Impact of the New EU Novel Food and Feed Regulation on the Supply Chains for Animal Products

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Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Montreal, Canada, July 27-30, 2003

Revised version
(August 25, 2003)

* The authors wish to thank Arcadia International for funding support of this study as well as Dr. R. de Borchgrave and participants to the conference "Traceability and Labelling of GMOs" organized by Arcadia International on October 3d 2002 and participants to the outlook meeting at the European Commission on December 18th 2002 for helpful comments. This paper contains extracts from the AGRA EUROPE's publication indicated in the reference list.

Abstract: This communication examines how the new EU novel food and feed regulation would affect markets and trade in commodities, feed ingredients and animal products. Market and trade effects are derived from a multiregion, multicommodity, multistage, non-spatial, partial equilibrium model in which supply chains for animal products are segmented into GM and non-GM lines of products.

Key words: GM regulation, EU, market segmentation, product differentiation, identity preservation, traceability, soybeans, soy meal, meat, modelling

Two new European regulations on stricter traceability and labelling of genetically modified organisms (GMO) and on genetically modified (GM) food and feed require that all GM products traded in the European Union (EU) be traced throughout the commercial chain and all food and feed consisting of or containing more than a 0.9% *de minimis* threshold of, or produced from, authorised GMO be labelled as such.[1] These regulations are expected to lead to the lifting of the nearly five-year *de facto* moratorium in the EU on the approval of new agricultural biotech products, to take place during 2003. Given the continued opposition of selected Member States, it is, however, not yet clear to what extend such lifting will become effective.[2] On the 13th of May 2003, the US administration announced that the US with Argentina, Canada and Egypt would eventually file a World Trade Organisation (WTO) case against the EU over its moratorium if the preliminary consultations to resolve differences over the next 60 days fail.

This contributed paper investigates to what extent the new EU novel food and feed regulation would affect the EU supply chain for animal products. Because the US administration argues that this regulation would be discriminatory and severely restrict US soybean and soy

[1] The two new regulations on the traceability and labelling of GMO and on GM food and feed proposed by the European Commission (Com 2001, 1821 final and Com 2001, 425 final) were adopted on July 22, 2003, by the EU Agricultural Council after a second reading on July 2, 2003, by the European Parliament. These regulations strengthen Directive 2001/18/EC ruling voluntary release of GMO in the environment in force since October 17, 2002. A tolerance of 0.5% will apply for three years to adventitious presence in food and feed of GM material that has not yet been authorised but has received a favourable EU scientific risk assessment.

[2] The time-scale may be somewhat longer than anticipated, since at the time of writing certain Member States are continuing to object to plantings on the grounds that there are no operating procedures in place for the co-existence of GM and organic crops.

meal exports to the EU feeding industry, this paper also examines the trade effects of this regulation on the US and the other exporting countries such as Brazil and Argentina.

As a result of this new EU regulation, it is very likely that operators in the food and feed supply chains would segment the food and feed markets into non-GM and GM lines of products to meet specifically the demand for non-GM food and feed from European consumers. The preservation of non-GM segments would allow producers to avoid the mandatory GM labelling that threatens to turn away a large proportion of consumers in the EU. Although the new regulation does not require labelling of products such as meat, milk or eggs obtained from animals fed with GM feed or treated with GM medicinal products, the retail industry is most likely to introduce a voluntary label on food from animals fed with non-GM feed to respond to consumer preference. Operators in the supply chain of animal products may, therefore, segment further the markets of animal products into products from animals fed with non-GM feed and products from animals fed with GM feed. The segmentation of the food and feed markets and, likewise, animal products into non-GM and GM lines will add costs of identity preservation (IP) and traceability, particularly along the non-GM supply chains, to guarantee that "GM-free" food and feed do not contain GMOs above the threshold and animal products are derived from animals fed with guaranteed "GM-free" feed.

Supplying non-GM material at any threshold level will incur additional costs and risks to producers. These costs are expected to be particularly high in the supply chains for animal products such as meat, milk and eggs for two reasons:

- First, the major source of protein used by the European feed industry to raise cattle, pigs and chickens is imported soybeans and soy meal. Already in 2001 these were 60% GM.[3]
- Second, in the European feed industry, there are no reliable and affordable sources of protein other than soybeans. This is in contrast to the vegetable oil industry, where oils from alternative origins, such as rapeseed and sunflower, for most food applications, can readily substitute soya oil. Markets for food products using oil as an ingredient should be much less sensitive to the new GM regulation than markets for protein feed and resulting animal products.

