Economic effects of European GMO Labeling policy

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Abstract
Consumer preferences and GMO legislation in the EU creates the need of a marketing channel preserving the identity of non-GMO soybeans from the farm level to the consumer level in exporting countries like the US. The paper discusses in detail how farmers decision changes with this new situation.

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1. Introduction

Public opinion in the European Union (EU) is currently strongly opposed to genetically modified organisms (GMOs). As a consequence, EU commercial production of transgenic crops remains almost nonexistent, and imports of GMO products from other countries are challenged by two types of regulations. First, the EU has adopted a lengthy process for approval of GMO varieties. Second, the EU has introduced a mandatory labeling system to inform consumers about the presence of GMOs in food products. Beside, food processors and distributors are already encountering economic incentives, created by consumer demand, to provide labeling for GMO free products.

Though there is a growing literature on economic effects of the introduction of GMO crops (e.g. Falck-Zepeda, Traxler and Nelson, 2000; Moschini, Lapan and Sobolevsky, 2000; Bullock and Nitsi, 2000) this study contributes in two ways: First, it explicitly accounts for the fact that parts of consumers strongly prefer GMO free products, i.e. products that do not have any GMO as ingredient at any stage of the production process. So far, rejection of GMO products by some part of consumers and the implied necessity of market segregation is only considered by Mayer and Furtan (1999) in a graphical analysis for the case of herbicide-tolerant canola in Canada. Second, since there is this strong rejection from parts of the consumers there is a need of market segregation at all stages of production. Hence, in opposite to the prevailing literature we explicitly model GMO and conventional soybeans as two distinct commodities.

The study is organized in the following way. The next section discusses how the EU's soybean market is affected by the introduction of herbicide resistant soybeans and

by consumer reservation against products containing GMO ingredients. It is shown that the circumstance that at least some consumer have preferences for GMO-free products combined with the recent legislation on labeling splits the soybeans market into two seperates markets, one for GMO-free soybeans and one for conventional soybeans, the market for conventional soybeans containing both GMO and non GMO soybeans. Section 3 analyses the impacts of these developments for an exporting country like the US. Starting at the individual farm level we discuss in detail who producers decision changes with market segregation between GMO-free and conventional soybeans.

2. Impacts of the introduction of genetically modified soybeans on the EU soybeans market

2.1 Situation before the introduction of GMOs

A theoretical model that illustrates the EU soybeans market before the introduction of GMO soybeans is shown in Figure 1. Domestic supply curve is S_d and Rest of the World's (ROW's) excess supply (supply minus demand) is S_r, adding up to total supply of soybeans within the EU of S_t. Since S_r illustrates the supply of soybeans of the ROW to the EU it includes not only cost of soybeans production, but also cost of handling and transportation. Domestic demand is given by D_d implying an equilibrium soybean price in the EU of P_t, a domestically produced quantity of Q_d, imports of Q_r and a total demand of $Q_t = Q_d + Q_r$.

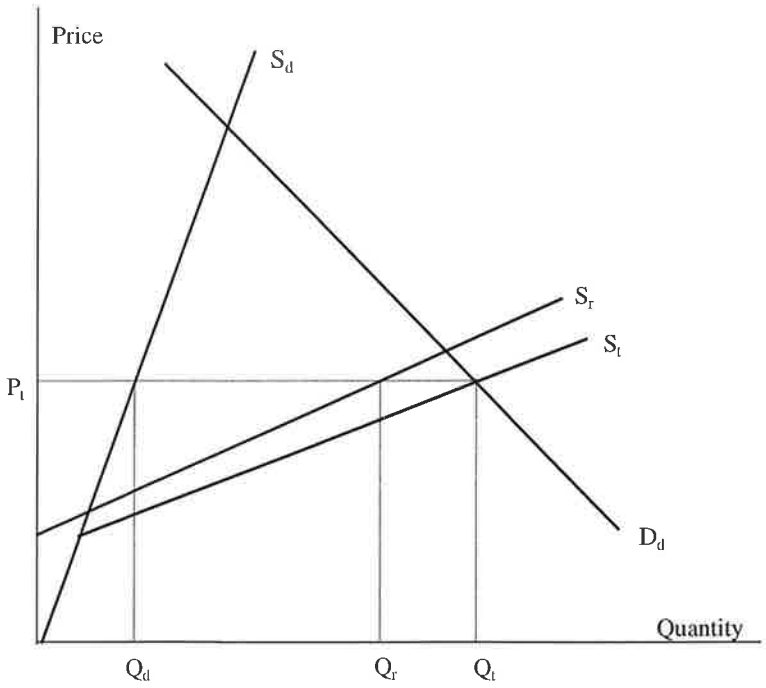

Figure 1: The EU soybeans market before the introduction of GMOs.

2.2. Situation after the introduction of GMOs

Herbicide resistant soybeans are a cost-reducing technology at least for some farmers (Bullock and Nitsi, 2000). Hence, adoption of this new technology will reduce aggregate marginal and average cost (as explained in more detail in Section 3). Hence, initial supply curves, as depicted in Figure 1, may pivot to the right as illustrated in Figure 2.[1]

[1] If the introduction of GMO soybeans is better described as a parallel of pivotal shift of the supply function would need some further investigation. That different assumptions on the kind of shift implied by the introduction of a new technology can lead to quite different estimates of the welfare implications is extensively discussed in the literature (e.g. Lindner and Jarett, 1978; Miller, Rosenblatt and Husak, 1988). However, concentrating on price and quantity effects in this theoretical expositions a pivotal shift seems reasonable.

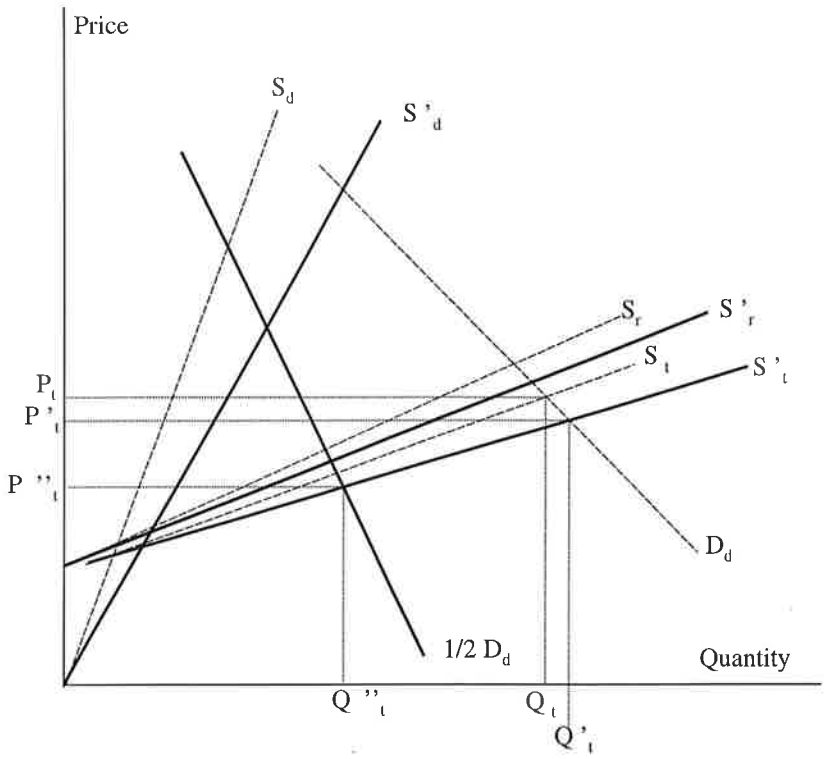

Figure 2: The EU soybeans market after the introduction of GMOs.

