

Assessing the Implementation Effects of the Biosafety Protocol's Proposed Stringent Information Requirements for Genetically Modified Commodities in Countries of the Asia Pacific Economic Cooperation

Guillaume P. Gruère and Mark W. Rosegrant

We analyze the potential effects of a generalized implementation of the Cartagena Protocol on Biosafety's proposed stringent information requirements on countries, members of the Asia Pacific Economic Cooperation (APEC). This rule would request all traded shipments containing living modified organisms intended for food, feed, or processing to carry a label with the list of precise genetically modified (GM) events in the shipments. We find that the benefits of such requirements are largely debatable and that this regulation would add significant implementation costs for importers of GM crops, for Protocol members adopting new GM crops, and for countries ratifying the Protocol.

The Cartagena Protocol on Biosafety (CPB), also called the Biosafety Protocol, was introduced in January 2000 as a supplementary agreement to the United Nation Convention on Biological Diversity in an effort to set up a harmonized framework of risk assessment, risk management, and information sharing on the transboundary movements of living modified organisms (LMOs)¹ (Secretariat of the Convention on Biological Diversity). The Protocol entered into force after ratification by one hundred countries in September 2003. There are now more than 150 members, but some of the largest LMO producers, such as Argentina, the United States, Canada, and Australia are not members of the Protocol.

■ *Guillaume P. Gruère is a research fellow in the Environment and Production Technology Division at the International Food Policy Research Institute (IFPRI).*

■ *Mark W. Rosegrant is director, Environment and Production Technology Division, at the International Food Policy Research Institute (IFPRI).*

Among the key measures of the Protocol, there are specific rules for trans-boundary movements of LMOs intended for direct uses as feed, food, or processing (noted LMO-FFPs), which are essentially unprocessed genetically modified agricultural commodities. This group of LMOs represents about 90% of all trans-boundary movements of LMOs (Kalaitzandonakes). There are two types of rules affecting LMO-FFPs: (1) rules applying to the import of a particular GM event,² and (2) information requirements on traded LMO-FFPs. Import approval measures for LMO-FFPs are less stringent than for LMOs intended for release into the environment, but they are still based on a precautionary approach, allowing nations to reject the import of any LMO-FFPs at least for a certain period. Their application could be in direct conflict with the Sanitary and Phytosanitary (SPS) agreement of the World Trade Organization (Cors, Phillips and Kerr, Winham, Redick). But so far their implementation has only encouraged developing countries to adopt national import approval regulations as done in developed countries.³ On the other hand, the proposed stringent information requirements on imported genetically modified (GM) commodities are highly controversial, because they are much stricter than any type of national mandatory labeling policies for GM food products and are therefore strongly opposed by large GM crop producing countries.

Under article 18.2.a., parties to the CPB “should request information” from exporters regarding the presence and the identification of LMO-FFPs in any shipment before importation. Initially, the CPB only recommended members to notify the potential presence of LMO-FFPs in traded shipments by stating that the shipment “may contain LMO-FFPs” and inviting countries to send the relevant information to the Biosafety Clearing House—an Internet open database. But the definitive nature of the information requirements was not finalized, and a decision was expected in the second meeting of the parties in Montreal, in June 2005. At this meeting, a more stringent information rule was proposed, requiring lists of precise LMO-FFPs (crop/trait/company) in all traded shipments and the setting of a threshold for adventitious presence of LMO-FFPs in non-LMO shipments, but no agreement was reached and the issue was reported to the third annual meeting of the parties in Brazil in March 2006 (Redick).⁴

During the third meeting of parties, in March 2006 in Brazil, Protocol members finally agreed to have a two-option rule on information requirements (BRIDGES). Shipments containing LMO-FFPs identified “*through means such as identity preservation systems*” must show that the shipment “contains” LMO-FFPs and provide a list of GM events present in the shipment. Shipments of LMO-FFPs that are not well identified will only have to label their shipment as “may contain LMO-FFPs,” and information on the complete list of GM events commercialized in the exporting country would be available to the importers via the Biosafety Clearing-House (BCH) or if not, on the importers’ request (Redick). In this context, the main difference between the two options is about the identification process—which can be done through means of identity preservation—but the rule does not specify who will decide which option to choose. As a consequence it was expected that LMO-FFPs exporters would decide which option applies and therefore prefer the “may contain” option. At the same time, parties decided to reconsider the rule during the 2010 meeting of parties with the possibility of extending the requirements with “contains” and list of events to all shipments of LMO-FFPs in 2012 (BRIDGES).

The other important feature of the agreement is the absence of a threshold level of adventitious presence, leaving room for importers' choice but no justification for the use of threshold levels.

The main issue with implementing list information requirements relates to the commingled nature of the global marketing system for major agricultural commodities. The main GM commodities are traded together by grade, not by GM event. In particular, the United States, the largest exporter of GM crops, that has approved over fifty events of GM maize, has a marketing system that does not make any distinction for exported maize (Kalaitzandonakes). In this context, a few recent studies have underscored the likely high cost of implementation of stringent information requirements for traded LMO-FFPs on large exporters of GM crops (JRG Consulting Group, Direccion Nacional de Mercados Agroalimentarios, Kalaitzandonakes, Foster and Galeano). These studies show that stringent documentation requirements would be very costly for the Argentinean soybean industry, the Canadian grain exporters, and the U.S. maize industry, respectively. Argentina, Canada, and the United States are three major producers and exporters of GM crops, and are not ratifying parties to the Cartagena Protocol. Two additional studies (Foster and Galeano, Huang et al.) draw similar conclusions for the case of two other large traders producing GM crops, Australia and China.

At the same time, a large group of countries, including many developing countries that are members of the Protocol, not producing but rather importing GM crops, have been clearly supporting the generalization of stringent "contains" information requirements, even if they would also bear the costs associated with this type of measure. Still, it appears that little is known about what these costs would be, and overall, there is a lack of analysis on the potential economic effects of stringent requirements on CPB member and nonmember developing countries that are importing GM crops.