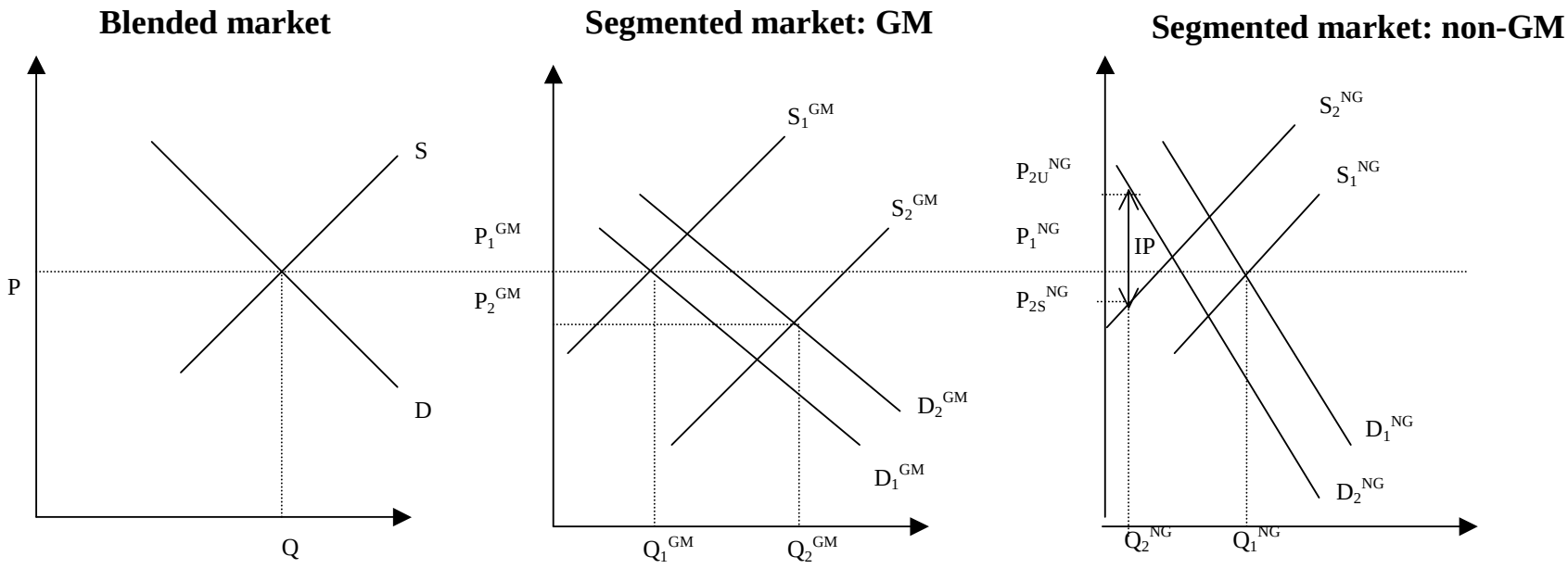
As a result, the economic effects of this new EU regulation are most likely to be felt in the supply chains for animal products. Distinct demand, supply and equilibrium prices are expected to develop for each of the two segments, GM and non-GM, of each chain.

Analytical framework

The analytical framework of this investigation uses the concept of market segmentation as given by standard microeconomic theory. Figure 1 pictorially shows the segmentation of the current undifferentiated or blended markets of soybeans, soy meal or animal products (left panel) into their equivalent GM and non-GM differentiated markets (respectively centre and right panels).

[3] Two thirds of EU protein requirement for feeding animals are covered by soybeans and soy meal, which are imported mainly from Brazil (42%), the US (35%) and Argentina (20%). The share of GM soybeans in total production is 90% in Argentina, 70% in the US and around 12% in Brazil in 2001 (de Borchgrave et al., 2003).

Figure 1. Market segmentation based on genetic modification[a]



[a] D = Demand, S = Supply, P = Price, Q = Quantity,
GM = Genetically Modified, NG = Non-GM, P_S = Supplier Price, P_U = User Price.

The resulting effects of this segmentation on equilibrium prices and quantities on each differentiated market depend on several factors:

- supply and demand shifts and elasticities of each differentiated market,
- additional costs for market segmentation,
- possibly, the market power of key economic agents.

First, figure 1 illustrates a likely forward shift of the differentiated supply of GM products (S_1^{GM} to S_2^{GM} in centre panel) and a likely backward shift of the differentiated supply of non-GM products (S_1^{NG} to S_2^{NG} in right panel) from the undifferentiated supply (S in left panel). In a world where biotechnology is becoming a standard for exported soybeans and soy meal, non-GM soybeans and soy meal can still be produced but at an additional cost compared to their GM equivalents. Eventually, the equilibrium position of the differentiated supply curve in one segmented market depends on the supplier price reached in the other segmented market at equilibrium. Cross-price effects exist between segmented markets in addition to competitive markets.

