Standards, trade and protection: the case of GMOs

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Abstract

A global economy-wide model (GTAP) is used to go beyond estimating how GM crop variety adoption affects adopting and non-adopting economies, with or without policy responses to this technology, by indicating effects also on real incomes of farmers. The results suggest the EU moratorium on imports of GM food helps EU farmers even though it requires them to forego the productivity boost they could receive from the new biotechnology. An upper-bound estimate of the cost of that EU moratorium to developing countries and the world also is provided.

Key words: Biotechnology, trade policy, political economy, regulation of standards, general equilibrium.

JEL codes: C68, D58, F13, O3, Q17, Q18

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Genetically modified (GM) crop varieties account for one-quarter of the global land area planted to maize, soybean and canola and cotton, (and 4.3 per cent of all arable land). This represents a dramatic increase from the pre-1996 level, when GM production was close to zero. Three countries dominate global production of GM food products : Argentina, Canada and the United States (US). In these countries production cost savings and minimal regulatory impediments have lead to rapid farmer adoption, and the GM shares of those crops average more than 60 per cent (James 2003). The US alone produces more than 40 per cent of of the world's maize and soybean, and its shares in global exports (including intra-EU trade) are 66 and 51 per cent, respectively. By contrast the European Union (EU) produces only six per cent of the world's maize and one per cent of the soybean. EU Farmers therefore benefit much less from adopting GM varieties of these crops than US farmers. Since 1998 when the EU implemented a moratorium, GM-adopting countries have lost EU market share to GM-free suppliers, particularly Brazil for maize and soybean and Australia and Central Europe in the case of canola (Foster, Berry and Hogan 2003). This has strengthened fears that EU members and possibly other food-importing countries would discount or deny market access to products of food-exporting countries if any GM crops are grown in, or even imported into, those exporting countries.

To what extent have relatively low farmer payoffs, as opposed to strong opposition by some consumer and other community groups, motivated the EU's moratorium on GM crop variety approval? The conventional explanation for the US-EU difference in GM regulations is that Europeans care more about the natural environment than do Americans, and trust their food safety regulators less. While not denying either of those possibilities, we seek further possible explanations in the first section of the paper. These are tested empirically using a modified version of the GTAP data and simulation model of the global economy, described in the second section. We go beyond earlier analysts (e.g., Nielsen and Anderson 2001; van Meijl and van Tongeren 2002; Nielsen, Robinson and Theirfelder 2003) by providing empirical estimates of the distributional effects within countries of GM production, consumption and import policies. The final section describes the political economy implications of these results.

Why do national GM policies diverge?

The precautionary stance taken by EU towards GM food contradicts previous statements made by the EU scientific community (European Commission 2001), implying that policy makers may have alternative motivations than the promotion of food safety and environmental health. Political economic theories suggest that governments respond to both public and private interest group pressure. Apart from differences in environmental preferences or in consumer trust in food safety authorities, the EU may have banned GM products to enhance the EU's monopoly power in international food markets (the optimal tariff argument, resurrected recently by Bagwell and Staiger 1999). Although this motivation seems unlikely given that the

EU's already maintains high import barriers to many farm products and is foregoing the productivity gains of the new biotechnology, we test it empirically.

Private interest group theory (Grossman and Helpman 1995) offers a more likely explanation for the policy differences. Anti-GM protest groups and biotechnology firms are active lobby groups on both sides of the Atlantic, so neither group is likely to be acting as the primary policy driver. The most obvious other interest group with an economic stake in these policies is the farm lobby.