This article provides an assessment of the potential direct effects of implementing a generalized rule on stringent information requirements with an application on countries that are members of the Asian Pacific Economic Cooperation (APEC). This group of countries includes mostly large traders of agricultural commodities, and presents all types of countries—GM producers or not, importers or exporters, CPB members and nonmembers, developing and developed countries—who would likely all be affected by stringent information requirements. We develop a conceptual framework, synthesizing the implementation effects of the generalization of stringent requirements on importers and exporters of APEC. We use recent trade and cost data to evaluate the immediate costs of implementing such requirement for all APEC countries.⁵ The conceptual framework is then applied more specifically to the case of maize, soybeans, canola, cottonseeds as well as the effects of adventitious presence on rice and wheat in six particular countries of APEC with significant economic stakes: China, Indonesia, Malaysia, Mexico, and Peru (all members of the Protocol and major importers). We also analyze the spillover effects that stringent information requirements would have on two nonmembers of APEC (in 2006) that could decide to ratify the Protocol: the Philippines and Russia.⁶

Our analysis shows that strict information requirements ("contains" with precise list of events and adventitious presence of GM in each shipment) would come at a large cost for exporters and importers, and affect the choice of production

technology in all countries involved. In addition, we argue that the benefits of such information requirements are not convincing compared to the default “may contain” rule with information on the potential list of GM events.

Conceptual Framework: Information Requirements and Trade Flows

Article 18.2.a of the CPB handles documentation requirements for exporters, including information on movements of LMO-FFPs. Under the proposed stringent option, countries that only produce and export non-GM would be exempt from verifications and tests. In contrast, countries that produce GM would have to obtain approvals in their export markets (which can be considered a fixed cost) and would also have to test each shipment to verify the accuracy of event identification. In other words, they would need to identify each GM event in the shipment, which would require *qualitative* genetic tests on each shipment (a variable cost). Moreover, if the GM producing countries export a non-GM commodity under identity preservation they would have to conduct tests in order to make sure the quantity of GM crops in the shipment is lower than the threshold levels of importers, which requires *quantitative* genetic tests (another variable cost).

On the other hand, importers that are members of the CPB would need to verify the truthfulness of the statements to insure the enforcement of the measures. To do so, they would have to conduct *qualitative* and *quantitative* tests (if they have a threshold) for each type of shipment. Under either alternative information rules, any GM shipment should be tested to be sure that there is no unapproved variety. Similarly, a non-GM shipment with a threshold level would require tests on behalf of the importer.

To assess the potential effects of the Biosafety Protocol’s Article 18.2.a, we divide countries into four groups according to their membership to the CPB and their adoption of GM crops:

Group 1: GM producers, not members of CPB, such as the United States or Canada.

Group 2: not GM producers, members of CPB, such as Japan, Indonesia, or Peru.

Group 3: GM producers, members of CPB, such as China or Mexico.

Group 4: not GM producers, not members of CPB, such as Russia.

The definition of these groups can be interpreted generally, based on the production of any GM crop, or conversely attributed by crop, based on the production of one or another GM crop. This distinction depends on whether a country producing one GM crop will be required to certify the presence or absence of this GM crop in any other shipment.

Figure 1 provides a schematic example of the group division and linkages before implementation of the CPB for the theoretical case of perfectly symmetric trade flows. In this figure, each group of country exports to all other groups, including itself.

In a short-term horizon, if we assume that groups remain the same, that is, that CPB membership is stable and that only exports from GM producing countries to CPB member countries would be affected by CPB information requirements,

Figure 1. International trade flows before implementation of the CPB: conceptual framework under symmetric trade flows

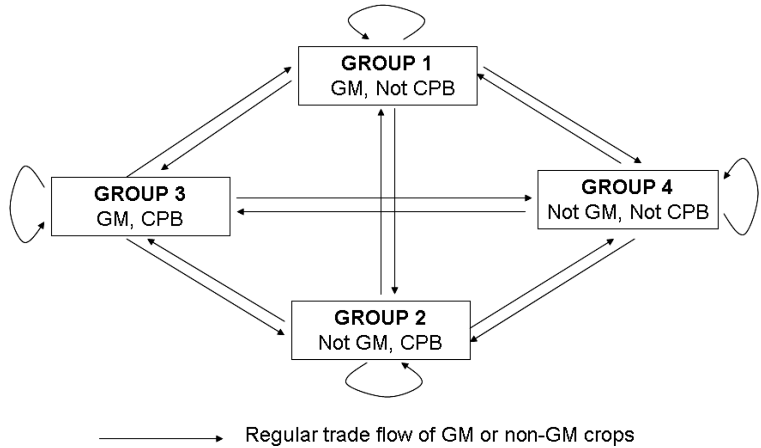
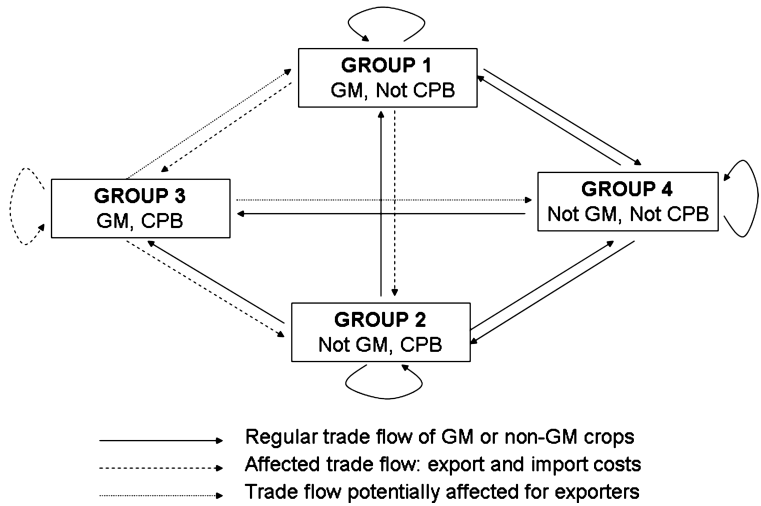


Figure 2. Short-run effects with the implementation of the CPB



then the following four bilateral trade flows would bear the costs of CPB implementation (by importers and exporters): exports of Group 1 to Group 2 and 3, and exports of Group 3 to Groups 3 and 2 as shown in figure 2. Moreover, in their report on the potential cost of information requirements for Canada, JRG Consulting assumed that the Protocol would also require CPB members producing GM to provide information on exports to any country. This means that two additional trade flows could be affected: exports from Group 3 to Group 4 and exports from Group 3 to Group 1.

