Hindering Trade or Protecting the Developing World?
Assessing the Impact of the Biosafety Protocol for the Case of China

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Abstract

Uncertainties about the effect of Biosafety Protocol (BSP) on global agricultural trade have caused concern among those with a stake in agrifood imports and exports. The primary goal of this paper is to analyze the effects of the BSP on both importing countries with a specific emphasis on China and exporting countries of soybean and maize. The results show that in absolute terms the BSP will require large investments internationally and will induce compliance costs. The BSP will increase the international price and domestic production in importing countries, and lower international trade and domestic production in the exporting countries. In absolute terms the impacts are large, amounting for each commodity into the tens of millions of dollars and varying largely among different scenarios. But in the percentage the impacts are small. Much smaller impacts are found in China because China has already invested in a system that provides almost all of the services that is contained within the BSP. Other developing nations may need more helps; and that it will be more costly.

Keywords: LMO, Biosafety Protocol, Trade, Impact, China

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Introduction

The Biosafety Protocol (BSP) entered into force in 2003 as part of the

Convention on Biological Diversity (CBD). The main objective of the BSP is to

contribute to the safe transfer across countries of living modified organisms (LMOs),

which will be released into the environment and could affect the conservation and

sustainability of biological diversity.[1] The BSP includes guidelines on how countries

exporting LMOs need to get a green light from importing countries through the use of

"Advanced Informed Agreements."

As countries continue to consider appropriate ways to implement the BSP's

documentation requirements for shipments of LMOs intended for food, feed and

processing (LMOs-FFP), many questions remain about its potential impacts. Some of

the proposed BSP provisions still lack details on how they are to be implemented in

practice, among them the requirements for the labeling of LMOs-FFP. Since most

agricultural commodities around the world are produced and traded for food, feed and

processing, biosafety labels for LMOs-FFP could prove costly and disruptive for

world agricultural commodity trade (Kalaitzandonakes, 2004). Ultimately, the extent

of these costs and disruptions will be determined by which documentation scheme for

LMOs-FFP are agreed upon under the BSP and the specific circumstances of various

countries that need to implement them.

Uncertainties about the effect of the BSP on global agricultural trade have caused concern among those with a stake in agrifood imports and exports. The concerns about the economic impacts of the different ways to implement the BSP documentation requirements are rising from a number of countries, regardless whether they have or have not ratified BSP, and are particularly pertinent for developing countries that are large importers of agricultural commodities. Answers to the likely impacts of implementing the BSP are important not only for large countries that have the capacity to develop biotechnology products of their own, but also for smaller nations that do not have the capacity to develop either biotechnology products or effective biosafety regulatory systems.

Recently, in response to the demand for answers to these questions, research has begun on the costs associated with the implementation of the BSP. An International Food and Agricultural Trade Policy Council (IPC) technical brief authored by Kalaitzandonakes (2004) documented in a detailed way some of the potential costs and benefits of the BSP. The report—which is based mostly on empirical work in the US, a major exporter—shows that compliance costs could be significant and distributed across the global food system. The report also proposes that a majority of the costs would likely be born by importing countries. The costs will be different for different commodities, and would likely be relatively higher for nations with unsophisticated food systems. Hence, it can be inferred from the work of Kalaitzandonakes that developing nations that are large importers are perhaps more exposed to compliance costs and risks associated with the BSP. However, the

conclusions of the global impacts of BSP as well as its impacts on exporting countries from Kalaitzandonakes' study are based on qualitative conjecture and not on the basis of quantitative analysis. Indeed until now, there has not been any quantitative analysis of the various costs and benefits from implementing the BSP in importing countries and, more broadly, of its impacts on global agricultural commodity trade.

The primary goal of this study is to analyze the effects of the BSP on both importing countries (with a specific emphasis on China) and exporting countries. To limit the scope of our study, we restrict ourselves to two commodities: soybeans and maize. While not completely comprehensive, focusing on these two commodities is defensible because soybeans and maize account for more than 80 percent of global GM crop area (James, 2005). Moreover, the two crops are important commodities in China's agricultural trade basket. China imported soybean more than 24 million metric tons in 2005, most of them were genetically modified. China's soybean import activity also is important for world markets since China's share constitutes a large part of the world's traded soybean volume. Maize is interesting also because of its likely importance in China's future trade. China, at least in the short run, may be both an importer and exporter of maize. Such a set of dynamics should provide some instructive contrasts in estimating the costs of the BSP. We also note that the impacts examined in this paper cover only certain dimensions of the potential costs of the BSP – the upfront costs associated with the establishment of a biosafety regulatory infrastructure; the operating costs of running it; the marginal costs of enforcing the BSP disciplines for biotech crops used in food, feed and processing.[2]

To meet our goal, in the next section we briefly describe the evolution of the biosafety protocol and identify key issues related to the implementation of the BSP and its potential effects on trade. In section 3, we document the emergence of China's biotechnology sector and review the regulations that have been created to govern LMOs; we also analyze the elements of China's biosafety regulation that could be affected (reformed/revamped/created anew) because of the BSP. In section 4, we estimate the costs that the BSP and other related regulations will add to the *direct cost* of soybeans and maize as they come across China's border. In section 5, we simulate the *fuller impacts* of the BSP on commodity prices, production, consumption and trade. Finally, in section 6 we conclude and draw conclusions on the potential impacts of the BSP on China and the world.