Second, figure 1 shows a less elastic demand for non-GM products (D^{NG} in right panel) than for GM products (D^{GM} in centre panel), as users and consumers in the non-GM segment are likely to be less price sensitive than their counterparts in the GM segment. The equilibrium position of the differentiated demand curves in each differentiated market (D_2^{GM} and D_2^{NG} in centre and right panels respectively) depends on the willingness to pay of users and consumers in each segment.[4] The equilibrium position of the differentiated demand curve in one segmented market also depends on the user price reached in the other segmented market at equilibrium. These cross-effects

[4] While studies on this topic are becoming available, there are still some doubts on the strength of the demand for non-GM products in Europe (Lusk, Roosen and Fox, 2003).

among segmented markets as well as among substitute markets explain the empirical results shown below.

Third, IP and traceability costs to mark and label the differentiation of the non-GM segment from the GM segment of products can be represented as a marketing margin between the supplier and the buyer of non-GM products in the right panel of figure 1. The supplier price is the price received by the supplier net of any additional IP costs while the user price is the price paid by the user including any additional IP costs. Depending on the relative elasticities of market demand and supply, these additional IP and traceability costs provide a price pressure that can be passed backward, resulting in a lower price received by the supplier (P_{2S}^{NG} in right panel), and forward, resulting in a higher price paid by the user or consumer (P_{2U}^{NG} in right panel) relative to the market price of the correspondent homogenous product (P in left panel).

Although figure 1 shows a case where the supplier price of non-GM products (P_{2S}^{NG} in right panel) is lower than the market price of the correspondent homogenous product (P_2^{GM} in centre panel), another case where the former price ends up being higher than the latter price is plausible. The backward shift of the supply of non-GM soy meal due to a higher user price of non-GM soybeans might be large enough to lead to both higher supplier and user prices of non-GM soy meal than the market price of the correspondent homogenous product as seen in the results below.

In sum, the resulting equilibrium prices of non-GM products received by the supplier and paid by the buyer as well as the quantity traded between them will depend on a number of inter-relating factors:

- the additional costs of supplying non-GM products,
- the elasticity of the demand for non-GM products compared to the elasticity of the supply of non-GM products,
- the strength of this demand, i.e., the willingness to pay for certified “GM-free” feed and food,
- the additional costs of preserving and tracing the non-GM attributes of the non-GM products.

Since demand and supply of agricultural commodities and food are commonly inelastic, it is expected that price effects will be larger than quantity effects. This implies that markets are more likely to adjust through price than quantity variations.

Considering that markets for the commodities, feed ingredients and animal products featured in this analysis are horizontally and vertically linked within a country but are also linked with those in other countries, we expect many indirect effects in different directions in addition to the direct effects. For example, an increase in user price as a result of additional IP and traceability costs will result in subsequent increases in producer and user prices downstream in the supply chain. These price increases may in turn result in substitution of one type of product for another type, in either derived or final demand. Markets in different countries may also be driven by various technology, institution and policy characteristics, which would make these links more unpredictable.

International trade further complicates the analysis. The EU supply of protein feed is largely dependent on imports of soybeans and soy meal from mainly Brazil, the US and Argentina. The EU is also a net importer of different other commodities such as sunflower seeds, pulse, maize and corn gluten feed (CGF) as well as a net exporter of

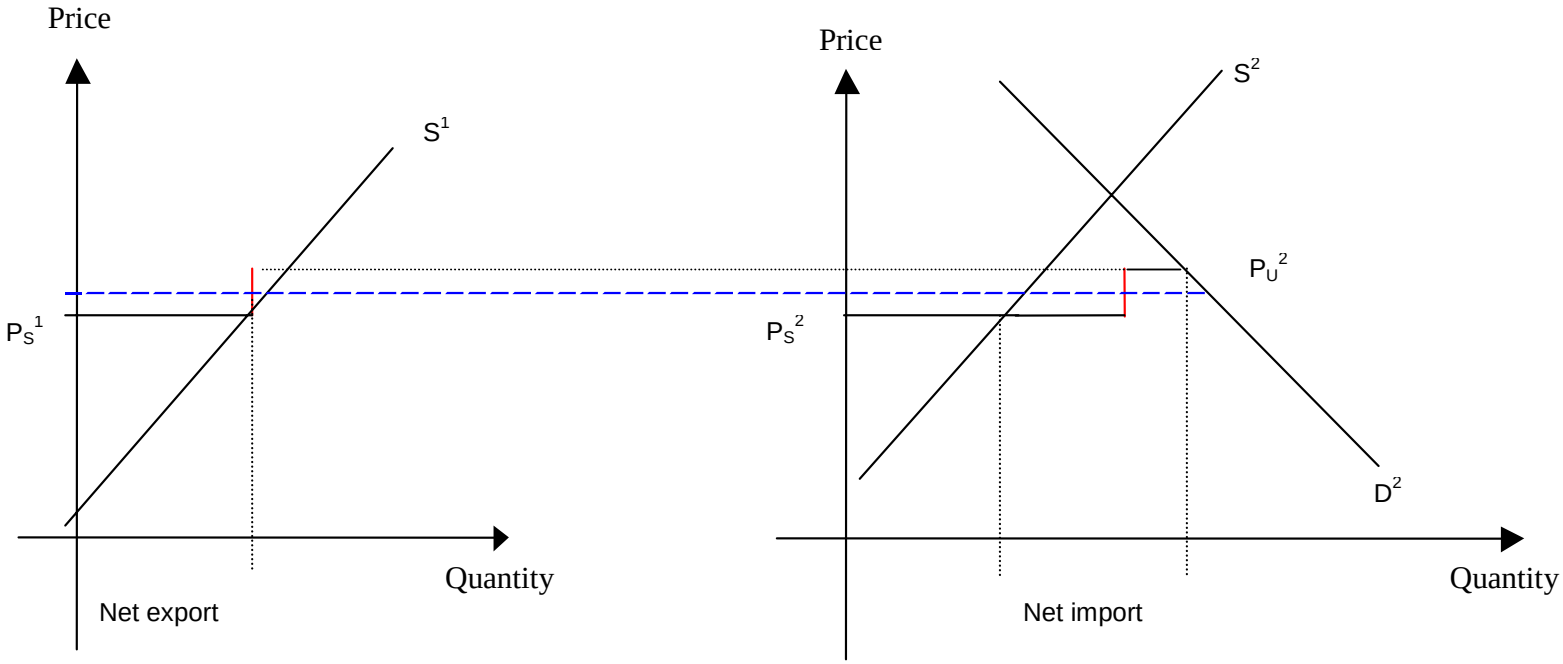
some others such as rapeseed, wheat and barley that can be used as either substitutes or complements to imported soybeans and soy meal. It is a net importer of other meals such as rapeseed and sunflower meals. Finally, it is a net exporter of beef, pork and poultry.