If consumers have no preferences for GMO or non-GMO soybeans (or meat produced by feeding GMO or non-GMO soybeans) the new equilibrium price will be where the new total supply curve S_t (now including GMO as well as non-GMO soybeans) intersects the total demand curve D_d implying a higher quantity demanded Q'_t (instead of Q_t) at a lower price P'_t (instead of P_t). Obviously, consumers would gain while producers fate is an empirical question.

Given the negative public perception of genetically modified food products in the EU it can be assumed that at least some consumers have preferences for food which is demonstrable free of GMO ingredients. Nevertheless, one can expect that demand for

GMO-free products depends not only on its own-price, but also on the price of soybeans containing GMOs (and vice versa). That means, that consumers are willing to pay more for GMO-free products, but only to a certain extent. However, for the sake of simplicity here we assume that demand for GMO-free soybeans and soybeans containing GMOs are strictly separable, i.e. that consumers preferring GMO-free products strictly refuse to buy products with GMO ingredients and all other consumers are strictly indifferent between GMO-free and GMO products and hence will always buy the cheaper one.

If GMO soybeans are adopted to some degree in the whole world and there is no segregation between GMO and non-GMO soybeans possible, consumer reservation would shift domestic demand from D_d to for example 1/2 D_d implying a lower price P''_t as well as a lower quantity Q''_t demanded. Obviously, this would have a negative welfare effect on domestic and foreign producers. Furthermore, those part of consumers who refuse to consume food containing GMOs are also negatively affected since their set of choices is reduced. Only consumers with no preferences for GMO-free food will gain.

2.3 Situation with labeling policy

Observing strong reservations of EU consumers has led to two reactions: First, a mandatory labeling system to inform consumers about the presence of GMOs in food products was recently approved. Besides, one can also observe a voluntary abstention from using GMOs and an accompanying voluntary labeling of GMO-free products of

food processors and distributors.[2] Second, commercial approval of GMOs have been slowed down or suspended indefinitely like for example for Bt corn in Germany very recently (Agrar Focus, 03/2000, p. 41).

Given these developments one may illustrate the soybeans market in the EU as one splitting up to two separated markets, one for identity-preserved, GMO-free soybeans (left hand panel in Figure 3) and one for conventional soybeans, including soybeans from GMO seed as well as from conventional soybeans seed (right hand panel). For simplicity we assume that domestic demand splits up into two equal parts. Since production of GMO soybeans in the EU is currently almost inexistent, we consider that GMO soybeans are only adopted in the ROW, implying a shift from S_r to S'_r, while the EU's supply function remains untouched. Moreover we assume that domestic supply S_d can be signaled as being GMO-free without any additional segregation cost while supplying identity-preservation in the ROW causes some additional cost. Assuming for the moment that these additional cost are too high, domestic supply would feed the demand for GMO-free soybeans, while ROW excess supply can only be offered to consumers with no preferences for GMO-free products. This would imply a high price for identity-preserved soybeans (P_h on the left hand panel of figure 3) and a low price for conventional soybeans (P_l on the left hand panel of figure 3), leaving EU producers and EU consumers with no preferences for GMO-free products better off and ROW producers and consumers refusing to consume GMO products worse off.

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[2] A recent example is the announcement of the important French food chain "Carrefour" to supply only pork and poultry from animals that are fed with GMO free soybean meal. The necessary 180 000t soybeans

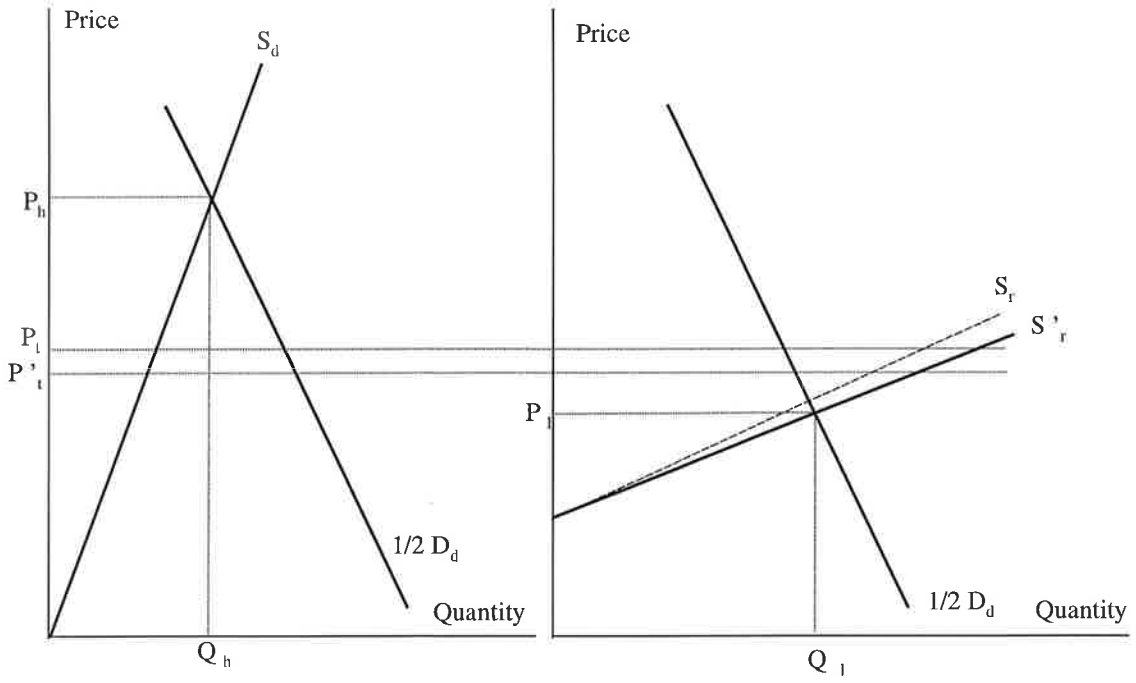

Figure 3: EU soybeans market with no segregation possible in the ROW

However, if there is a demand for GMO-free products that can only be served by EU production at a high price, the ROW will possible try to segregate at least some part of their non-GMO soybeans production as GMO-free.

3. Impacts of the introduction of genetically modified soybeans on the soybeans market in an exporting country

The preceding section has presented the price and quantity outcome in the EU, in the case where a fraction of demand for soybeans is only for GMO-free soybeans and where

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will be imported from controlled production in Brazil (Agra-Europe, 2000).

countries allowing GMO soybeans are not able to supply GMO-free soybeans. We now turn to an exporting country allowing GMO soybeans, in order to analyze the effects of the creation of a marketing channel preserving the identity of non-GMO soybeans from the farm level to the consumer level. This marketing channel is called "identity-preserved" marketing channel, and noted as *IP*.

In order to analyze the price and quantity effects following from the creation of this IP channel, it is necessary to understand the determinants of adoption of GMO and non-GMO soybeans, and how they are modified by identity preservation. Therefore, section 3.1 describes the outcome in the absence of market segregation, while section 3.2 describes the outcome in the presence of an identity preserved marketing channel.