The evolution of the Biosafety Protocol and key issues related to trade

The BSP emerged from the Convention of Biological Diversity (CBD) which itself contains specific provisions on certain biotechnology products but also emphasized the need for a protocol to set out conditions for their safe transfer, handling and use (Mackenzie et al., 2003). In 1994, at the first CBD conference the parties to the convention authorized a series of meetings to consider the "need and modalities" for such a protocol. A draft of the Protocol was produced in February 1999 at a meeting held in Cartagena, Colombia and was adapted on January 29, 2000 in Montreal, Canada. On September 11, 2003, the BSP entered into force and as of March 2006, 132 countries had ratified it.

The BSP's stated objective is to contribute to the safe transfer, handling and use of all LMOs that could adversely affect the conservation and sustainability of biological diversity or pose risks to human health. The BSP defines LMOs as those living organisms (e.g. plants, trees and animals including fish) with novel genetic material introduced through the use of modern biotechnology (i.e. recombinant DNA and cell fusion techniques). Two types of LMO uses are the main focus of the BSP: intentional release to the environment; and the direct use for food, feed and processing. To ensure the safe transfer, handling and use of LMOs the Protocol includes several broad and cross-cutting provisions.

For the safe transfer and handling of LMOs intended for introduction to the environment, the BSP requires the use of Advanced Informed Agreements (AIAs). Prior to the first transboundary transfer exporters must provide documentation with detailed information about the LMO and its intended use. The importing country then can evaluate the information and perform risk analysis in order to decide whether to allow importation of the LMO or request additional information in accordance with its domestic regulatory framework.

Importing countries can place conditions or refuse imports when they judge that there is insufficient knowledge regarding the potential impact of specific LMOs on their biodiversity. Indeed, the BSP, in-line with the CBD, has advocated the use of the "precautionary principle" (de Greef, 2004). In this context, the BSP allows restrictions on the trade of LMOs in the presence of perceived risks, however small.

The BSP also allows importers to take into account the socioeconomic impacts that could emerge from the importation of the LMOs.

Transboundary shipments of LMO-FFPs do not require AIAs. Instead, countries must report biosafety regulatory decisions that permit the cultivation of LMOs inside their borders through a web-based database—the Biosafety Clearinghouse. Furthermore, exporting countries must provide relevant information about cargoes containing LMO-FFPs and indicate that they are not intended for introduction in the environment. Importing countries could require prior consent for the importation of LMO-FFPs in a way consistent with domestic regulatory policies by indicating so in the Biosafety Clearinghouse. Countries that lack regulatory infrastructure might still reserve the right to an evaluation on the first importation of an LMO-FFP and, as with AIAs, they can use "precaution" and socioeconomic considerations in reaching their decision.

A variety of other provisions also are included in the BSP such as: simplified procedures for the transboundary movement of LMOs that present minimal risk; emergency measures for unintentional or illegal transboundary movements of LMOs; as well as rules and procedures for liability and redress in the case of damages caused by LMOs. Because of its broad rules and comprehensive procedures, the BPS has been viewed by some as a first step to a homogeneous and harmonious global biosafety regulatory framework (Jaffe, 2005).

By requiring signatories to develop domestic biosafety regulatory systems and to cooperate for the strengthening of human resources and institutional capabilities in

developing countries, the BSP has been the driving force for the expansion of biosafety regulation across the globe in recent years (Jaffe, 2005). This could prove important for developing countries and countries in transition. Indeed, the safe development and use of LMOs have been viewed by some as a key strategy for food security and economic growth in such countries (FAO, 2004). But while indigenous public sector biotechnology research in many developing countries has continued to grow, commercialization has lagged, in part, due to inadequate biosafety regulatory capacity (Cohen, 2005). Under such conditions, well-functioning national biosafety regulations could facilitate the safe and efficient development, transfer, and use of new biotechnologies in such countries.