Since this paper focuses on the impact of the new EU novel food and feed regulation on the EU supply chain of animal products, the traceability and labelling requirement as a result of this regulation is strictly implemented in our model to the EU domestic markets and imports of agricultural commodities, feed ingredients and animal products. Also, at this stage of this study, net trade instead of gross trade is considered.[5] Figure 2 illustrates how net trade of a final product subject to traceability and labelling requirement from the part of an importing country is modelled.[6] As already shown in figure 1, the EU importing region (country 2 in the right panel of figure 2) implements a traceability and labelling regulation which generates a margin of additional costs between the user and supplier prices of the labelled product (respectively P_U^2 and P_S^2 in the right panel of figure 2). The same margin is applied to the EU imports of the labelled product in the same way an import tax is modelled in traditional trade models. Without a domestic demand for a labelled final product in the exporting country 1, only its supplier

[5] A refinement to this study is considering gross trade instead of net trade and distinguishing EU imports by origin and EU exports by destination with an Armington specification. This has the triple advantage of (i) introducing imperfect substitution among EU imports by origin and imperfect transformation among EU exports by destination, (ii) quantifying trade effects on bilateral basis and (iii) implementing different additional costs of traceability and labelling on different exporting countries.

[6] For clarity, import tax or export subsidy between countries 1 and 2 is not represented in figure 2 but is actually implemented in our model.

Figure 2. Modelling net trade effects between importing country 2 imposing traceability and labelling on exports from country 1



price prevails in the domestic market of the exporting country. Net trade of labelled intermediate products are similarly treated with the exception that a domestic market, however, exists for these products in the exporting countries. For trade to balance, EU net imports of labelled products equal the sum of net exports of labelled products from the rest of the countries.

Market power may in addition intervene in the final outcomes. By exercising its market power on the supplier firms, an operator can pass the additional IP and traceability costs upstream. Similarly, by exercising its market power on the users or consumers it can pass forward these costs.[7] In monopolistic competition, some operators in the non-GM segment may differentiate their products from GM products in such a way as to extract part of the consumer surplus. Consumer perception of added value may be achieved by associating the non-GM attribute to a quality label. The degree of vertical integration along the supply chain can also affect how the additional IP and traceability costs are passed backward or forward.

It becomes clear that anticipating the outcomes of the new GM regulation becomes very complex without the help of an empirical model designed to represent the main features of these markets and their links and disentangle the main economic effects.

Model specification and scope

The foregoing shows the impossibility of tracing analytically entangled direct and indirect effects caused by market segmentation and IP cost margin throughout the non-GM and the GM segments of the supply chain within and between different countries.

This study therefore relies on an empirical model to quantify and analyse the economic implications of the new EU novel food and feed regulation on the supply chain of animal products. The model is a multi-region, multi-commodity, multi-stage, non-spatial, partial equilibrium model. It is static and deterministic and assumes perfect competition at each stage of the supply chain. It is built using GAMS (General Algebraic Modelling System).

The main originality of this model is the segmentation of the supply chain into a non-GM segment and a GM segment in all regions. This segmentation is modelled by adding IP costs between stages of the non-GM supply chain that are only applied on EU domestic production and foreign production bound for the EU market. It is also modelled by using lower demand elasticities for non-GM products than for GM products on the basis that users and final consumers of non-GM products are less sensitive to prices.