US farmers clearly have a strong interest in a low degree of GM crop regulation, so that they can exploit the new technology before it is disseminated beyond the US. The interests of EU farmers, however, are less clear-cut. Had they been allowed to adopt, EU crop farmers would have benefited very little to date because the first-available GM food crops (maize and soybean) are of minor direct importance to them. In addition, because their landscape is much more densely settled buffer zoning costs more per hectare of GM crop there than in broad-acre landscapes such as in the US. On the other hand, the EU livestock sector, which is almost as big as that of the US, has an interest in lower costs of feedstuffs. But given that North America and Argentina have already adopted GM technology, EU food producers may be more competitive than GM adopters in their own and in third-country markets if consumers in those markets are sufficiently GM-averse, and if these markets require compliance with strict labelling regulations for GM foods. If those strict labelling and high standards also applied to feed ingredients (as is intended in the EU from now on), then EU livestock producers also could support anti-GM policies since they are unlikely to benefit as much from the GM technology as maize-and-soybean-intensive North American livestock producers.

The GTAP model modifications and scenarios

To test the theory that farm interest groups have an economic stake in GM policies empirically, we use a well-received empirical model of the global economy (the GTAP model) to examine the effects on national and farmer welfare of some countries adopting the new GMO technology without and then with government and consumer responses in other countries. The Version 5.4 database used for these applications (Dimaranan and McDougall 2002) draws on the global economic structures and trade flows of 1997, just prior to the EU moratorium on GM crop varieties (See Hertel, 1998 for comprehensive model documentation. The model is solved with GEMPACK software described in Harrison and Pearson, 1996).

The simulations use a standard, long-run, neoclassical GTAP closure. This closure is characterized by perfect competition in all markets, flexible exchange rates and fixed endowments of labour, capital, land and natural resources. One outcome of this specification is that wages are flexible and the labour market operates at full employment. This assumption can play an important role in the incidence of technological change in agriculture, particularly for the landless poor, however an analysis of the effects of this assumption is beyond the scope of this paper. In addition investment funds are allocated among regions to equate the change in expected rates of return.

Production

In our GTAP simulations we assume 45 per cent of US and Canadian coarse grain production is GM. When they are assumed to adopt, all Latin American countries and Australia adopt GM coarse grains at two-thirds the level of the US (i.e., 30 per cent of coarse grain production is GM) while all other countries adopt GM coarse grains at one-third the level of US adoption (i.e., 15 per cent of coarse grain production is GM). For oilseeds, we assume that 75 per cent of oilseed production in the US, Canada, Argentina and Brazil is GM. Again Other Latin American countries and Australia are assumed to adopt at two-thirds the extent of the major adopters and the remaining regions adopt at one-third the extent of the major adopters.

The adopting sectors are each sub-divided into GM and non-GM varieties, and an output-augmenting, Hicks-neutral productivity shock is implemented on the GM varieties of these commodities to capture their higher productivity. This assumption leads to a uniform reduction in the level of primary factors inputs needed per unit of GM output.[1] When a region does not adopt GM technologies, no regional factor productivity shock is included and no distinction is made between GM and non-GM production in these regions. In the constant-elasticity-of-substitution production nest, producers choose first between imported and domestic inputs according to the model's Armington elasticities, and then choose whether or not to use GM or non-GM intermediate inputs in their production of final goods.

Consumption

In order to capture consumer aversion to GM products, two changes are made to the traditional GTAP demand structure. First, elasticities of substitution between GM and non-GM products in the European Union, Australia and New Zealand where consumers are GM-averse are set at low levels to capture the perceived low substitutability of these products. In addition, preference shift parameters are included to capture the group of consumers in some countries that, because of food safety and/or environmental concerns, refuses to consume GM crops regardless of their price. In such cases a 25 per cent reduction in final demand for output of crops that may contain GMOs is assumed, following Nielsen and Anderson (2001).

Factor ownership

We examine the effects on intra-regional distribution of income by dividing the economy into three groups of households: farmers, unskilled labourers, and owners of human and other capital. Income of each group comes from a combination of factors. Farm households earn income from farm and non-farm activities. The existing GTAP database provides information about the availability and use of land, unskilled labour, skilled labour, other natural resources and other capital in the agricultural sector, and likewise in other sectors. Non-farm activities of farm households are assumed to earn income from factors in the same proportion as activities conducted by the typical urban capital-owning household. Hence factor shares for farm households are a weighted sum of factor shares used in agricultural production and the factor income shares of capital owners.[2] The shares of farm household income from non-farm activities are assumed to be 90 per cent in Japan and Korea, 50 per cent in China and the EU, 35 per cent in US and Canada, 25 per cent in Australia, New Zealand, and Eastern Europe, and 20 per cent in the remaining developing countries. The expenditure shares are assumed to be the same for all households, so real household incomes are calculated simply by deflating by the consumer price index.