This simple framework already provides some important insights. First, the most affected countries in terms of trade flows are Group 3 countries that are both members of the Protocol and GM producers. These countries would have to control imports from all GM producing countries and exports to other members, as well as exports (under the JRG Consulting assumption) to all nonmember countries. Secondly, non-GM producers that are members of the Protocol would only have to control imports of shipments coming from GM producing countries. Thirdly, the only nonmembers affected are the producers of GM crops that are also exporters, whereas importing GM producers and non-GM producers will not be affected.

In the following section, we analyze the potential benefits of stringent information requirements compared to the “may contain” option. We then use the above identification of affected bilateral trade flows to explore the potential implementation costs of information requirements for all APEC countries.

Benefits and Costs of Stringent Information Requirements in APEC

Potential Benefits: Information for CPB Members Trading GM Commodities

In this section, we discuss the potential benefits of stringent “contains” documentation requirements with the precise list of GM events in comparison with the “may contain” documentation requirements with the option to require a list of commercialized GM events, without any consideration of costs or negative effects of such regulation (which will be the object of the following section).

First it is important to note that the use of a “contains” rule with list of events for information on commodity shipment would not affect in any way the use of domestic regulations on the labeling of consumer products derived from LMOs. All mandatory labeling policies of GM food currently implemented only require food to be labeled by stating that a particular ingredient is GM (or derived thereof), but none of them requires food producers to list the specific GM events on the label (Gruère and Rao). Therefore, the “may contain” statement rule on an imported shipment is sufficient to trigger labeling of consumer products in countries with mandatory labeling. A more stringent “contains” rule with precise list of events on shipments would not result in any difference in consumer labeling. In other words, this new requirement would not result in any direct informational benefit to the consumer.⁷

LMO-FFPs are largely traded commodities that are not differentiated in function of the technology of production. There is a market niche for non-GM soybeans and corn used for food in Japan and Korea, and for non-GM soybeans in the European Union, but the largest share of the market is based on commingled sources of GM/non-GM crops. Under the provisional rules, the “may contain” statement associated with the BCH provides basic information on the content of shipments based on their origin, and invites the importer to obtain more information if necessary by directly contacting the exporter.

In APEC countries that have implemented approval procedure for imported GM food, and that do not allow unauthorized GM event, the importers can test the

imported commodities, but this happens after the delivery is made. For instance Japan has a 0% threshold on unapproved varieties of GM food, and a 1% threshold for GM feed varieties approved in other countries (Gruère). If a test reveals that the shipment contains unapproved varieties, the imports are rejected. This encourages exporters and indirectly exporting growers to adopt varieties approved in Japan, while seed companies do send applications for new varieties through the Japanese regulatory system. The “may contain” statement may be used to trigger random tests of unapproved varieties, but no test of approved varieties is necessary. In countries that have not implemented an approval procedure, the shipment comes with a “may contain” statement, and does not require any further authorization to be used. In some cases this information may trigger the rejection of GM, but in most cases it does not affect imports.

The implementation of the “contains” requirement with list of events would provide more precise information on each imported shipment. Provided the information is correct, and verifiable, this would arguably allow importing countries to have a better control on what comes in, including approved LMO-FFPs, unapproved LMO-FFPs, or LMO-FFPs that are neither approved nor unapproved in countries without regulations. If they decide to reject certain GM events in absence of complete authorization,⁸ only well-documented shipments with the proper GM events will be accepted.

In cases of introduction of unwanted GM events in the marketing chain, this system would supposedly allow for a more rapid detection of unwanted varieties as a support to the recall mechanism. In the case of Starlink[®] corn, a corn variety only approved for feed in the United States, but commingled with corn used for human consumption, Japan first stopped all corn from the United States, therefore not making any distinction. After the destruction of the targeted corn in the United States, Japan continued testing and detecting Starlink corn for several years after the crisis.

Overall, what would be the marginal benefit of this additional information? If there is an unwanted GM variety, all shipments containing it would be rejected, there would be no sorting out of shipments, but unlike the case of the “may contain” option, some shipments (without the unapproved event) may be approved from a country that is producing the unapproved variety. For example, Japan controlled imports of Starlink corn without strict information requirement, but its response could have been more limited with a precise list of events set up on the export side provided it could trust such information. At the same time, the Starlink case showed that despite efforts on the export side, the unwanted corn event persisted for a longer time in the market chain, which shows that in such case, import control for unapproved variety (which would have occurred with or without a precise list of events) is necessary. More generally, the use of precise lists of events as support for a trade filter will depend on the degree of risk aversion of the importer: a risk-averse country may prefer to reject all imports than to filter, even with stringent information requirements (as shown in the case of Bt 10 maize in several countries and unapproved GM rice events in Europe).

On the other hand, in the absence of crisis linked to the introduction of unwanted GM events, the effects of the two options are similar. In countries with approval regulations, unapproved shipment will be rejected. For countries without approval regulations, this would provide information that would not be relevant

for approval or rejection, because what matters in these countries is the presence or absence of any GM material. In addition, the stringent rule would not provide any additional benefit for the setting up of identity preservation schemes that already exist with the “may contain” rule and apply mostly to non-GM crops.

Lastly, the “contains” rule will not provide clear benefits for managers of environmental risks. Environmental regulators seek to avoid the dispersion of unwanted LMO-FFPs material into the environment. This can be done through various means, such as processing or containment at port of entry, but would not in itself be facilitated with a precise list of GM events (“contains”) instead of a qualitative statement (“may contain”) coupled with additional information from the BCH.

To sum up, there are three main differences between “may contain” and “contains” rules: (1) the “contains” rule requires testing for both unapproved *and* approved varieties from exporters and importers, (2) with the “contains” rule, voluntary testing becomes mandatory for exporters, and (3) the “contains” rule provides a justification for a selective importing policy (filtering the rejected events) rather than an import ban in case of shocks.