Despite the potential for greater safety and integration, there are real concerns about the ultimate effect of the BSP. Some have cautioned that because of the limited definition of key provisions (e.g., an adequate safety standard and the appropriate role of socioeconomics on decision making) the BSP may fall short of delivering on its key objective: the establishment of a harmonious regulatory system with standardized rules which safeguards the environment and effectuates international trade (Jaffe, 2005). Others have gone further suggesting that the differential capacity of various countries to implement the BSP could, in fact, impede technology transfer and agricultural trade (Watanabe et al., 2004). In fact, Watanabe et al. identified various structural factors (e.g. shortage of indigenous expertise; political turmoil; conflicting national "expert" guidance; distrust of foreign assistance) along with inadequate national legal frameworks as key barriers that could prevent some developing

countries from implementing the provisions of the BSP in a harmonious, predictable, and efficient way.

Beyond technical concerns, others have noted that some of the BSP provisions themselves could lead to trade restrictions and significant compliance costs (Kalaitzandonakes, 2006). Indeed, some of the BSP provisions still lack detail on how they are to be implemented in practice. Key among them are the specific requirements for the labeling of LMO-FFPs. Since most agricultural commodities around the world are produced and traded for food, feed and processing, biosafety labels for LMO-FFPs could prove costly and disruptive for world agricultural commodity trade. How costly and disruptive will, ultimately, be determined by the implementation details of the labeling scheme for LMO-FFPs which are still under consideration.

Far more than theoretical concerns, the process to make decisions on the implementation details of the BSP are ongoing in the mid-2000s. The signatory parties were obligated by the BSP to decide on the "detailed labeling requirements" for LMO-FFPs within two years from its entry into force. Yet, by the end of the second meeting of the parties (MOP-2) in June 2005 no consensus could be reached. The parties added some clarity to the labeling rules during a subsequent meeting in March 2006 but many of the detailed labeling requirements remain undefined, ambiguous or subject to further review and consideration. Clearly, many questions remain about the ways that the BSP might be implemented and its potential impacts. In this paper we seek answers to just such a set of questions by analyzing the capacity

of countries to implement the basic provisions of the BSP and on the implications of alternative labeling regimes for LMO-FFPs on trade and economic welfare.

China's biosafety regulation regime

When evaluating the potential impacts of implementing the BSP, activities for both setting up and operating the necessary biosafety bureaucracy as well as ensuring compliance must be considered. On both such sets of activities China has important advantages that are not shared by many other developing countries. Aided by its strong centralized governance, sound scientific/management infrastructure and large number of scientists, China has developed a comprehensive biosafety regulatory system in the course of the last 15 years (Huang et al., 2005).

Recognizing the importance of coordination among ministries, a Joint Monitoring and Management Commission (JMM) was established in the late 1990s. The JMM is composed of representatives from the Ministry of Agriculture (MOA), the National Development and Reform Commission, the Ministry of Science and Technology, the Ministry of Health, the Ministry of Commerce, the National Inspection and Quarantine Agency (NIQA) and the State Environmental Protection Authority. These officials are responsible for the coordination of key issues related to biosafety, including the responsibility to examine, approve and develop policies and regulations that relate to a.) GMO production; b.) the labeling of GM products in the marketing chain; and c.) the management of GMO imports and exports.

Following the directives of the JMM, China's MOA is the primary organization in charge of the implementation of agricultural biosafety regulations and GMO commercialization. Within the MOA, leaders have set up the Leading Group on Agricultural GMO Biosafety Management to oversee all GMO biosafety activities. The routine administrative work and day-to-day operations are carried out by the MOA-based Agricultural GMO Biosafety Management Office (BMO).

China's biosafety regime functions relatively well with regards to monitoring and regulating the imports of LMOs. There are several reasons for this. First, China already has a well-established domestic regulatory system for many other parts of its food system. Second, even before the formal setting up of the JMM and BSP, China already had experience with the issues of importing GM soybeans. Finally, the new bio-safety system was not created anew, but, rather, it was patterned after (and in many cases built up next to) the institutions that China has developed to regulate the food imports through a more traditional quarantine system.

The depth of China's system can be seen by examining some of the procedures it has developed to deal with the trade of GMOs. For example, if a GM event is approved after undergoing regulatory review in China, the MOA then places the event on a list of products approved for import. China's system—in some ways—has been set up to facilitate trade, not restrict it. Recognizing the comprehensiveness of regulations outside of China, national leaders, at least so far, have taken a fairly accepting view of the results from biosafety procedures that affect imported GM commodities. If a GM event has passed through the biosafety regulatory process in

the United States or Canada, it has generally been assumed to meet China's food safety and environmental regulations. Additional requirements are only imposed when a foreign technology is imported into China for local production.