3.1 Situation in the absence of segregation of GMO and non-GMO products

Currently commercialized GMO soybeans are soybeans resistant to glyphosate. Use of these GMO soybeans reduces some costs compared with non-GMO soybeans (Bullock and Nitsi, 2000). First, glyphosate is a relatively inexpensive herbicide effective on a broad range of weeds. Therefore, if GMO soybeans are planted glyphosate replaces more expensive and selective herbicide cocktails. Second, because glyphosate is easy to use, glyphosate resistant soybeans save management cost. Since most nonglyphosate herbicides are relatively selective in the weeds they can control, use of these herbicides requires farmers to scout fields and identify weed types, and often mix and spray a number of different kinds of herbicides. Because glyphosate controls a broad spectrum of weeds, it can be relatively easy to use, and scouting and identifying weeds becomes less

important. Third, glyphosate can kill larger weeds than nonglyphosate herbicides, which provides farmers spraying postemergence herbicides with a larger time window. At the same time, GMO soybean seeds are provided by biotechnology and seed companies charging a higher price than for non-GMO seeds.

Because of differences in for example weed situations, weather and management practices from one farm to another, some farmers may find it more profitable to use GMO seeds while others may find it more profitable to use non-GMO seeds (Bullock and Nitsi, 2000). At the farm level, the decision to adopt or not adopt GMO soybeans is a result of the comparison of unit profits obtained from planting GMO soybeans and unit profits obtained from planting non-GMO soybeans.

This is illustrated in Figure 4 and Figure 5 for two types of farms. Farms of type A are farms for which adoption of GMO soybeans decreases marginal costs (for example, their fields are exposed to weeds which Roundup controls very effectively or their weed problem is very small). Farms of type B are farms for which adoption of GMO soybeans increases marginal costs (for example, their fields are exposed to weeds which Roundup does not control very effectively). If the farm level and the handling level are considered as vertically integrated, the marginal cost curves represented in Figure 4 and Figure 5 can be viewed as marginal cost curves for supplying handled soybeans. The figures are represented for given input prices aggregated in a vector w^0.

Two farms of type A (i.e., farms for which adopting the GMO technology decreases marginal costs) are represented in Figure 4: a farm A1 (left hand panel), and a farm A2 (right hand panel). Marginal cost curves of non-GMO soybeans (noted n) are represented

by doted lines, while marginal cost curves of GMO soybeans (noted g) are represented by plain lines. Changing from non-GMO soybeans to GMO soybeans shifts marginal cost curves of production of (handled) soybeans from $MC_n^{A1}(q_n, w^0)$ to $MC_g^{A1}(q_g, w^0)$ for farm A1, and from $MC_n^{A2}(q_n, w^0)$ to $MC_g^{A2}(q_g, w^0)$ for farm A2, where q_n and q_g are the quantity of non-GMO soybeans and GMO soybeans, respectively. The decrease in marginal costs following from the adoption of the GMO technology is higher for farm A1 than for farm A2.

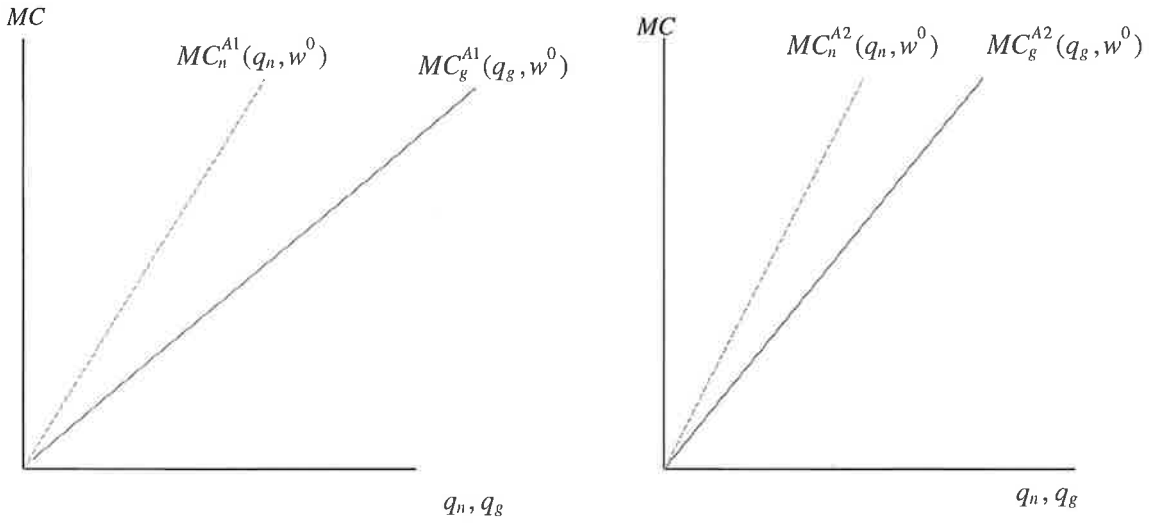

Figure 4: Marginal cost curves of farms A1 and A2

Similarly, two farms of type B (i.e., farms for which adopting the GMO technology increases marginal costs) are represented on Figure 5: a farm B1 (left hand panel), and a farm B2 (right hand panel). Using GMO soybeans instead of non-GMO soybeans shifts the marginal cost curves of soybean production from $MC_n^{B1}(q_n, w^0)$ to $MC_g^{B1}(q_g, w^0)$ for

farm B1, and from $MC_n^{B2}(q_n, w^0)$ to $MC_g^{B2}(q_g, w^0)$ for farm B2. The increase in marginal costs following from the adoption of GMO technology is higher for farm B1 than for farm B2.

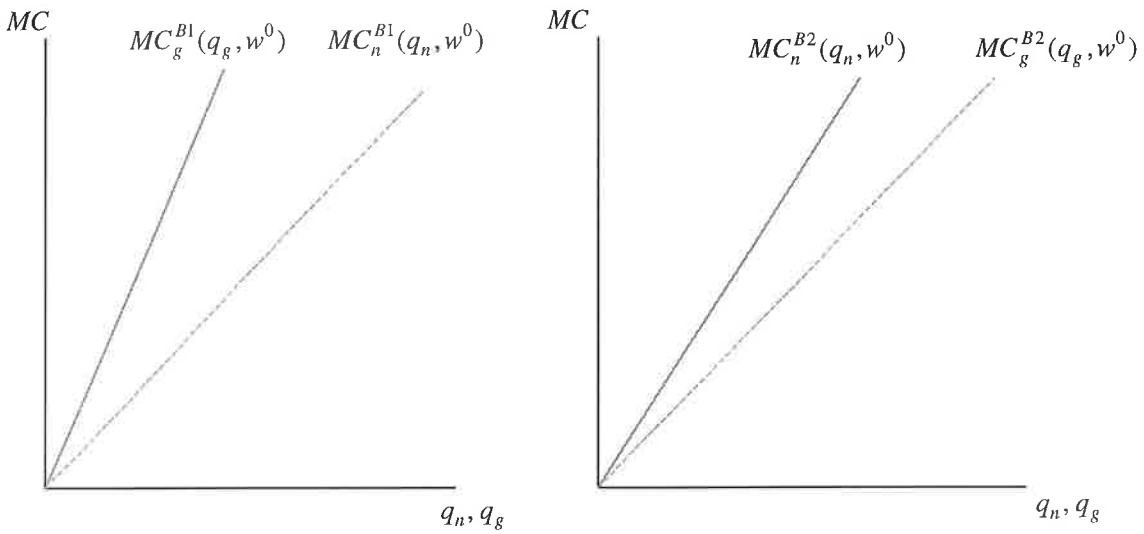

Figure 5: Marginal cost curves of farms B1 and B2

In the absence of segregation, GMO and non-GMO (handled) soybeans obtain the same price. Therefore, farms of type A will supply GMO soybeans. Hence, supply of GMO soybeans by a farm of type A is a function of the equilibrium price of handled soybeans, p, and of the equilibrium vector of input prices, w^0. The supply curve of farm A1, $S_g^{A1}(p, w^0)$, is identical to the marginal cost curve $MC_g^{A1}(q_g, w^0)$ in Figure 4. Likewise, the supply curve of farm A2, $S_g^{A2}(p, w^0)$, is identical to the marginal cost curve $MC_g^{A2}(q_g, w^0)$. On the contrary, farms of type B always supply non-GMO