On the one hand, for importing countries with approval procedures, point (1) does not provide a clear benefit and point (2) may not be significantly different—because of liability: to mitigate risks exporters have an economic incentive to avoid unapproved varieties. On the other hand, for countries without approval procedures, this system provides a basis for rejection in case of a surprise event. But these latter countries are likely to implement an approval procedure in the future, and then they may not gain much from systematic testing on approved varieties. Finally, point (3) could be beneficial for GM exporters if importers were actually keen on using selective information rather than market bans for risky varieties. However, the CPB allows countries to reject imports without quantitative justification (in the presence of potential risk and for a certain time period), and thus allows member countries to reject all imports of GM in case of uncertainties.⁹

Quantitatively, this more stringent measure was designed to reduce uncertainties, but in fact the outcome would critically depend on the accuracy and frequency of testing and the credibility of the market chain institutional arrangements. The “may contain” statement does not provide certainties on the content, but it still allows importers to obtain a complete list of possible GM events, with information on more GM events potentially present than what is likely to be found in the shipment—a statistical Type II error. In contrast, the “contains” statement provides “certain” information on GM events, which runs the risk of a statistical Type I error, that is, the undetected presence of unstated GM events. The objective of risk managers is to reduce Type I errors, because it implies the acceptance of unwanted (potentially hazardous) products. As a result, in the case of crisis, a risk-averse policymaker may decide to avoid any import from the producing country, in order to avoid Type I error. But any country can do that with a “may contain” statement; thus, there is no clear advantage of the “contains” statement in this situation.

Potential Costs: Importers and Exporters, Members and Nonmembers

To assess the potential cost of stringent information requirements, we first divided countries into the four above-defined groups, based on their GM crop

adoption status and CPB membership as of 1 January 2006. We then systematically analyzed the destinations and origins of APEC's economies recent trade flows (using averages of import and export volumes on the period 1999–2004) for the current four major LMO-FFPs—maize, soybeans, rapeseed (canola), and cottonseed—using the United Nations Comtrade bilateral trade data base at the 4-digit level (United Nations Statistics Division). More specifically, we sorted average export volumes according to the group of the destination of exports (within and outside APEC) from all APEC countries in each group and we sorted average import volumes according to the group of origins of imports (within and outside APEC) to APEC countries for these four commodities. Based on our above identification of affected bilateral trade flows, we then aggregated separately export and import quantities affected for all countries members of APEC. The division of trade quantities by group of countries helps us determine the total share of import or export quantity potentially affected by the implementation of stringent information requirements.

We use these shares and quantities of exports to compute ranges of estimates of the potential implementation costs of stringent requirements in APEC countries. Our approach is similar to estimating an exposure in the setting of a risk assessment. By multiplying the total quantity of bilateral trade flows affected by per unit compliance cost estimates (similar to a hazard rate in risk analysis), we obtain an approximate implementation cost for these countries. Assuming that the testing and implementation costs do not vary for each trade flow, the magnitude of the total impact under any scenario depends directly on the volume of trade affected by stringent information requirements.

We first study trade flows of the four products for all APEC members. We know that exporters will be required to provide information on the content of shipment, but importers will also have to pay for the system to work. International trade control happens at port of entry, and importers have to control what is in the shipments and whether the information provided is correct. Although a nation could decide not to conduct any test of imports, and trust the exporters, it would encourage fraud, especially with the numerous cargoes that transit in a port or another. In countries that have labeling or approval regulations, the risk would be borne by the private companies using these ingredients, and these companies will have to test for themselves. On the other hand, member countries without any domestic regulations are trying to set up approval regulations and testing capacities. In particular, most developing countries of the CPB are asking financial support to the United Nations Global Environmental Facility, the capacity building component of the CPB for testing facilities of GM imports. Therefore, it is reasonable to assume that there will be testing by importers in all APEC countries.

We use data from the four major GM crops to derive the actual distribution of volume of imports and exports by groups or destination and origin based on a five-year average bilateral trade flows. The results are shown in table 1 and table 2, and help us to derive shares of imports and exports as shown in table 3.

We find that information requirements would be applied to a very minimum annual average of 52 million tons of imports of these crops in APEC, representing 66% of total imports of these four crops in APEC. Furthermore, at least 74 million tons of exports, representing 68% of all exports of the four crops from APEC countries, would be directly subject to information requirements. Our conceptual

Table 1. Trade flow analysis of average imports of maize, soybeans, canola, and cottonseed for all APEC countries

Volume of Imports (Metric tons)	Country of Origin				Total Imports/ Group
	GROUP 1	GROUP 2	GROUP 3	GROUP 4	
APEC importing country					
GROUP 1 (GM, not CPB)	3,707,480	145,461	6,436*	60,700	3,920,077
GROUP 2 (No GM, CPB)	42,969,103	4,380,186	5,298,439	1,225,500	53,873,228
GROUP 3 (GM, CPB)	4,167,307	27,127	238,409	0	4,432,842
GROUP 4 (No GM, not CPB)	10,620,756	6,421,116	481,573*	67,699	17,591,144
Total APEC imports	61,464,645	10,973,890	6,024,857	1,353,900	79,817,292

Note: The bold numbers represent volumes affected by a list requirement.

*Tests required only at exporters under JRG option.

Table 2. Trade flow analysis of average exports of maize, soybean, canola, and cottonseed for all APEC countries

Volume of Exports (Metric tons)	APEC Exporting Country				Total APEC Exports
	GROUP 1	GROUP 2	GROUP 3	GROUP 4	
Country of destination					
GROUP 1 (GM, not CPB)	4,720,744	130,960	2,529*	45,366	4,899,600
GROUP 2 (No GM, CPB)	69,270,951	4,677,575	825	1,127,676	74,077,037
GROUP 3 (GM, CPB)	4,322,980	98,518	0	1,709	4,423,207
GROUP 4 (No GM, not CPB)	18,836,911	5,102,661	5,210*	227,273	24,172,055
Total exports/group	97,151,586	10,009,715	8,564	1,402,034	108,571,900

Note: The bold numbers represent volumes affected by a list requirement.