Simulations

Several sets of simulations are considered below to address the questions posed in the introduction. We look at the impacts of GM adoption by the US, Canada and Argentina first, without and then with policy reactions in other countries. Then we add the EU to the list of adopters to explore the tradeoffs for the EU between productivity growth via GM adoption and the benefits of remaining GM-free given the prior move to adopt in the Americas. Following Stone et al. (2002), these model simulations assume that total factor productivity is higher for GM than for non-GM varieties by 6 per cent for oilseeds and 7.5 per cent for coarse grains; in the later cases of rice and wheat, a modest 5 per cent productivity difference is assumed to provide a conservative estimate of the impact of adoption of these two crops.

The base case is compared with several alternative scenarios. One involves an EU moratorium on GM imports from Argentina, the US and Canada, where it is assumed there is no segregation between GM and non-GM products and therefore the EU import ban (modelled as a prohibitive tariff) is imposed on all coarse grains and oilseeds from those three GM adopters. Another scenario assumes the EU, Japan and Korea implement labelling policies that allow consumers to choose between non-GM products and those that may contain GM content. In this option, diehard consumers in the EU, Korea and Japan avoid consuming coarse grains and oilseeds. (This is modelled as a 25 per cent reduction in final consumption of coarse grains and oilseeds in those countries.) In a third alternative scenario the EU abandons its stand against GM products while all other countries remain non-adopters. A final scenario assumes that the EU's acceptance of GM products would induce the rest of the world to adopt GM varieties of coarse grains and oilseeds as well.

Model results

The aggregate economic welfare effects of these various cases are summarized in Table 1 for all scenarios. Table 2 presents the welfare effects for the first two scenarios disaggregated into three parts: resource allocative efficiency effects, changes in the region's terms of trade, and technological change.

The global benefits of the first group's GM adoption is substantial (US$2.3 billion per year) if there are no adverse reactions elsewhere. The major importing regions of the EU and Northeast Asia share about one-quarter of the global benefits, while Brazil, Australia, New Zealand and Rest of Sub-Saharan Africa experience small welfare declines (because of an adverse change in their terms of trade and, in the case of Brazil, a reduction in resource allocative efficiency). In the absence of any adverse reactions abroad, the GM-adopting countries expand their output and net exports of coarse grains and oilseeds (and meat) while the opposite happens in the rest of the world. Consumption of these products expands in all regions because they are now cheaper, but especially in the GM-adopting regions since in this model the Armington assumption ensures that imported products are an imperfect substitute for domestically produced products.

When the EU imposes its moratorium, however, this is similar to an increase in farm protection there and causes the EU to be worse off by $3.1 billion per year (less whatever value EU consumers place on having avoided consuming GM products). In addition this policy leads to a one-third reduction in the gain to GM-adopting North America, a welfare improvement for Brazil, and a slight welfare decline for food-importing regions of the rest of the world. However, when the EU moratorium is imposed on imports from GM-adopting countries, the international prices of coarse grains and oilseeds fall more – and GM-adopting countries slightly reduce their output of these crops. In Europe, output expands because the import ban drives up domestic prices.

Suppose the EU provided labelling information and allowed individual EU consumers to respond according to their preferences. If one-quarter of them simply avoided these products because they may contain GMOs, the welfare effects are almost the same as in the base case, because even though there is less EU consumption there is also less protected production in high-cost Europe and therefore less resource waste. Alternatively, if the EU allowed GM adoption, it would gain more from its own productivity gains. In this case, net importers of these products elsewhere in the world would also experience welfare improvement, while net exporters of coarse grains and oilseeds (both GM adopters and non-adopters) would experience welfare declines. The net global gains would be just seven per cent more than in the base case because coarse grains and oilseeds are minor crops in the EU compared with North America, assuming the EU moratorium has no impact on the GM policies of other countries.