At the first stage of farming and collecting soybeans, IP costs amounting to $25/mT of soybeans, i.e., about 15% of the US FOB soybean price, are first accounted for as an initial marketing margin.[8] At the following stage of crushing soybeans into soy meal, additional IP costs amounting to $10/mT of soy meal, i.e., about 5% of the US FOB soy meal price, are then accounted for as a second marketing margin.

At the last combining stage of raising and slaughtering livestock and distributing meat carcasses, additional I costs amounting to $15/mT of beef carcass, $20/mT of pork carcass and $25/mT of poultry carcass, i.e., about 1 to 2% of the EU meat carcass price, are finally accounted for as a third marketing margin. These IP unit costs are most likely to increase with larger supply of non-GM products as explained in de Borchgrave *et al.* (2003).

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[7] Oligopoly and oligopsony power in the US beef packing industry has been identified (Schroeter, 1988).

The model includes five stages in the supply chain:

1. agricultural commodities,
2. feed ingredients,
3. nutrients,
4. livestock,
5. meat.

The five stages are vertically linked through prices for both non-GM and GM supply chains and, in addition, through IP cost margins for the non-GM supply chain only. Agricultural commodities include soybeans and its main substitutes as sources of protein and energy: rapeseed, sunflower seeds, peas, beans, wheat, barley and maize. Feed ingredients include soy meal and its main substitutes in animal feeding: rapeseed meal, sunflower meal, corn gluten feed, pulses and cereals. Nutrients include protein and energy. Livestock includes cattle, pigs and chickens. Animal products are restricted to beef, pork and poultry.

At every stage, markets are horizontally linked through prices. A double-log functional form is used for both vertical and horizontal price linkages, ignoring input substitution between the above products and other inputs such as labour, capital and energy used in producing the output. A constant elasticity of substitution form is used for substitution among feed ingredients for nutrient requirement and a Leontief form is used for complementarity between protein and energy, implying constant returns to scale in the feed industry and livestock rearing. Nutrient requirement is based on livestock diets.

[8] IP costs are those for the US taken from de Borchgrave *et al*. (2003). IP costs are lower for Brazil and higher for Argentina.

Cross-effects between the non-GM and GM supply chains are allowed through price linkages.

These supply chains are duplicated for each of the seven regions included in the model: the US, Brazil and Argentina as the major soya producing and exporting regions, and the EU, China, Japan and the rest of the world as the major soya consuming and importing regions. Markets of these seven regions are linked across borders through domestic consumer prices determined in each region and tariff margins. The additional IP costs are only applied on EU domestic production and foreign production bound for the EU market (see figure 2).

Demand and supply elasticities are taken from various academic studies.[9] Parameter calibration was performed using data from an average of years 1999-2001, with policy parameters reflecting the situation of the 1996 Farm Bill and pre-Agenda 2000 and an initial non-GM market share of 20% (see data sources in the appendix). The simulation analysed below consists in adding an exogenous IP cost margin between every stage of the non-GM supply chain.

Results and interpretation

Results from simulating market segmentation between GM and non-GM lines of products suggest that adding IP cost margins in the non-GM supply chain has many direct and indirect price and quantity effects in both supply chains. As expected, price effects are generally larger than quantity effects. These effects are, however, limited in most

[9] Demand elasticities to price are adjusted so that the absolute value of the direct price elasticity is greater than the sum of the cross-price elasticities.

markets. The greater variations in prices, demands and supplies are found in the feed ingredient markets, particularly in the non-GM soy meal market, and, to a lesser extent, the agricultural commodity markets, particularly in the non-GM soybean markets. Consumer prices of meat from animals fed with non-GM feed increase by 6% for pork, 4% for beef and 3% for poultry while supplier prices of meat from animals fed with GM feed increase by 5% for pork, 4% for beef and 1% for poultry. As a result, demands for "non-GM" pork, beef and poultry drop by 2%, 1.5% and 0.5% respectively while supplies of "non-GM" pork and beef increase by 3% and 1% respectively. Prices, demands and supplies in the markets of meat from animals fed with GM feed generally vary by less than one percentage. Trade effects are generally larger than demand and supply effects. EU exports of rapeseed increase while EU exports of wheat and barley decrease. EU imports of non-GM soybeans, maize, peas and beans increase while EU imports of sunflower and GM soybeans decrease. EU imports of non-GM soy meal decrease while EU imports of rapeseed meal and, to a lesser extent, sunflower and GM soy meals and CGF increase. EU exports of "non-GM" pork and beef and, to a lesser extent, of poultry increase while EU exports of "GM" pork, beef and poultry decrease. A sensitivity analysis shows that all these market effects nearly double by doubling IP costs.