*Tests required only at exporters under JRG option.

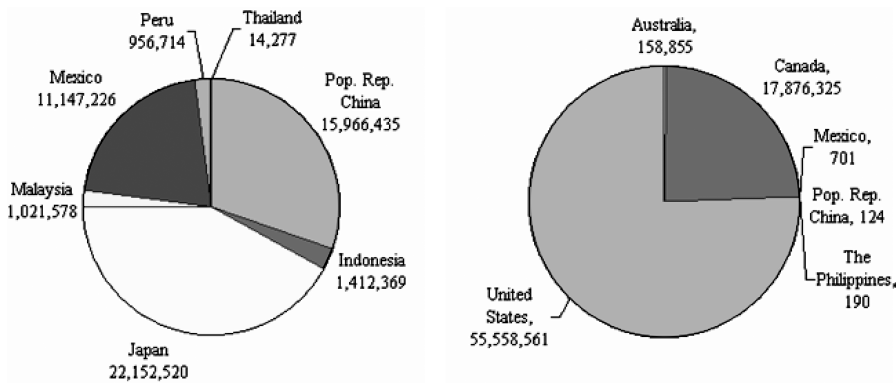
division of trade flows is based on symmetric trade flows, but in reality trade flows are not symmetric, particularly for APEC countries, as shown in table 3. Current GM crops are mostly traded from Group 1 countries (GM producers, not members of the CPB) to Group 2 countries (members of the CPB and not GM producers). Thus, because there will likely be significant variables costs associated with stringent documentation requirements, most of the costs will be borne by nonmember exporters and producers of GM crops on the one hand, and importers of the crops that are members of the CPB on the other. Figure 3 provides the distribution of volume affected in the short run by APEC economy. As expected,

Table 3. Distribution of imports and exports by trade flows of maize, soybeans, canola, and cotton seeds for APEC countries

Exporter	Importer	% Total APEC Export	% Total APEC Imports
Group 1	Group 1	4.5	4
	Group 2	64	54
	Group 3	4	5
	Group 4	17.5	13
Group 2	Group 2	4.5	6
	Group 4	4.5	8
Group 3	Group 1		1
	Group 2		7
Group 4	Group 2	1	2
Total		100	100

Note: Affected trade flows are reported in boldface.

Figure 3. Distribution of average volume of imports (left panel) and exports (right panel) affected by APEC economies (metric tons)



exports from the United States and Canada would be largely affected, but on the import side, Japan, China, Mexico, and to a lesser extent Indonesia, Malaysia, and Peru would all have a share of imports requiring documentation.

Moreover, the application of thresholds of adventitious presence to all current GM and non-GM crops (to control within species commingling) would extend the requirements to about 5.5 million tons of imports for all APEC economies, and 4.5 million tons of exported commodities. Similarly, the application of adventitious presence requirements on rice and wheat exported to CPB members (to control between species commingling) would affect a minimum of 13 million tons of imports for APEC countries and 34.5 million tons exported by APEC countries. Adding up the different volumes, assuming that an extensive threshold level is adopted and that the “contains” statement holds for all potentially GM crops,

we estimate that importing requirement would affect about 70.5 million tons of maize, soybeans, rapeseeds, cottonseed, rice, and wheat for all APEC countries. On the export side, the total volume affected would reach 113 million tons of grains each year.

The costs of information requirements can be divided into export and import costs. Export costs have been identified (Kalaitzandonakes): testing at port of export, setting up a tracking system in the marketing channel, assuring the risk of rejection due to uncertain tests, and paying for additional charges related to waiting time costs due to lengthy tests at port of entry. On the importer's side, direct costs relate to the implementation and enforcement of the measure, such as testing and documentation inspection and enforcement.

It is currently difficult to obtain precise estimates of quantitative costs at the national level. However, previous reports have provided partial estimates of these costs. We choose to make assumptions based on these reports and derive ranges of total testing costs. The report on Canada (JRG Consulting) uses unit cost estimates of CAN\$6–CAN\$15 for traceability and testing for each ton exported, which corresponds to \$3.6–\$9/ton (GM crops and non-GM crops). At the same time, Kalaitzandonakes assumes much lower costs for exports mostly related to testing. We choose to use a wide range of unit cost for exports of \$1–\$9/ton. On the import side, Kalaitzandonakes also analyzes in detail the potential costs of testing, under different scenarios. We choose to use his unit cost assumption for a 20 sample/cargo testing (following the minimum requested by the European Union) applied to 25,000 ton cargo average, with rapid testing to obtain results in 0–2 days, and with 0–2 days delay in harbor, which ends adding up to a range of \$0.5–\$4/ton.¹⁰

Using these estimates, that is, assuming that all countries are able to implement an efficient testing system with similar infrastructures and capacities as North America, the total cost of documentation requirements for APEC economies could range between \$100 and \$900 million per year. Extensions for adventitious presence for the four crops, plus wheat and rice may add up some \$50–\$400 million to make the total cost for APEC between \$150 million and \$1.3 billion/year as shown in table 4. But while Japan and Australia may have similar testing

Table 4. Estimated costs for APEC under North American conditions

Import unit cost*	\$0.5/ton	\$1.5/ton	\$4/ton
Export unit cost*	\$1/ton	\$5/ton	\$9/ton
Total export costs	\$74 million	\$370 million	\$666 million
Total import costs	\$26 million	\$78 million	\$208 million
Total "Contains"	\$100 million	\$448 million	\$874 million
Adventitious presence (AP) in four crops, rice and wheat	\$48 million	\$223 million	\$425 million
Total "Contains" + AP	\$148 million	\$671 million	\$1,300 million

*Source for unit cost assumed: authors' choice, based on JRG Consulting for exports and Kalaitzandonakes for imports (20 samples/cargo, 0–2 days testing, 0–2 days' delays).

and infrastructure capacity as North America, this is unlikely to be the case for developing countries, so the costs they would face are likely considerably higher. Furthermore, we do not consider the cost the system may impose on each country adopting a new GM crop. In the next section, we focus on six APEC countries, to consider the costs that they could face with such requirements under other scenarios.