However, if the rest of the world became uninhibited about adopting GM varieties of these crops, global welfare would increased by nearly twice as much as it would when just North America and Argentina adopt. While the EU too would gain more in this scenario because of improved terms of trade, almost all of the extra global gains would be enjoyed by developing countries (final column of Table 1).

The cost of the EU's policy stance can be thought of as in the range of the difference between columns four and two and the difference between columns two and five of Table 1, depending on how much one believes the EU's stance is determining the rest of the world's reluctance to adopt GM varieties of these crops. For the EU that cost range is (406 + 3145 =) $3551 million to (595 + 3145 =) $3740 million per year, while for the world as a whole the range is (2.43+ 1.24 =) $3.67 billion to (4.05+ 1.24 =) $5.29 billion per year.

In at least two respects the estimate of a $5.3 billion welfare improvement understates the global welfare cost of the EU's policy. First, the second scenario in Table 1 (the EU moratorium) ignores the fact that the EU's stance has already induced some other countries to also impose similar moratoria. Sri Lanka was perhaps the first developing country to ban the production and importation of GM foods. In 2001 China did the same (with some relaxation in 2002), having been denied access to the EU for its soy sauce exports because they may have been produced using GM soybeans imported by China from the US. If that China moratorium was included along with the EU moratorium, the global welfare loss in scenario 2 is -$2548 million instead of -$1243 million per year. And second, these comparative static simulations ignore the dynamic impacts of on-going GM food research and development activities and the considerable reductions in investment in this area influenced by the EU's extreme policy stance.

What do the results suggest about GM policy drivers?

Two political economy questions were raised earlier in the paper. Is the EU policy response to GM adoption in the Americas consistent with a public-interest strategy aimed at capturing terms of trade benefits for the EU; and are the policy responses by the EU consistent with the theory of special-interest politics whereby farmers benefit from the policy chosen even if the national economy as a whole is worse off?

EU terms of trade

The terms of trade for the EU improve when the EU implements a moratorium in response to North America and Argentina adoption of GM coarse grains and oilseeds. However, the extent of farm protection provided by the moratorium is far more than is optimal in terms of boosting EU economic welfare through improved terms of trade. The comparison shows that EU welfare is $3.4 billion per year lower because of the moratorium: the loss in allocative efficiency of $3.6 billion greatly outweighs the gain from the terms of trade change of just $0.2 billion (compare the upper and lower parts of Table 2).

A comparison of the final two columns of Table 1 reveals that if the EU abandoned its moratorium and allow domestic production and imports of GM coarse grains and oilseeds, the EU would gain from its own actions. If this policy change induced other countries to also allow GM production of those crops, the EU welfare would improve by an additional (595 – 406 =) $189 million per year, due to a further improvement in the EU's terms of trade. Clearly these results do not support the view that an improvement in the terms of trade is the primary reason for the EU's protectionist response to GM adoption by others.

The farm lobby

The alternative explanation suggested earlier is that the EU farm lobby stands to gain from the current policy regime although farmers forego access to a lower-cost technology. The effects on real farm household incomes, summarized in Table 3, are indeed consistent with this political economy. The first three rows of Table 3 show Argentinean farmers' incomes increase slightly and farmers' income in the US and Canada decreases only slightly as a result of their adoption of GM varieties. Even though the productivity gains are more than offset by the price declines for North American farmers (since they are such a dominant part of the global market for maize and soybean), if any small sub-set of those farmers did not adopt they would be even worse off by suffering the price decline but not enjoying the productivity growth.