soybeans. In Figure 5 the supply curve of farm B1, $S_n^{B1}(p,w^0)$, is identical to the marginal cost curve $MC_n^{B1}(q_n,w^0)$, while the supply curve of farm B2, $S_n^{B2}(p,w^0)$, is identical to the marginal cost curve $MC_n^{B2}(q_n,w^0)$.

At the aggregate level, the supply of GMO soybeans is equal to the sum of individual supply curves of farms of type A, while the supply of non-GMO soybeans is equal to the sum of individual supply curves of farms of type B.[3] A possible outcome is illustrated on the left hand panel Figure 6, representing the domestic soybean market (which scale is different from Figures 4 and 5). The aggregate supply curve of GMO soybeans is equal to the sum of individual supplies by farms of type A, $\sum_{Ai} S_g^{Ai}(p,w^0)$. The aggregate supply curve of non-GMO soybeans is equal to the sum of individual supplies by farms of type B, $\sum_{Bi} S_n^{Bi}(p,w^0)$. Total supply of soybeans, $S_t(p,w^0)$, is equal to the sum of these two curves.

On the left hand panel, the domestic demand curve is $D_d(p)$. On the right hand panel, $S_X(p,w^0)$ is the excess supply of handled soybeans (equal to the difference between curves $S_t(p,w^0)$ and $D_d(p)$) and $D_X(p)$ is the excess export demand curve. The equilibrium price of handled soybeans, p_e, is determined by the intersection of $S_X(p,w^0)$ and $D_X(p)$.

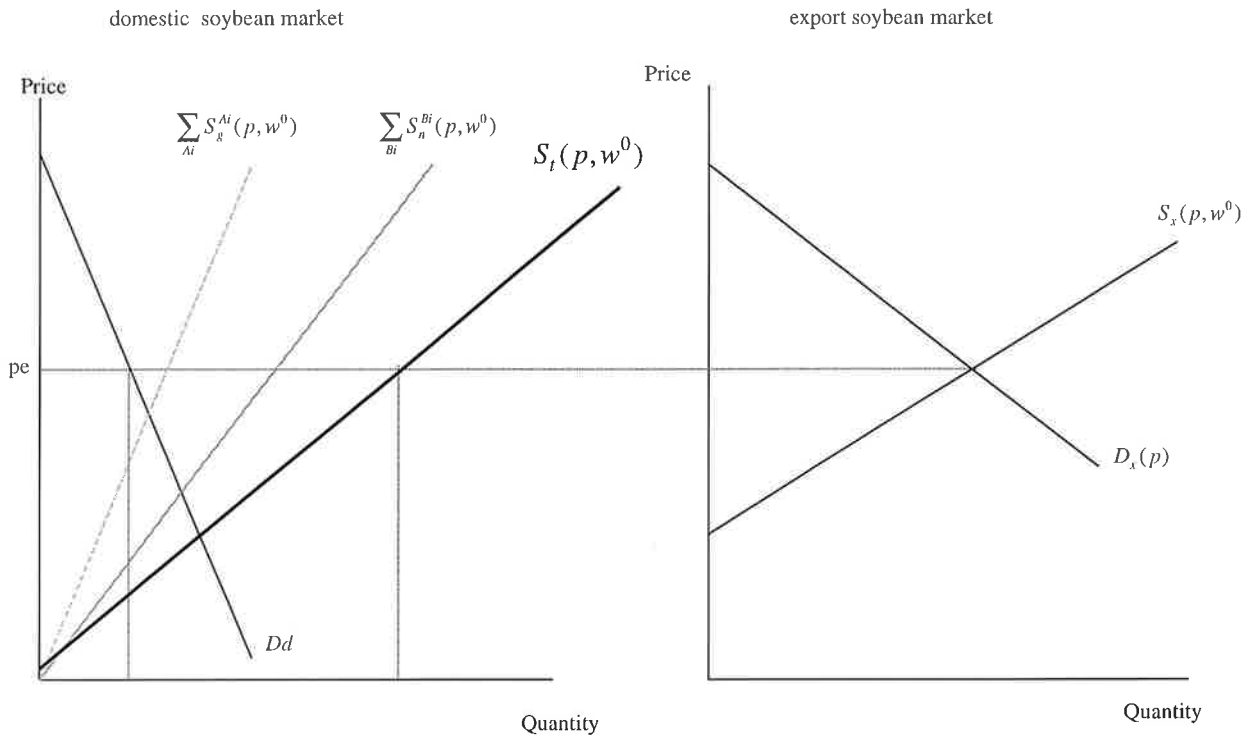

Figure 6: Equilibrium in domestic and export soybean markets, in the absence of segregation

3.2 Situation with segregation of GMO and non-GMO products

Let us now consider how production decisions are affected by the creation of an IP marketing channel in this country. Two soybean markets are now distinguished: a market for IP soybeans, and a market for other soybeans, which we call conventional soybeans.

In order to be sold in an IP market, soybeans have to be GMO-free at the consumer level. Obviously, they are produced using non-GMO seed. In addition, they have to be kept separated from GMO soybeans at the production and handling stages in order to

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[3] To simplify the presentation, we do not consider here whether farms choose to supply soybeans rather

maintain a high purity level. Most farmers supplying identity preserved GMO-free soybeans incur some additional costs compared to other soybean producers: they have to make sure that planters, harvesting combines and on-farm storage bins are not contaminated from GMO soybeans before usage; they may have to cover longer distances to bring their beans to an elevator segregating GMO free soybeans and to wait for the result of a GMO test before unloading their soybeans at the elevator; they may have to store their soybeans on-farm if reasonably close elevators do not accept them at harvest time. Moreover, maintaining the purity of soybeans also requires cleaning handling facilities before using them for IP soybeans, and testing soybeans to ensure they are GMO-free. Further, with the apparition of the IP market, one more commodity has to be handled, which may cause a loss of flexibility for handlers, and results in a higher handling cost for both conventional and IP soybeans. For simplicity reasons, the following discussion is limited to the case where introducing an IP channel does not modify the costs of supplying conventional handled soybeans, while it results in an additional constant per unit handling cost noted c_{IP} for non-GMO handled soybeans.

In order to make his production decision, each farmer now compares the unit profits obtained from GMO soybeans (still noted g), with the unit profits from non-GMO non-IP soybeans (still noted n), as well as with the unit profits from non-GMO IP soybeans (noted IP). Let us consider the outcome for farms of type A and B.

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than alternative crops.