Implementation Effects of Strict Information Requirements under Alternative Scenarios for Six APEC Economies

To complement this aggregate assessment, we focus on six APEC economies (China, Mexico, Indonesia, Peru, the Philippines, and Russia) and derive affected volumes of trade under different scenarios on membership and GM crop production. The first four countries are CPB members, China and Mexico are GM producers, exporters and importers (Group 3 overall), while Indonesia and Peru are significant importers of GM food (Group 2). The Philippines and Russia are not members of the CPB,¹¹ the Philippines are producing GM maize (Group 1) and Russia is not (Group 4). For each crop, we evaluate how stringent information requirements ("contains" statement with list requirements) would impact the six countries trade flows first under current production technology conditions and second if these countries were adopting GM varieties. In addition, for countries that are not members of the CPB we look at the possibility of their entering the Protocol.

Maize

The results of our analysis for maize are shown in table 5. First, under current conditions, Mexico, Peru, and Indonesia would have to test large volumes of imports. Secondly, the implementation of information requirements would provide an economic disincentive for China to adopt GM maize, because of its current exports to CPB members. Third, such a measure would create significant costs of entry into the CPB for Russia and the Philippines.

Soybeans

The same procedure is used in the case of soybeans (table 6). Because most soybeans are produced and exported in countries with GM, over 90% of imports in the three CPB member countries would be affected. On the other hand, GM adoption would not make a large difference for the six countries in the short run, and only the Philippines would face a significant entry cost if it were to ratify the Protocol with this measure.

Other Crops

The trade flows of rapeseed and cottonseed that are potentially GM are also significant but not as large as for the other crops. China (650,000 mt) and Mexico (1,078,373 mt) would be the biggest concerned by volume of trade among the six countries.

In the case of rice, China (887,000 mt) and Mexico (681,521 mt) would also be the first countries to pay the cost of a low threshold of adventitious presence

Table 5. Trade volumes (metric tons) and share of total trade flows of maize affected by CPB requirements under different scenarios

Maize (metric tons) APEC Economy (Group for Maize)	Exports		Imports		Total
	Average Share of Quantity Affected	Average Quantity Affected	Average Share of Quantity Affected	Average Quantity Affected	Traded Quantity Affected
China (Group 2)					
CPB current situation	0%	0	2.10%	191	191
CPB effects with GM ⁽¹⁾	45.54%	4,267,305	2.10%	191	4,267,496
CPB effects with GM ⁽²⁾	100%	9,370,937	2.10%	191	9,371,128
Mexico (Group 2)					
CPB current situation	0%	0	99.99%	5,932,121	5,932,121
CPB effects with GM ⁽¹⁾	27.24%	12,504	99.99%	5,932,121	5,944,625
CPB effects with GM ⁽²⁾	100%	45,906	99.99%	5,932,121	5,978,027
Indonesia (Group 2)					
CPB current situation	0%	0	22.56%	265,715	265,715
CPB effects with GM ⁽¹⁾	87.92%	35,354	22.56%	265,715	301,069
CPB effects with GM ⁽²⁾	100%	40,213	22.56%	265,715	305,928
Peru (Group 2)					
CPB current situation	0%	0	96.65%	904,271	904,271
CPB effects with GM ⁽¹⁾	84.77%	4,476	96.65%	904,271	908,747
CPB effects with GM ⁽²⁾	100%	5,280	96.65%	904,271	909,551
Philippines (Group 1)					
CPB current situation	77%	190	0%	0	190
Membership with GM ⁽¹⁾	77%	190	47.04%	117,470	177,560
Membership with GM ⁽²⁾	100%	247	47.04%	117,470	177,717
Russia (Group 4)					
CPB current situation	0%	0	0%	0	0
CPB effects with GM	3.47%	446	0%	0	446
Membership no GM	0%	0	35.72%	144,061	144,061
Membership with GM ⁽¹⁾	3.47%	446	35.72%	144,061	144,507
Membership with GM ⁽²⁾	100%	12,856	35.72%	144,061	156,917

⁽¹⁾ Assuming only exports to CPB countries have to be documented.

⁽²⁾ Assuming all exports from CPB members have to be documented.

on rice trade. Moreover, if China adopted GM rice, its trade volume affected by requirements would double. In the case of wheat, the volume of trade affected for China, Mexico, Indonesia, and Peru would exceed 8 million tons of wheat. In addition, the Philippines would have to test 2 million tons of wheat if it became member after the implementation of this measure. In contrast, Russia would incur most costs by ratifying the CPB and adopting GM wheat (4 to 5 million tons).

Minimum Cost Estimation

The minimum total costs include testing and documentation for importers and a comprehensive segregation system to handle exports. Once again, we use estimates of unit costs to report ranges of possible implementation costs. We assume

Table 6. Trade volumes (metric tons) and share of total trade flows of soybeans affected by CPB requirements under different scenarios

Soybeans (metric tons) APEC Economy (Group for Soybeans)	Exports		Imports		Total Traded Quantity Affected
	Average Share of Quantity Affected	Average Quantity Affected	Average Share of Quantity Affected	Average Quantity Affected	
China (Group 2)					
CPB current situation	0%	0	99.92%	15,316,600	15,316,600
CPB effects with GM ⁽¹⁾	81.16%	201,254	99.92%	15,316,600	15,517,854
CPB effects with GM ⁽²⁾	100%	247,974	99.92%	15,316,600	15,564,574
Mexico (Group 3)					
CPB current situation	31.76%	701	99.35%	4,136,732	4,137,433
CPB effects ⁽²⁾	100%	2,208	99.35%	4,136,732	4,138,940
Indonesia (Group 2)					
CPB current situation	0%	0	94.18%	1,146,654	1,146,654
CPB effects with GM ⁽¹⁾	67.98%	439	94.18%	1,146,654	1,147,079
CPB effects with GM ⁽²⁾	100%	646	94.18%	1,146,654	1,147,299
Peru (Group 2)					
CPB current situation	0%	0	90.56%	52,438	52,438
CPB effects with GM ⁽¹⁾	88%	8	90.56%	52,438	52,446
CPB effects with GM ⁽²⁾	100%	9	90.56%	52,438	52,447
Philippines (Group 4)					
CPB current situation	0%	0	0%	0	0
CPB effects with GM	n.a.	0	0%	0	0
Membership no GM	0%	0	96.38%	270,213	270,213
Membership with GM ⁽¹⁾	n.a.	0	96.38%	270,213	270,213
Membership with GM ⁽²⁾	100%	0	96.38%	270,213	270,213
Russia (Group 4)					
CPB current situation	0%	0	0%	0	0
CPB effects with GM	93.53%	11,838	0%	0	11,838
Membership no GM	0%	0	73.50%	19,845	19,845
Membership with GM ⁽¹⁾	93.53%	11,838	73.50%	19,845	31,683
Membership with GM ⁽²⁾	100%	12,657	73.50%	19,845	32,502

⁽¹⁾ Assuming only exports to CPB countries have to be documented.