Note from columns two and three of Table 3 that American farmer income declines greatly when the EU imposes a moratorium, but declines only a small amount when the EU allows consumers avoid GM products by implementing a GM-labelling regime. EU farmers' income, on the other hand, declines slightly if there is GM adoption in the Americas, but increases when the EU imposes a moratorium on American imports. That advantage disappears if either EU consumers are allowed to choose for themselves or if EU farmers are allowed to adopt GM varieties (in which case the price decline evidently fully offsets the productivity gain for them – see columns 1 to 4 of row 8 of Table 3).

In short, the EU ban on production and imports of products that may contain GMOs harms American farmers' and benefits EU farmers, compared with the EU's alternatives of embracing the new technology or allowing EU consumers the right to choose. These results are thus not inconsistent with the hypothesis that farm interest group influence GM policy in these regions.[3]

Implications for the global trading system and developing countries

These findings have worrying implications for the global trading system. If it is in the interests of farmers in food-importing countries of Europe and elsewhere to forego adopting this new biotechnology in order to reduce their competitive disadvantage vis a vis more-efficient export-oriented producers, then those protected producers have incentives to join with consumer and environmental groups and lobby for tough GMO standards. It would not even be in the interests of Cairns Group farmers in Australia and New Zealand to oppose that stance. These standards could replace traditional forms of government assistance to agriculture, which current trade negotiations are seeking to dismantle in agricultural-protectionist countries. Not only would that negate the benefits of negotiating lower farm support programs in the current Doha round of WTO negotiations, but it could increase friction in the WTO's Dispute Settlement Body.

For developing countries, our results show that the EU moratorium benefits food-importers (and Japan and Korea), because of an improvement in their terms of trade. However, the above analysis does not take into account that moratoria will slow the investment in agricultural biotechnology, and thus reduce future market and technological spillovers to developing countries. Furthermore, future generations of GM products are likely to provide health and nutritional benefits to consumers, as in GM rice enhanced with Vitamin A. The costs of delaying investments in those GM technologies will fall heavily on the world's poor consumers (Anderson, Jackson and Nielsen 2004).

In contrast to trade moratoria, labelling policies potentially provide a mechanism for accommodating consumers' preferences for non-GM food, although not without some cost to the global economy in terms of necessary identity preservation systems. Their adoption in place of the current EU ban would provide both rich-country and poor-country consumers with greater choice than they currently have. However, more economic modelling research is required to include the costs of segregating GM-inclusive and GM-free products and to explore the incidence of the identity preservation cost between GM and non-GM farmers, between farmers as a group and others, and between rich and poor countries.

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TTable 1: Economic welfare effects of GM coarse grain and oilseed adoption by various regions

(equivalent variation in income, US$ million)

	US, Canada and Argentina adopt			US, Canada, Argentina and EU adopt	All adopt
	With no moratoria responses	With EU moratorium	With EU consumers free to boycott		
United States	939	628	936	928	897
Canada	72	7	67	70	65
Argentina	312	247	310	307	287
Brazil	-36	256	-46	-53	317
Other Latin America	125	184	130	128	356
Australia	-9	-4	-10	-10	2
New Zealand	-5	2	-5	-5	-6
EU-15	267	-3145	326	406	595
Eastern Europe	7	-10	9	8	35
China	107	111	113	110	235
India	0	3	1	0	252
Japan + Korea	322	341	178	335	430
Other Asia	36	44	39	37	134
South Africa	3	7	4	4	9
Rest of Sub-Saharan Africa	-2	14	-2	-2	60
Rest of World	152	75	169	167	380
WORLD	**2290**	**-1243**	**2219**	**2429**	**4047**

Source: Authors' GTAP model simulation results.