The magnitudes and directions of changes are given below in more details first for the EU agricultural commodity markets (Table 1), second for the EU feed ingredient markets (Tables 2 and 3) and third for the EU meat markets (Table 4). Note that all the price and quantity variations are given relative to the prices and quantities observed during the 1999-2001 base period when no IP costs are added to the non-GM supply

chain of animal products. Because the results are presented in percentage variation, their interpretation does not depend on the initial share used for calibration.

1. The EU agricultural commodity markets (Table 1)

Results for the EU non-GM soybean market:

- The supplier price of non-GM soybeans net of IP costs decreases by 2.3% relative to the market price of soybeans observed in 1999-2001 as a result of an IP cost margin between supply and demand, a result pictured in the right panel of figure 1.
- As a result of a lower supplier price, the supply of non-GM soybeans drops by 1.6% relative to the supply of soybeans observed in 1999-2001.
- The user price of non-GM soybeans including IP costs increases by 10% relative to the market price of soybeans observed in 1999-2001 as a result of the IP cost margin between supply and demand, a result also pictured in the right panel of figure 1.
- Despite the increase in the user price, the derived demand for non-GM soybeans increases by 2.6% relative to the demand of soybeans observed in 1999-2001 to meet the increase in supply of non-GM soy meal.
- Imports of non-GM soybeans increase by 2.9% relative to the imports of soybeans observed in 1999-2001 to meet the increasing supply deficit in non-GM soybeans. Argentina and the US see their exports of non-GM soybeans to increase by 2.9 and 0.2% respectively while Brazil sees its exports of non-GM soybeans to decrease by 1.1%.

Results for the EU GM soybean market:

- The market price of GM soybeans decreases by 0.6% relative to the market price of soybeans observed in 1999-2001 as a result of a larger cross effect of the non-GM soybean market on supply than on demand as pictured in the centre panel of figure 1.
- The derived demand for GM soybeans decreases by 0.8% while the supply of GM soybeans stays constant.
- As a result, imports of GM soybeans decrease by 0.9%. Argentina, Brazil and the US see their exports of GM soybeans to decrease by about 0.2%.

Results for the other EU agricultural commodity markets:

- All the market prices of the other agricultural commodities drop by less than one percentage as a result of a larger cross effect on supply than on demand.
- As a result of lower market prices, demands for most of the other agricultural commodities increase by less than one percentage while supplies of some of them slightly decrease.
- Exports of rapeseed increase by 32.8% as a result of a lower domestic demand while exports of wheat and, to a lesser extent, of barley decrease as a result of a higher domestic demand.
- Imports of maize, peas and beans increase by a couple of percentages to meet the increasing supply deficit in these commodities while imports of sunflower decrease by 1.7% as a result of a lower domestic demand.

2. The EU feed ingredient markets (Tables 2 and 3)

Results for the EU non-GM soy meal market:

- The supplier price of non-GM soy meal increases by 11.4% as a result of a higher user price of non-GM soybeans, a result that has been already introduced above.
- As a result of a higher supplier price, the supply of non-GM soy meal increases by 2.6%.
- The user price of non-GM soy meal increases by 14.1% as a result of the IP cost margin.
- Consequently, the derived demand for non-GM soy meal decreases by 16.2%.
- Imports of non-GM soy meal drop by 33.9% as a result of a decreasing supply deficit. The US, Brazil and Argentina see their exports of non-GM soy meal to decrease by 23.2, 4.6, 1.9% respectively.

Results for the EU GM soy meal market:

- The market price of GM soy meal decreases by 1.3% mainly as a result of a lower market price of GM soybeans.
- As a result of a lower market price, the derived demand for GM soy meal increases by 0.7% while the supply of GM soy meal decreases by 0.8%.
- Imports of GM soy meal increase by 2.2% to meet the increasing supply deficit. The US and Brazil see their exports of GM soy meal to increase by 2.1 and 0.4% respectively.

Table 1. Price and quantity variations in the EU agricultural commodity markets (%)

	% Variation in			
Commodity	**Price**	**Supply**	**Demand**	**Net Trade**
Non GM Soybeans				-2.9
- supplier	-2.3	-1.6		
- user	10.0		2.6	
GM Soybeans	-0.6	0.0	-0.8	0.9
Rapeseed	-0.7	0.0	-0.7	32.8
Sunflower	-0.4	0.1	-0.7	1.7
Peas	-0.4	0.0	0.3	-1.6
Beans	-0.7	0.0	0.6	-0.7
Wheat	-0.6	0.0	0.2	-2.7
Barley	-0.7	-0.1	0.1	-0.7
Maize	-0.6	-0.1	0.1	-2.2

Table 2. Price and quantity variations in the EU feed ingredient markets with a CES of 2 (%)