⁽²⁾ Assuming all exports from CPB members have to be documented.

n.a.: = not applicable.

that a “contains” with list requires testing costing \$0.5 to \$4 per ton imported, and \$1 to \$9 per ton exported. With these assumed unit costs, we provide ranges of possible costs estimates in table 7.

Discussion

Our range of cost estimates is wide, because there are still large uncertainties on the rules of implementation, and the unit cost for each commodity and each

Table 7. Estimated minimum annual implementation costs under alternative scenarios*

Million USD	China	Mexico	Indonesia	Peru	Philippines	Russia
Current conditions						
Total four crops	\$8 to 64 million	\$6 to 45 million	\$1 to 6 million	\$0.5 to 4 million	Insignificant	\$0
Adventitious presence (AP) in non-GM grain trade: rice & wheat						
Total non-GM AP	\$2 to 32 million	\$2 to 20 million	\$0.5 to 4 million	\$1 to 5 million	Insignificant	\$0
Total AP and "Contains"	\$10 to 96 million	\$8 to 65 million	\$1.5 to \$10 million	\$1.5 to 9 million	<\$10,000	\$0
Additional costs for GM crop adoption						
GM maize	\$4,267,305	\$12,504	\$35,354	\$4,476	n.a.	\$446
	\$84,338,433	\$413,154	\$361,917	\$47,520		\$4,014
GM soybeans	\$201,254	n.a.	\$439	\$8–72	\$0	\$11,838
	\$2,231,766		\$5,814			\$106,542
GM rapeseed & cottonseed	\$0	\$0	\$302–21,618	\$4–36	\$72	\$36,563
					\$648	\$329,067
GM rice & wheat (includes AP)	\$1,531,872	\$407,488	\$4,964	\$640	\$669	\$0
	\$26,127,720	\$4,135,356	\$59,652	\$5,985	\$7,434	
Total GM	\$6 to 113 million	\$0.4 to 4.5 million	\$0.04 to 0.4 million	<\$50,000	<\$11,000	\$0.05 to 0.5 million
Additional costs for CPB membership						
Total CPB membership					\$1 to 10 million	\$0.1 to 1 million

n.a. = not applicable.

*Assumptions: For GM: import unit costs \$0.5–\$4/ton, export unit costs: \$1–\$9/ton.

country will differ widely, potentially out of the assumed range. The real cost values are expected to be in the upper end of the range of cost estimates for developing countries, and particularly less developed countries, because they may not have the capacities and materials to conduct such intensive tests. Furthermore these costs do not represent the total cost of stringent documentation requirements, because they do not account for possible trade rejections, delays, or trade dispute. Nonetheless, we can draw three important lessons from these results. Stringent information requirements would:

- i. Impose significant costs on CPB importers of the current GM crops and potentially other grains, due to the large share of GM producing countries in the world exports.
- ii. Impose a new entry cost for the adoption of current and future GM crops on CPB exporters especially if they export mainly to other CPB member countries.
- iii. Impose a significant cost of entry for Protocol membership to new countries, thus potentially slowing the adoption of harmonized rules for traded living modified organisms.

Conclusions

In this article, we analyze the direct effects of generalizing the CPB's proposed stringent information requirements with a "contains" statement and the list of precise events for traded shipments of GM crops on importing and exporting countries members of the APEC.

We first compare the potential benefits of "contains" information requirements for members of the CPB relative to the default "may contain" option, associated with the potential list of possible GM events, and show that despite the wide support for the first option among CPB members, its relative benefits are highly debatable, both in terms of risk management and uncertainties.

We then conduct a bilateral trade flow analysis to derive average annual volumes of trade affected by information requirements under different scenarios for countries of APEC. Because most of the requirement costs will be dependent on volume, we use trade volumes to measure the extent of the potential effects for APEC as a whole and for six different APEC economies (China, Mexico, Indonesia, Peru, the Philippines, and Russia) under specific scenarios. The results show that implementing stringent information requirements would impose a significant cost on large importers of these crops from GM producing countries. At the same time, exporters that are members of the Protocol would face an additional cost of entry if they were to adopt new GM crops, and there could be an additional cost for countries willing to enter the Protocol after implementation of these requirements. Translating this in terms of costs for APEC and for the six countries, we estimate costs ranging from \$100 million to \$1.3 billion/year for APEC, and between an insignificant amount and over \$100 million for the six particular APEC economies we study.

These first results appear to indicate that many CPB members, particularly importing developing countries strongly supporting the generalization of stringent information requirements may not have realized its full costs, and may largely overestimate its benefits. Their support could partially be explained by the fact that national representatives at the CPB come from the Ministries of Environment instead of the Ministries of Agriculture or Trade, and that many of them do not pay attention to the consequences of regulation on agricultural commodities (Gruère).¹²

Overall, the results of our article call for a more complete quantitative cost-benefit assessment in each country before deciding whether or not to support a general application of stringent information requirements. The analysis shows that the two current options of "may contain" and "contains" information requirements lead to comparable informational advantages but that the second option results in much higher implementation costs. Furthermore, even if stringent information requirements were generalized in 2010, all countries would likely not be able to implement it properly, which would greatly reduce the already low marginal informational value of such requirements, with the risk of becoming an effective technical barrier to trade for GM commodities.