Supply of soybeans by farms of type A

Individual supply curves of soybeans *IP* by farms A1 and A2 are represented on Figure 7. Let us first consider farm A1 on the left hand panel. Marginal cost curves for soybeans g, $MC_g^{A1}(q_g, w^0)$, and for soybeans n, $MC_n^{A1}(q_n, w^0)$, are identical with Figure 4. The marginal cost curve for soybeans *IP*, $MC_{IP}^{A1}(q_{IP}, w^0)$, is obtained by shifting the curve $MC_n^{A1}(q_n, w^0)$ upwards, the vertical shift being equal to the unit cost of identity preservation c_{IP}, equal to distance FG. At a price p_c^0 for conventional soybeans, profit obtained for soybeans g is given by the triangle CEG, while profit obtained from soybeans n is given by the smaller triangle CDG (so that farm A1 always prefers soybeans g to soybeans n). At a price p_{IP}^{A1} for soybeans *IP*, profit obtained from IP soybeans is given by the triangle ABF, which area is equal to the area of the triangle CEG. In other words, when the price of IP soybeans is equal to p_{IP}^{A1} and the price of conventional soybeans is equal to p_c^0, farm A1 obtains the same profit level for IP soybeans and for GMO soybeans. If the price of conventional soybeans remains fixed at p_c^0, for a price of soybeans *IP* smaller than p_{IP}^{A1}, farm A1 supplies GMO soybeans, while for a price of soybeans *IP* higher than p_{IP}^{A1}, it supplies IP soybeans. In the latter case, the supplied quantity is determined by the intersection of the IP soybean price and the marginal cost curve for IP soybeans $MC_{IP}^{A1}(q_{IP}, w^0)$. The supply curve for IP soybeans by farm A1 is then given by the bold line $S_{A1}^{IP}(p_{IP}, p_c^0, w^0)$ in Figure 7.

The same reasoning applies to farm A2 on the right hand panel in Figure 7. For the same price of conventional soybeans p_c^0, farm A2 starts to supply IP soybeans at price p_{IP}^{A2}, which is lower than price p_{IP}^{A1}.

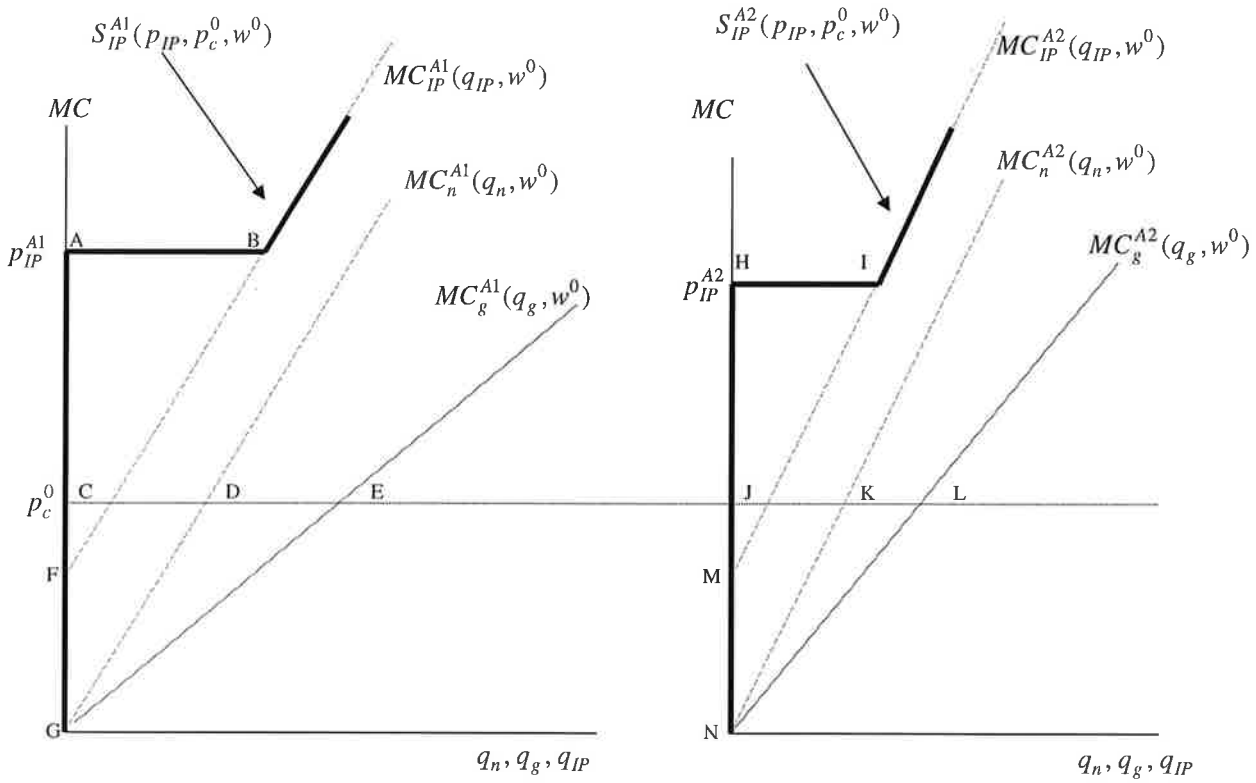

Figure 7: Supply of IP soybeans by farms A1 and A2

At the aggregate level, for given prices p_c^0 and w^0, the supply curve of IP soybeans by farms of type A is equal to the sum of individual supply curves of farms of type A. No farms supply IP soybeans if the equilibrium price of IP soybeans is less or equal to $p_c^0 + c_{IP}$. If the equilibrium price of IP soybeans becomes higher than $p_c^0 + c_{IP}$, farms for

which the GMO technology is not much cost-reducing begin to supply IP soybeans. As the equilibrium price of IP soybeans increases, more and more farms supply IP soybeans. An example of aggregate supply of IP soybeans by farms of type A is given in Figure 8.

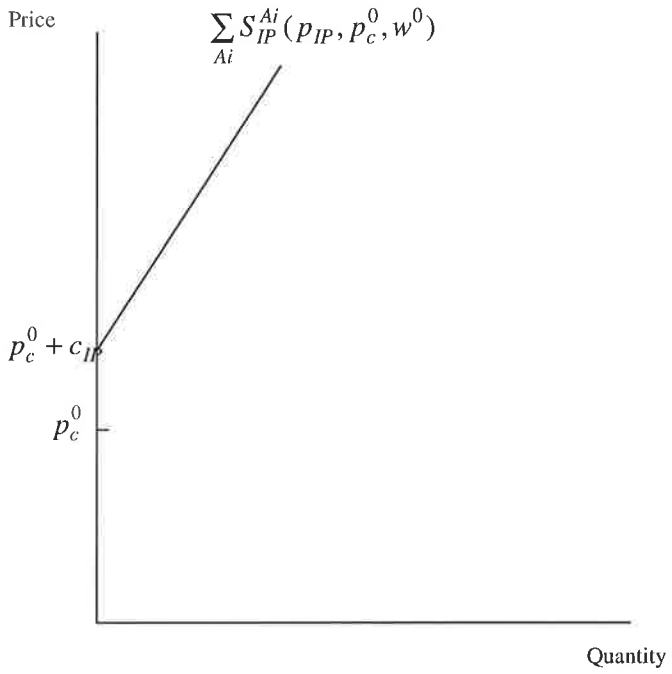

Figure 8: Aggregate supply of IP soybeans by farms of type A

The aggregate supply function is written for a given price of conventional soybeans p_c^0. An increase in this price from p_c^0 to a higher price $p_c^{0'}$ would cause some farms to shift from soybeans *IP* to soybeans *g*. As a result, the aggregate supply curve of soybeans *IP* would shift upwards, from $\sum_{Ai} S_{IP}^{Ai}(p_{IP}, p_c^0, w^0)$ to $\sum_{Ai} S_{IP}^{Ai}(p_{IP}, p_c^{0'}, w^0)$.