	% Variation in			
Feed Ingredient	**Price**	**Supply**	**Demand**	**Net Trade**
Non GM Soy meal				33.9
- supplier	11.4	2.6		
- user	14.1		-16.2	
GM Soy meal	-1.3	-0.8	0.7	-2.2
Rapeseed meal	-1.1	-0.7	2.5	-22.5
Sunflower meal	-0.9	-0.7	2.1	-5.7
Pulse feed	0.3	-0.2	-0.2	NA
Cereal feed	0.3	-0.1	-0.2	NA
CGF[a]	0.0	NA	0.4	-0.4

(a) Corn Gluten Feed

Results for the other EU feed ingredient markets:

- Market prices of rapeseed and sunflower meals decrease by about 1% as a result of lower commodity prices.
- As a result of lower market prices, demands for rapeseed and sunflower meals increase by 2.5 and 2.1% respectively while their supplies decrease by 0.7%. Demand for CGF increases by 0.4%.
- Imports of rapeseed and sunflower meals and, to a lesser extent, CGF increase to meet the increasing supply deficit in these feed ingredients.

These above results are very sensitive to the size of the constant elasticity of substitution (CES) used in the model. Doubling the CES from 2 to 4 doubles the changes in demand of feed ingredients, exacerbating the substitution of GM soy meal and feed ingredients for non-GM soy meal (Table 3).

3. The EU meat markets (Table 4)

Results for the EU markets of meat from non-GM fed animals:

- The increase in the supplier and consumer prices is larger for meats from non-GM fed animals whose diet depends more on soy meal: consumer prices of meat from non-GM fed animals increase by 5.7% for pork, 3.6% for beef and 2.6% for poultry while supplier prices of meat from non-GM fed animals increase by 4.7% for pork, 3.6% for beef and 1.4% for poultry.

- As a result, demands for pork, beef and poultry from non-GM fed animals decrease by 1.8%, 1.5% and 0.5% respectively.
- Supplies of pork and beef from non-GM fed animals increase by 2.9 and 1.3% respectively, as a result of a higher supplier price while the supply of poultry from non-GM fed chickens decreases by 0.3% probably due to the increase in user price of non-GM soy meal not fully compensated by the smaller increase in the supplier price of this type of meat.
- Exports of pork, beef and poultry from non-GM fed animals increase by 88, 63 and 2% respectively.

Results for the EU markets of meat from GM fed animals:

- Market prices of meat from all GM fed animals decrease by 0.1% as a result of small variations in the user prices of GM soy meal and other oilseed meals.
- Consequently, supplies of meat from GM fed animals slightly decrease while demands of meat from GM fed animals slightly increase.
- Exports of pork, beef and poultry from GM fed animals decrease by 37, 28 and 14% respectively.

Price gaps at the consumer level between meat from non-GM fed animals and meat from GM fed animals are significant: 5.8% for pork, 4.0% for beef and 2.7% for poultry. Consumers of meat from GM fed animals are expected to benefit from a lower price while consumers of meat from non-GM fed animals are expected to lose from a much higher price.

Table 3. Price and quantity variations in the EU feed ingredient markets with a CES of 4 (%)

	% Variation in			
Feed Ingredient	**Price**	**Supply**	**Demand**	**Net Trade**
Non GM Soy meal				61.1
- supplier	10.1	2.5		
- user	13.6		-30.3	
GM Soy meal	-1.6	-0.9	2.9	-6.5
Rapeseed meal	-1.4	-0.7	6.2	-48.9
Sunflower meal	-1.1	-0.7	5.1	-12.5
Pulse feed	0.1	-0.1	-0.1	NA
Cereal feed	0.1	-0.1	-0.1	NA
CGF[a]	0.0	NA	0.5	-0.5

(a) Corn Gluten Feed

Table 4. Price and quantity variations in the EU meat markets (%)

		% Variation in			
Meat		**Price**	**Supply**	**Demand**	**Net Trade**
Beef:	Non-GM				62.7
	- supplier	3.6	1.3		
	- user	3.9		-1.5	
	GM	-0.1	-1.0	0.3	-28.1
Pork:	Non-GM				88.1
	- supplier	4.7	2.9		
	- user	5.7		-1.8	
	GM	-0.1	-1.7	0.2	-37.2
Poultry:	Non-GM				1.8
	- supplier	1.4	-0.3		
	- user	2.6		-0.5	
	GM	-0.1	-1.1	0.2	-14.1

In sum, IP costs in the non-GM supply chain induce substitution of GM soy meal and other oilseed meals for non-GM soy meal in EU consumption and, to a lesser extent, substitution of meats of GM-fed animals for meats of non-GM fed animals in EU consumption. However, these IP costs increase the supplier price of non-GM soy meal and, in turn, induce substitution of non-GM soy meal for GM soy meal as well as the other oilseed meals in EU production. These opposite effects in the EU soy meal market lead to an estimated total decrease in EU soy meal imports of about 5%. An EU novel food and feed regulation with the lower tolerance level of GMOs initially put forward by the European Parliament in July 2002, would have increased IP costs and, hence, amplified these substitution effects, thus missing the intended purpose of developing supply chains based on non-GM feed ingredients and products.

