary system, but that now this cost is paid by the government, which raises the funds by levying a tax on all consumers for an amount t. Or,

equivalently, the costs are paid from existing tax revenues which are then not available for financing of other public goods. And given that the monitoring costs are now distributed among all consumers, we have that $t < C$.

The prices resulting in the market equilibrium with mandatory labelling are now the following: $P_u^m = c_u$ and $P_s^m = c_s$. In this case, consumers with $\theta \geq \widetilde{\theta}$, where $\widetilde{\theta} = P_s^m - P_u^m = c_s - c_u$ buy the GMO-free (unlabeled) product and their utility is $U_s^m = a + \theta - c_s - t$. On the other hand, with mandatory labelling, consumers with $\theta < \widetilde{\theta}$ buy the products labeled as "GMO-based", with an utility of $U_u^m = a - c_u - t$.

5 Welfare effects of the labelling system

As introduced above, the purpose of the paper is not to give an exact measure of the welfare effects of the different labelling systems but rather to formally show how and why we believe these systems have a different impact of different groups of firms and consumers, so to explain the different positions on which system to enforce in the policy arena. We then offer a preliminary analysis of the welfare effects of the two systems on the different agents involved.

5.1 GMO-free firms

Under a mandatory system, the sound or GMO-free firms attain a higher market share than under a voluntary system, since $\widetilde{\theta} < \widehat{\theta}$. Thus they prefer the mandatory system, also because it does not make them to pay all the costs from distinguishing themselves from the GMO-based firms which they incur when having to set up a third-party labelling system under a

voluntary system. Note that these firms are more common in Europe than in the US.

5.2 GMO-based firms

With the same reasoning, one can show that GMO-based firms have higher market shares under a voluntary system. This is because such a system imposes all monitoring costs on GMO-free firms, making their products more costly (beyond the price difference caused already by the higher production costs).

These higher costs induce some consumers to buy GMO-based products, those same consumers that under a mandatory system would prefer GMO-free products. Note also that these firms are more common in the US.

5.3 "Green" consumers

We may recognize that there are some consumers that would buy GMO-free products under both systems, those who in our model would have $\theta \geq \widehat{\theta}$. These consumers prefer the mandatory system because the utility under such a system, $U_s^m = a + \theta - c_s - t$, is strictly greater than that under the voluntary system, $U_s^v = a + \theta - c_s - C$, since $C > t$. The intuition is that a voluntary system passes all monitoring costs onto consumers of GMO-free products, while a mandatory system spreads the costs equally across all consumers, and potentially to other taxpayers which do not even consume the product at all.

The position of these consumers can be best summarized with the following argument: "GMO-based firms are already saving on production costs and they should not receive an additional advantage by making it harder for the good guys". These consumers are more

easily found in Europe, where a more pessimistic view of technology progress is quite common in intellectual circles and media.

5.4 GMO consumers

One has also to recognize that a proportion of consumers do not value "Gmo-freeness" per se enough to induce them to buy GMO-free products under either system, and these are the consumers with a preference parameter $\theta < \widetilde{\theta}$. These consumers prefer the voluntary system, since $a - c_u > a - c_u - t$.

They indeed pay the same price for the good under both systems, but under the voluntary system they do not have to bear the costs of the monitoring efforts. Their position will be like "If the green consumers think that GMO-freeness is so important to them, then they should pay for the cost of distinguishing these products. We do not care about whether they are one way or the other, so we should not pay for the distinction". These types are more common or more heard in the US.

5.5 "Borderline" consumers

For a good part of consumers, those with a preference parameter such that $\widetilde{\theta} \leq \theta < \widehat{\theta}$, purchasing decisions are very sensitive to prices. Indeed, they do not buy products labeled as GMO-based under a mandatory system, but given the higher price of GMO-free products under a voluntary system, they would opt for GMO-based products.

These consumers prefer the mandatory system if and only if their utility under that system is higher than that under the voluntary system. That is to say, only if $U_u^v = a - c_u <$

$a + \theta - c_s - t = U_s^m$, which implies that $\theta \geq t + (c_s - c_u) \equiv \theta^*$. We know that they satisfy $\widetilde{\theta} \leq \theta < \widehat{\theta}$ and this implies that $c_s - c_u \leq \theta < c_s - c_u + C$.

Since $t < C$, the critical value θ^* will lie within this interval. Thus, we can split them up into two groups. Those with $\widetilde{\theta} \leq \theta < \theta^*$ prefer the voluntary system, while those with $\theta^* \leq \theta < \widehat{\theta}$ prefer the mandatory system.

6 Concluding remarks

The controversy over which labelling system, either voluntary or mandatory, is to be preferred is igniting debates in the policy arena. Indeed, while economic analysis seems to prefer the former, in reality many countries, e.g., Europe, Australia, New Zealand, Japan actually have chosen the mandatory one.

In this paper we explicitly model the choice between the two systems, taking into account differences in consumers' preference and implementation costs. We find that the superiority of one system over the other depends on the relative importance of different groups of producers and consumers. We indeed find that mandatory labelling may result welfare superior in those countries where highly GMO-averse consumers are prevalent and producers are using mainly a no-GMOs technology. On the other hand, when consumers are not strongly averse and prefer the price reduction associated with GMOs and producers mainly adopted GMOs technologies, a country optimally prefers to enforce a voluntary labelling system.

The model presented in this paper is very simple, yet it captures some of the main aspects of the problem and explains what one actually observes in reality. One could extend

the analysis to consider differences in total monitoring costs under the two systems, which would likely reinforce the results presented here. In addition, to be more realistic, one should consider the endogeneity of the type for the firms. We assume that producers' type is given, when producers can in fact decide whether to adopt GMOs technology or not. One could also consider imperfect monitoring and see whether it can effect market equilibrium.

Even with the above mentioned and other extensions, we believe that this simple model is only a first attempt to answer these topical policy questions. Important matters remain untouched. For example, many believe there is a need for harmonization of a world trading system in which different systems coexist. Others think that mandatory labeling could be detrimental to GMOs market development, while a voluntary approach would be less "punitive" and would help emerging the preferences of all consumers, concerned and unconcerned. We believe that these are important issues that deserve more research and modelling efforts.

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