Similarly to Figure 7 individual supply curves of GMO soybeans of farms A1 and A2 are derived in Figure 9. At a price p_{IP}^0 of soybeans *IP*, farm A1 obtains a profit equal to

triangle ABC when supplying IP soybeans. At a price p_c^{A1} of conventional soybeans, this farm obtains a profit DEG for soybeans *n*, and a profit DFG for soybeans g, with area DFG equal to area ABC. Hence, this farm supplies soybeans *g* along its marginal cost curve $MC_g^{A1}(p_c, p_{IP}^0, w^0)$ starting from price p_c^{A1} of conventional soybeans. Its supply curve of soybeans *g* is given by the bold line $S_g^{A1}(p_c, p_{IP}^0, w^0)$. At the same price p_{IP}^0 for soybeans *IP*, farm A2 supplies soybeans *g* for prices of conventional soybeans higher than p_c^{A2}, with p_c^{A2} higher than p_c^{A1}.

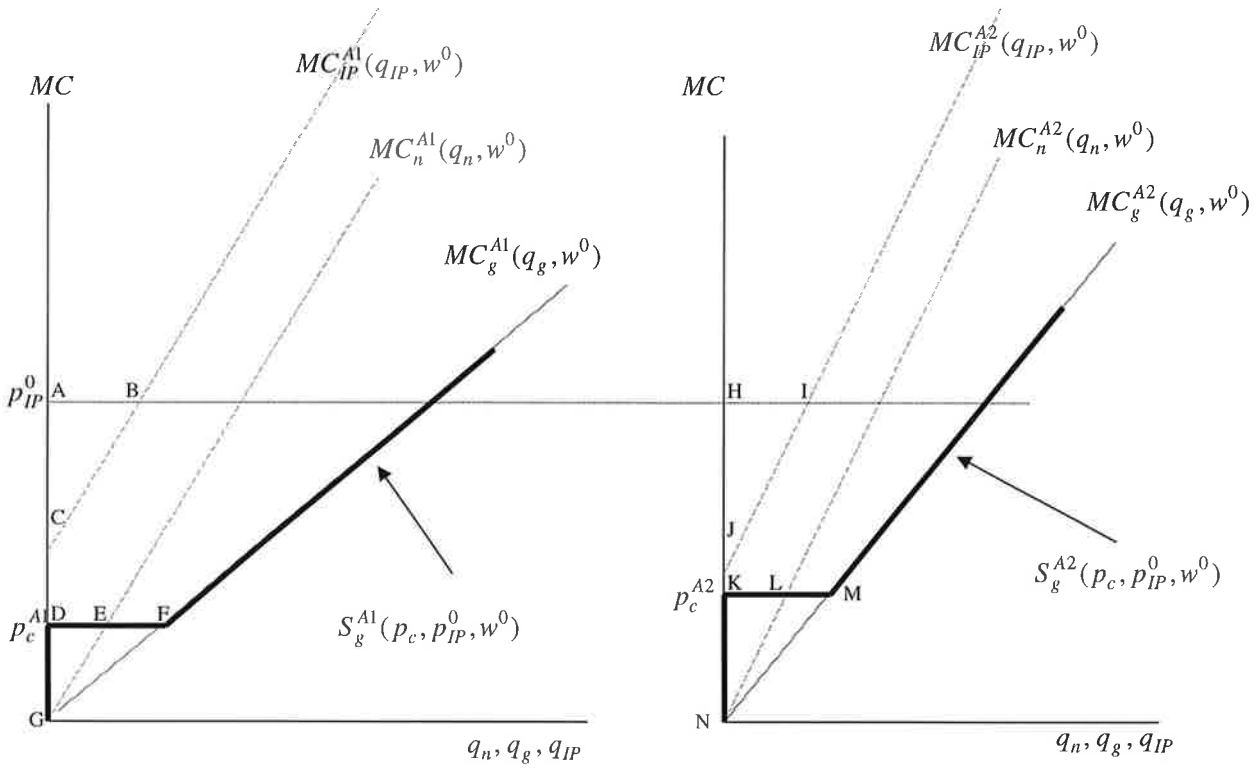

Figure 9: Supply of soybeans *g* by farms A1 and A2

The aggregate supply of soybeans g by farms of type A is represented on Figure 10. An increase in the price of soybeans *IP* from p_{IP}^0 to a higher price p_{IP}^0' would cause some farms to shift from soybeans g to soybeans *IP*. As a result, the aggregate supply curve would shift upwards, from $\sum_{Ai} S_g^{Ai}(p_c, p_{IP}^0, w^0)$ to $\sum_{Ai} S_g^{Ai}(p_c, p_{IP}^0{}', w^0)$.

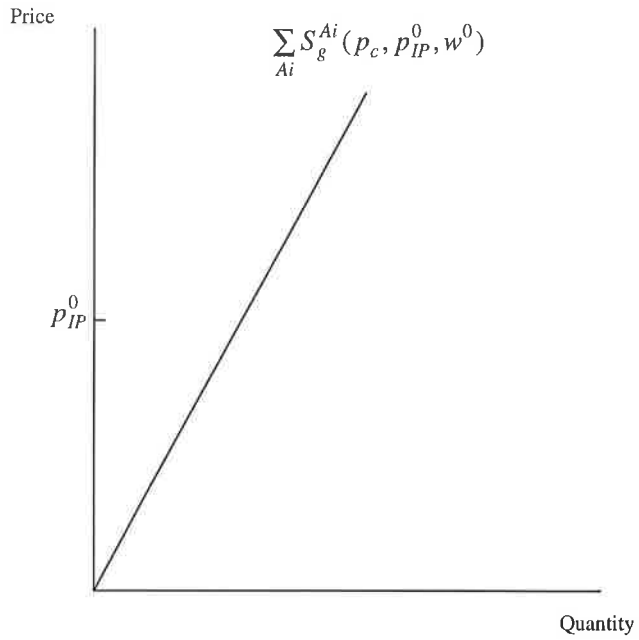

Figure 10: Aggregate supply of GMO soybeans by farms of type A

Supply of soybeans by farms of type B

Individual supply curves of soybeans *IP* by farms B1 and B2 are represented on Figure 11 below. At any price of conventional soybeans, profit obtained on soybeans n is higher than profit obtained on soybeans g. The decision to supply soybeans *IP* or not then depends on the relative profits of soybeans *IP* and soybeans g. Because of the particular

assumption of constant unit handling costs for identity preservation, the marginal cost curve of soybeans *IP* is an upward translation of the marginal supply curve of soybeans *n*. It results that for a given price of conventional soybeans p_c^0, all farms of type B supply soybeans *IP* when the price of soybeans *IP* is equal or higher than p_{IP}^B, with $p_{IP}^B = p_c^0 + c_{IP}$ (in figure 11, c_{IP} is equal to distance FG as well as AC for farm B1, and to distance MN as well as HJ for farm B2).