Table 2: Economic welfare decomposition of GM coarse grain and oilseed adoption by the US, Canada and Argentina
(% changes)

(a) With no policy responses

	Allocative efficiency impacts	Terms of trade impacts	New GM technology impacts	Total
United States	70	-368	1204	939
Canada	17	-43	101	72
Argentina	19	-50	338	312
Brazil	-18	-14	0	-36
Other Latin America	70	55	0	125
Australia	2	-11	0	-9
New Zealand	0	-4	0	-5
EU-15	181	102	0	267
Eastern Europe	5	-1	0	7
China	85	27	0	107
India	3	-3	0	0
Japan + Korea	98	239	0	322
Other Asia	17	19	0	36
South Africa	3	1	0	3
Rest of Sub-Saharan Africa	0	-2	0	-2
Rest of World	98	54	0	152
WORLD	**647**	**0**	**1643**	**2290**

(b) With EU moratoria response

	Allocative efficiency impacts	Terms of trade impacts	New GM technology impacts	Total
United States	192	-690	1153	628
Canada	17	-111	96	7
Argentina	5	-89	330	247
Brazil	100	125	0	256
Other Latin America	79	106	0	184
Australia	3	-7	0	-4
New Zealand	0	2	0	2
EU-15	-3431	288	0	-3145
Eastern Europe	-15	1	0	-10
China	85	28	0	111
India	-3	6	0	3
Japan + Korea	98	250	0	341
Other Asia	13	33	0	44
South Africa	2	5	0	7
Rest of Sub-Saharan Africa	1	12	0	15
Rest of World	33	42	0	75
WORLD	-2821	-1	1579	-1243

Source: Authors' GTAP model simulation results.

Table 3: Percentage change in farm household real income in selected regions, various GM adoption and policy response scenarios

	US, Canada, and Argentina adopt			US, Canada, Argentina and EU adopt
	With no moratoria responses	With EU moratorium	With EU consumers free to boycott	With no moratorium responses
United States	-0.18	-0.36	-0.20	-0.19
Canada	-0.26	-0.57	-0.28	-0.27
Argentina	0.01	-0.10	0.00	0.00
Brazil	-0.00	0.15	-0.01	-0.02
Other Latin America	-0.06	-0.06	-0.07	-0.07
Australia	-0.04	-0.03	-0.04	-0.04
New Zealand	-0.03	0.00	-0.03	-0.03
EU-15	-0.03	0.74	-0.05	-0.05
Eastern Europe	-0.03	0.08	-0.03	-0.03
China	-0.02	-0.02	-0.03	-0.02
India	0.00	0.00	-0.03	-0.03
Japan + Korea	-0.01	-0.01	-0.01	-0.01
Other Asia	-0.04	-0.03	-0.04	-0.04
South Africa	-0.03	0.02	-0.04	-0.04
Rest of Sub-Saharan Africa	-0.01	0.04	-0.01	-0.01
Rest of World	-0.04	0.03	-0.04	-0.04

Source: Drawing on the authors' GTAP model simulation results.

[1] For studies that differentiate the degrees of factor/input saving, see van Meijl and van Tongeren (2002). We ignore that complication because it makes little difference to the results being analysed here.

[2] This measure of impact on farmer income is different from the partial equilibrium measure of producer surplus used by, for example, Lindner and Jarrett (1978) who show that even with a completely inelastic demand curve a parallel shift (but not a pivotal shift) downwards in the supply curve will not reduce producer surplus. The measure of farm household income change used here can generate a loss for producers partly because it is a general equilibrium measure that also captures off-farm earnings of farm households, but also because the technology shock only applies to the GM varieties which then have to compete with the (sometimes preferred) non-GM varieties of that crop. Hence the price-depressing impact can more than offset the effect of the productivity improvement on profits of GM adopters.

[3] Further support for that hypothesis was found in another scenario, not reported here, in which the remaining OECD countries also ban coarse grain and oilseed imports from the adopting countries. In that scenario EU farmers benefit even more, giving them further reason to support EU consumer and environmental groups' opposition to GM products. Farmers in Japan and Korea, by contrast, are worse off in that scenario. This is because they produce almost no feedgrains or oilseeds and so their large import-competing livestock sectors have a strong interest in obtaining the lowest-priced feedstuffs from abroad (and hence in preventing tough GM legislation), otherwise they will be less able to compete with foreign livestock producers. The much-less-stringent GM consumer policies in Japan and Korea are thus also consistent with the special-interest hypothesis.