In contrast to the substitution effects observed in the demand of feed ingredients and meats in favour to GM soy meal and meats from GM-fed animals, there is a substitution effect in the demand of agricultural commodities in favour to non-GM soybeans, pulses and cereals. Because the supply of these commodities tends to decrease, imports of non-GM soybeans, pulses and maize increase and exports of wheat and barley decrease. The total increase in EU soybean imports is estimated at 0.1%. Notice that EU soybean imports tend to specialise in non-GM while EU soy meal imports tend to specialise in GM resulting in increased crushing of non-GM soybeans into non-GM soy meal and decreased crushing of GM soybeans into GM soy meal in the EU. This observation depends on the magnitude of IP costs in each producing country.

Preliminary results indicate that exports of agricultural commodities and feed ingredients from exporting countries are not dramatically affected. As far as the US are

concerned, results from the simulation show a slight 0.1% decrease in US exports of soybeans and a 3% decrease in US exports of soy meal. US exports of cereals, sunflower meal and CGF, however, tend to increase. Therefore, results from the model's simulation fail to support the US worries that the new EU novel food regulation would severely restrict US trade. Modelling EU imports by origin would, however, provide better insights in the development of the EU-US trade flows as a result of the new EU novel food regulation.

Conclusions

Given an initial 20% market share of non-GM products for parameter calibration purpose, IP cost implications of the new GM regulation as simulated with this model have limited impact on price, demand, supply and trade of the GM segment of the supply chain of animal products. Impacts on non-GM soy products are, however, substantial upstream the supply chain, but are damped downstream through absorption in the livestock and meat value chain.

The directions of change are interesting to note because of their potential amplification if IP costs increase as, for instance, a result of a larger non-GM market share. The key directions are:

- an increase in EU user prices of non-GM soybeans and soy meal as well as in consumer prices of animal products, particularly pork and beef, from non-GM fed animals,

- a subsequent decrease in EU demand for non-GM soy meal and meats from non-GM fed animals,
- a decrease in EU supplier prices of non-GM soybeans but an increase in EU supplier prices of non-GM soy meal and, to a lesser extent, meats from non-GM fed animals,
- a subsequent decrease in EU supply of non-GM soybeans but an increase in EU supply of non-GM soy meal,
- all of which leads to a substitution of cheaper GM soy meal, other oilseed meals and meats for more expensive non-GM soy meal and meats in the supply chain of animal products.

More stringent standards on GM traceability and labelling, as first proposed in the amendments of the European Parliament, or a larger market share of non-GM products, would result in higher segregation costs. This would then amplify the increase in user prices of non-GM soybeans, soy meal and animal products. Unless there is a strong demand for animal products from non-GM fed animals that are certified as such, these additional costs would further constrict the market for non-GM soy meal and animal products to the benefit of GM products.

This outcome falls far short of the development of a non-GM segment of the supply chain of animal products, if this was the intention of the new European GM regulation. Of course, the major assumption in this argument is that the additional IP and traceability costs fall on non-GM, rather than on GM agricultural commodities, feed ingredients and food.

These analysed trends depend heavily on the structure of the model and elasticity parameters. A further stage in this study would be the simulation of exogenous shocks. These shocks represent likely development in international markets and could include:

- an increase in Brazilian supply of soybeans, on the basis that production capacity in Brazil could bring supply from the current 50 million tonnes to over 60 million tonnes of soybeans per year,
- an increase in Chinese demand for soybeans which, together with Taiwan, currently absorbs 12 million tonnes per year, on the basis that demand for meat in China is expected to continue to increase with increasing income,
- an increase in the EU demand for meat from non-GM fed animals, accompanied by a parallel decrease in the EU demand for meat from GM-fed animals,
- an adaptation of the policy parameters to account for further CAP reforms, particularly in the beef and dairy sub-sectors,
- a possible WTO dispute settlement on GMO labelling,
- an agreement at the current WTO round of negotiations on agriculture.

Another further stage in this study as already suggested above would be to develop the economic model:

- by distinguishing EU trade by origin to account for imperfect substitution across EU import sources and export destinations as well as to specify better the trade effects of the EU novel food and feed regulation on specific countries,
- by introducing increasing returns to scale in the feed industry,
- by relying on estimated willingness to pay for certified “GM-free” food products.

Appendix: Sources of data and parameters

Data and parameter	Source
Supply, stock variation, export, import, feed use	FAOSTAT
EU imports by origin	EUROSTAT-COMEXT
Prices	European Commission, ONIC, USDA, FAPRI
Elasticities	Various studies
Policy parameters	OECD, FAPRI, Agris US Analyse
GMO characteristics	ISAAA, European Commission, USDA, Graham Brookes
IP Costs	ARCADIA Studies
Nutrient animal requirements	INRA
Meal content per oilseed	FEDIOL

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