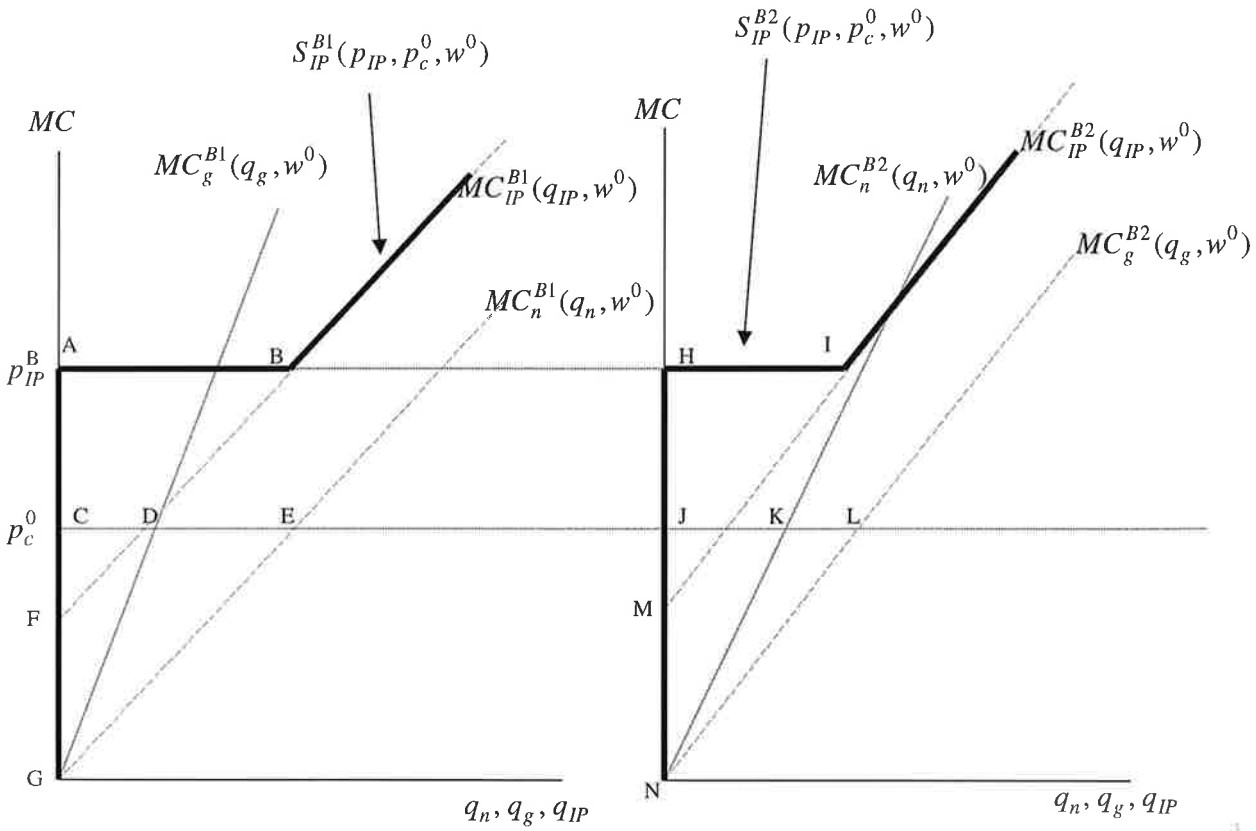

Figure 11: Supply of soybeans *IP* by farms B1 and B2

For given prices p_c^0 and w^0, the aggregate supply of soybeans *IP* by farms of type B is then given by $\sum_{Bi} S_{IP}^{Bi}(p_{IP}, p_c^0, w^0)$ on Figure 12. An increase of the price of conventional soybeans from p_c^0 to a higher price $p_c^{0'}$ would result in an upward shift of this aggregate supply, from $\sum_{Bi} S_{IP}^{Bi}(p_{IP}, p_c^0, w^0)$ to $\sum_{Bi} S_{IP}^{Bi}(p_{IP}, p_c^{0'}, w^0)$.

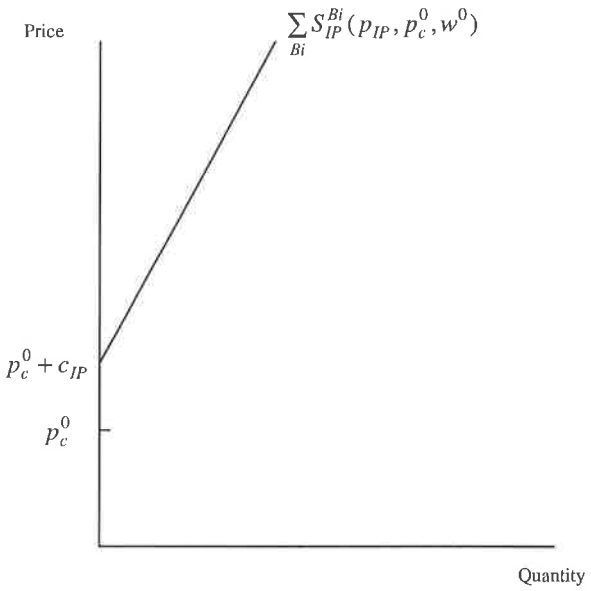

Figure 12: Aggregate supply of soybeans *IP* by farms of type B

Finally, individual supply curves of soybeans *n* by farms B1 and B2 are derived in Figure 13. For a given price of IP soybeans p_{IP}^0, all farms of type B supply soybeans *n* when the price of soybeans *n* is equal or higher than p_c^B, with $p_c^B = p_{IP}^0 - c_{IP}$ (in Figure 13, c_{IP} is equal to distance FG as well as AC for farm B1, and to distance MN as well as HJ for farm B2).