Lastly, while our analysis focuses on the direct and immediate effects of implementation, it is clear that stringent information requirements could also have market effects in the medium to long run. Strict information requirements would likely act as a tariff targeted on mixed GM/non-GM exports. GM exporters would face a higher cost of export to CPB members and this additional cost would be

transmitted to world prices. Exporting producers and consumers in the importing countries would be the losers, and the rent would go to the testing companies or institutions that inspect the shipments. In this context, pure non-GM exporters may gain from this requirement. In the long run, documentation requirements could also create significant trade diversion of GM exports toward nonmembers of the CPB. In recent years, the cost of differentiating GM from GM-free crops was kept relatively low by the presence of assured GM-free sources. In this context, CPB compliance costs would be the lesser of reallocating assured supplies to the right importers and exporters or the direct costs of compliance. The amplitude and direction of these possible market and trade effects of strict information requirements would need to be empirically evaluated with international simulations. We intend to pursue this avenue of research in the future.

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Endnotes

¹A living modified organism (LMO) is defined in the Cartagena Protocol on Biosafety as any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology. LMOs are usually considered to be the same as genetically modified organisms (GMOs).

²Crop/trait combination.

³In view of the decision of the Dispute Settlement Body of the WTO on the Dispute between the United States and Canada and the European Union (EU), import approval regulations like in the EU may be consistent with the SPS agreement.

⁴Adventitious presence can be defined as the accidental or involuntary presence of a LMO into a lot labeled as non-LMO because of commingling. More specifically one can distinguish two types of cases: one for within species commingling (e.g., GM maize in a non-GM maize shipment), and second for between-species commingling (e.g., GM maize in a non-GM barley shipment).

⁵In this article, we assess the cost of implementation, and do not provide an empirical analysis of the potential medium to long-run market effects of strict information requirements. This type of analysis is proposed as an avenue for future work with international economic simulations.

⁶As noted in the cost assessment section, CPB membership in this study is based on each country's membership status as of 1 January 2006. At that time, the Philippines was not a party to the CPB, but it became one between the completion of the study and the date of this article's publication.

⁷Opponents to the technology will likely favor any stringent control on GM products, and they would therefore indirectly benefit from any obstacle to the technology, but we assume that all consumers are not opponents to the technology.

⁸Provided they follow the CPB rules, and assuming that it is done without violating their possible WTO commitments.

⁹Of course, any WTO member importer applying a precautionary ban could be in violation with its SPS commitment, if it does not provide a proper justification or any other response within a reasonable time.

¹⁰Overall, these unit costs on the export and import side represent about 1% to 13% and 0.5% to 6% of total shipping costs for agricultural commodities going from the United States to China (ranging from \$67 to \$100/ton), respectively, using 2006–07 soybeans data from the U.S. Department of Agriculture (United States Department of Agriculture). Naturally, this cost share will vary depending on trade flows and commodities; it will be lower for efficient, high volume, trading systems, and higher for less efficient, low volume, trading systems.

¹¹As of 2006, see endnote 6.

¹²Some of the most outspoken representatives at the CPB seem to consider that LMOs are environmental hazards that need to be strictly regulated and avoided as much as possible.

References

- BRIDGES "Constructive Ambiguity Saves LMO Labeling Discussions at MOP-3." *BRIDGES Trade Biores* 6, no. 5(2006):1-3.
- Cors, T.A. "Biosafety and International Trade: Conflict or Convergence?" *Int. J. Biotechnol.* 2(2000):27-43.
- Dirección Nacional de Mercados Agroalimentarios. "Contexto y Opciones Para La Exportación Segregada de Maíz y Soja OVM y No OVM en Condiciones de Bioseguridad, Conforme al Protocolo de Cartagena." Proyecto FAO/SAGPYA TCP/ARG 2903. United Nations Food and Agriculture Organization, 2004.
- Foster, M., and D. Galeano. "Biosafety Protocol-Implications of the Documentation Regime." Canberra, Australia, Australian Bureau of Agricultural and Resource Economics. ABARE eReport 06.2, 2006.
- Gruère, G.P. "An Analysis of Trade Related International Regulations of Genetically Modified Food and their Effects on Developing Countries." EPTD Discussion Paper 147. Washington, DC: International Food Policy Research Institute, 2006.
- Gruère, G.P., and S.R. Rao. "A Review of International Labeling Policies for Genetically Modified Food to Evaluate India's Proposed Rules." *AgBioForum* 10(April 2007):51-64.
- Huang, J., D. Zhang, J. Yang, S. Rozelle, and N. Kalaitzandonakes. "The Costs of Implementing the Biosafety Protocol—A Look at China." IPC Technology Issue Brief 17. Washington, DC, International Food & Agricultural Trade Policy Council, 2006.
- JRG Consulting Group. "Economic Assessment of the Ratification of the Cartagena Protocol, Based on the Outcome of the 1st Meeting of Parties." Final Report Prepared for Agriculture and Agri-Food Canada, 2004.
- Kalaitzandonakes, N. "The Potential Impacts of the Biosafety Protocol on Agricultural Commodity Trade." IPC Technology Issue Brief. Washington, DC, International Food & Agricultural Trade Policy Council, 2004.
- Phillips, P.W.B., and W.A. Kerr. "Alternative Paradigms: The WTO versus the Biosafety Protocol for Trade in Genetically Modified Organisms." *J. World Trade* 34(August 2000):63-75.
- Redick T. P. "The Cartagena Protocol on Biosafety: Precautionary Priority in Biotech Crop Approvals and Containment of Commodities Shipments, 2007." *Colorado J. Int. Environ. Law Pol.* 18(Winter 2007):51-116.
- Secretariat of the Convention on Biological Diversity. "Cartagena Protocol on Biosafety to the Convention on Biological Diversity: Text and Annexes." Montreal, Canada: Secretariat of the Convention on Biological Diversity, 2000.
- United Nations, Statistics Division. United Nations Comtrade database, DESA/UNSD. Consulted in December 2005.
- United States Department of Agriculture. Grain Transportation Report. 28 June 2007.
- Winham, G.R. "International Regime Conflict in Trade and Environment: The Biosafety Protocol and the WTO." *World Trade Rev.* 2(March 2005):131-55.