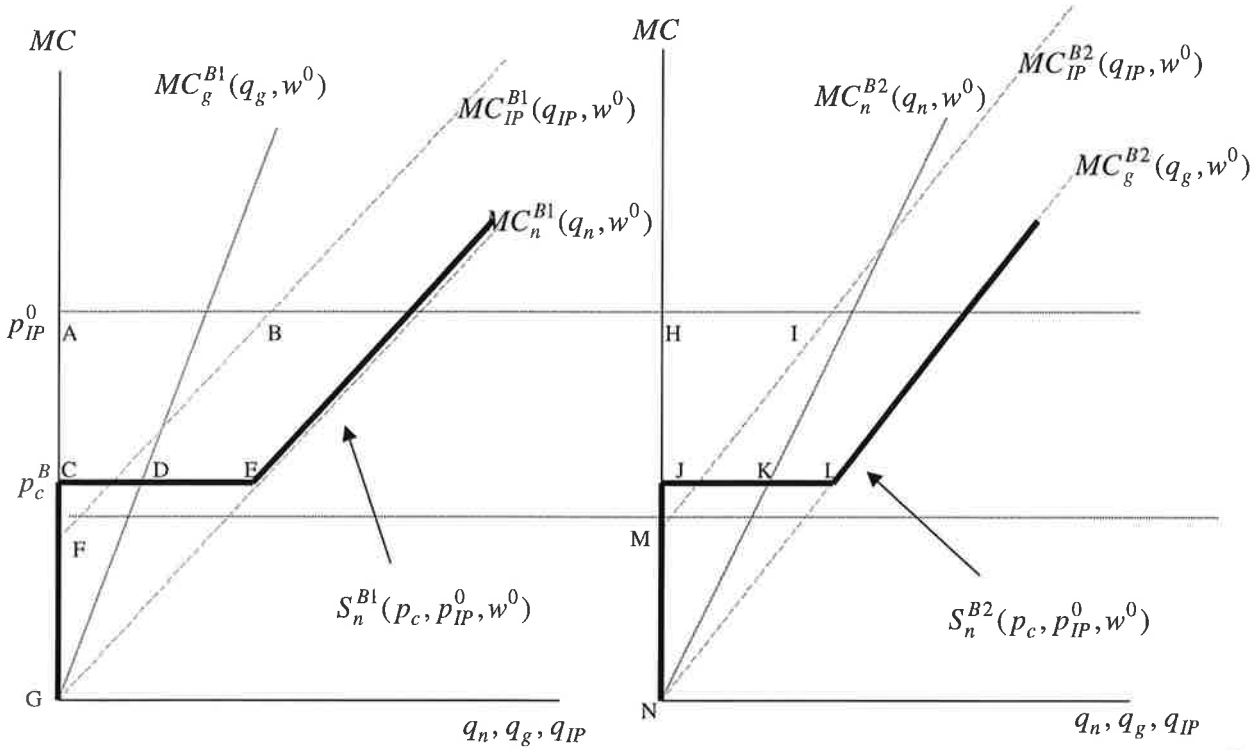

Figure 13: Supply of soybeans *n* by farms B1 and B2

The aggregate supply of soybeans *n* by farms of type B is represented on Figure 14 below as $\sum_{Bi} S_g^{Bi}(p_g, p_{IP}^0, w^0)$. An increase in the price of IP soybeans would result in an upward shift of this curve $\sum_{Bi} S_g^{Bi}(p_g, p_{IP}^0, w^0)$ to $\sum_{Bi} S_g^{Bi}(p_g, p_{IP}^{0\prime}, w^0)$.

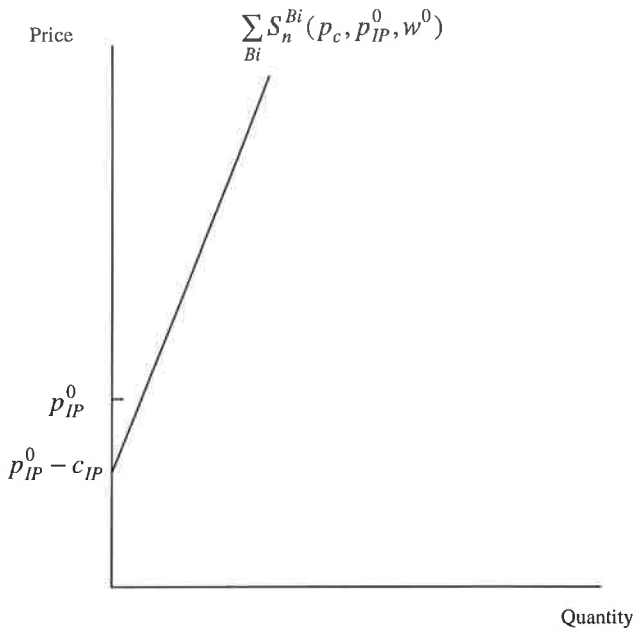

Figure 14: Aggregate supply of soybeans n by farms of type B

Aggregate supply of identity-preserved and conventional soybeans

The aggregate supply of identity-preserved soybeans is the sum of the aggregate supply by farms of type A (figure 8) and the aggregate supply by farms of type B (figure 12), for given equilibrium prices of conventional soybeans and inputs. The aggregate supply of conventional soybeans is the sum of the aggregate supply of GMO soybeans by farms of type A (figure 10) and of the aggregate supply of non-GMO non-IP soybeans by farms of type B (figure 14), for given equilibrium prices of identity-preserved soybeans and inputs. The outcome is illustrated by figure 15.

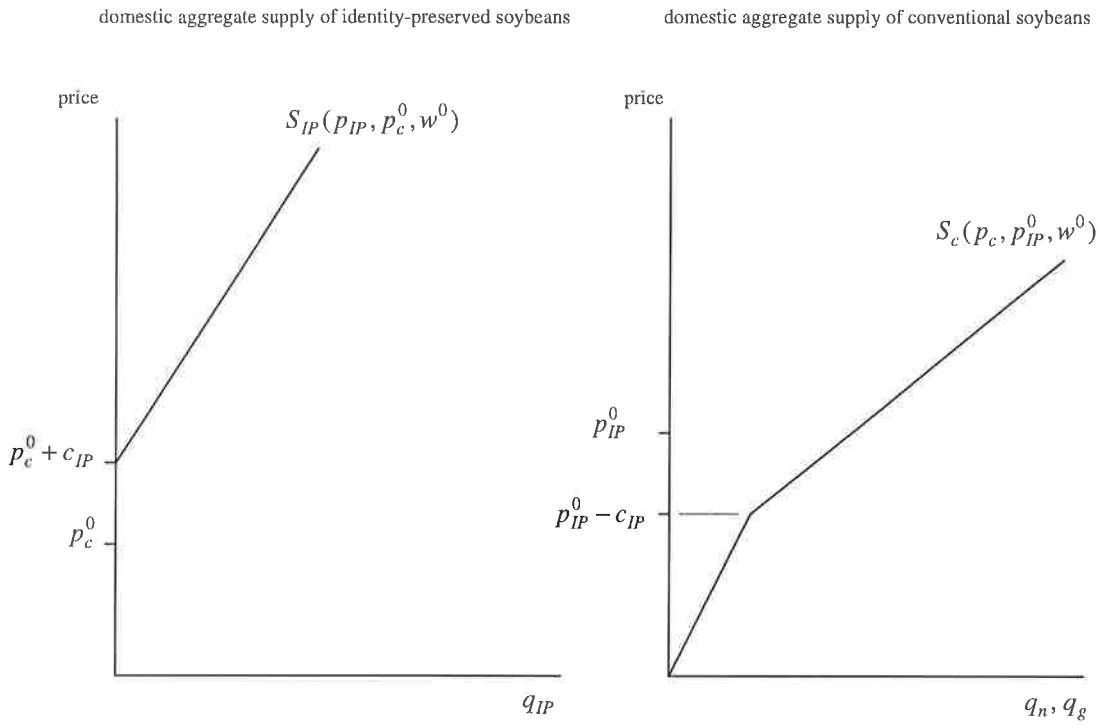

Figure 15: Aggregate supply of identity-preserved and conventional soybeans

4. Conclusion

Two questions are addressed in this paper. The first one is the price and quantity effects of GMO labeling in the EU, when EU consumers show different preferences over GMO and non-GMO soybean products, and when soybeans are imported from countries not segregating non-GMO soybeans. The second question is then whether countries allowing GMO soybeans export identity-preserved soybeans, and, if yes, which quantities. The main determinants of the apparition and size of such an identity-preserved channel are the shape of demand functions in the EU (how much consumers are ready to pay for GMO-free products, and how much more than for conventional soybeans); the cost of identity-preservation; the cost savings from the GMO technology. These three sets

of parameters determine the equilibrium price premium (i.e. the difference between prices of identity-preserved and conventional soybeans), which has to be high enough to cover the costs of identity preservation, and to give an incentive to some farms to supply identity-preserved soybeans (the more GMO technology is reducing for farmers, the stronger the incentive has to be). Otherwise, no soybeans are identity-preserved by the exporting country. Further analysis will pursue this study at the theoretical as well as empirical levels.

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