There are other approval procedures for those interested in brining food commodities into China. For all approved LMOs, exporters (typically foreign trade firms that are selling food commodities into China) also have to apply to the MOA for an *export permit* for each and every shipment. In the documentation, exporters certify that the LMOs that are included in the shipments have all been approved by the MOA. At the same time importers (typically domestic firms inside China) must apply for *import permits*. The application for an import permit, which is much like the export permit, lists the LMOs that will be brought in. In the mid-2000s, requests for export or import permits have typically taken no more than 30 days to execute. Since ordering, executing and fulfilling the importation of a large soybean or maize shipment from another country into China is a time consuming process (typically 3 to 6 months), as long as the applications for import and export permits are started early in the process, they do not restrict trade or add any holdup costs to the importation process beyond the actual fees paid.

China has also developed measures to deal with imported GM commodities when the shipment arrives at the border. In each port there are local authorities that are responsible for ensuring compliance of the shipment with the approval certificates. When the shipment arrives, the importer typically files a form called the Import Goods Claim for Inspection and Quarantine. This request form references both the

export and import permits. It also (re)states that the shipment is "in compliance" with China's GM regulations.

Once the form is filed, the biosafety authorities in the port begin the inspection procedure. When the tests prove the importer is in compliance, the shipment is released for unloading as long as the fees for the tests have been paid. According to China's regulations, for the first 10,000 tons, 20 samples are randomly chosen. After the first 10,000 tons, an additional sample is randomly chosen for each 1,000 tons. Therefore, for a 60,000 ton vessel that is fully loaded, a total of 70 samples need to be tested. The tests are done in a local laboratory that is under contract to the port biosafety authority. The tests performed are essentially equivalent to a test needed to identify whether or not the shipment contains LMOs or not and what types of LMOs are present. When comparing China's current biosafety regulation with the BSP labeling requirements for LMOs-FFP it becomes clear that China's procedures already exceed the current "may contain"or "contain" labeling regimes settled on during the March 2006 MOP-3.[3]

Establishing and operating biosafety regulations

In order to evaluate the potential impacts of the BSP, both the bureaucratic costs of setting up and operating biosafety regulations and the compliance costs of implementing them must be considered. Unlike many developing countries, China has a biosafety regime in place. Therefore, developing countries that are evaluating the costs and implications of the BSP may find China's experience with setting up a biosafety regulatory framework and associated outlays of interest.

As a result of increasing imports of LMOs-FFP and the commercialization of Bt-cotton inside China, China has raised its annual budget for biosafety-related activities significantly over the past several years (Huang et al., 2005). When China started the commercialization of Bt-cotton in 1997, the budget allocated to both biosafety research and regulatory management was trivial. In 1997 it was estimated that the total budget allocated to both biosafety research and the administration of biosafety management was only US$ 120,000. Nearly half of this budget was used in biosafety research (e.g., food safety and environmental safety) on Bt-cotton lines that were generated by the Chinese Academy of Agricultural Sciences. Another large share was used for covering the costs of running the Biosafety Committee.

The rapid growth of agricultural biotechnology and the commercialization of Bt-cotton in the late 1990s, however, posed a challenge to the capacity of China's biosafety regulation. In response to this challenge, China raised the annual budget for agricultural GMO biosafety research from a little over US$ 80,000 in 1999 to nearly US$ 1.5 million in 2002 (Huang et al., 2005). By 2004, the annual operating expenditures for agricultural GMO biosafety research reached almost $2.5 million. Currently, China spends about US$ 3 million annually on agricultural biosafety related works (excluding the expenditures required to implement its labeling and market inspection duties inside China and at the border).

GM soybean imports

The large and rising volume of imported GM soybean under China's biosafety regulatory regime provides a good empirical case to examine the costs of testing

LMOs. Since the late 1990s, with the opening of the domestic soybean market to international trade, China's soybean imports have increased significantly. After 2003, annual soybean imports exceeded 20 million metric tons, accounting for more than 55 percent of domestic demand (Table 1). Because China primarily sources soybeans from GMO producing countries, most of the imported soybeans are LMOs. Between 2001 and 2005, more than 99 percent of China's soybeans came from the US, Brazil and Argentina. During each year, the share of imports from the US has been the largest, although the relative shares of the three sources fluctuate over time.

In addition, since GM soybeans imports enter China through almost all of its ports (mainly because there are soybean crushing facilities in all major port cities), China has already had to invest into the biosafety import monitoring and management systems in many different locations. Importantly (for this analysis, especially), the fact that these investments have already been made means that these costs are due to China's own domestic biosafety regulations and not directly attributable to the BSP.[4] Finally, because almost all imported soybeans are immediately delivered to crushing plants on or close to the port and turned into soybean oil and meal, there is a very limited chance that unauthorized LMOs could find their way to local production. All of these issues, of course, affect our assessment of the cost of the BSP to China.

The costs of testing LMOs: approach and baseline results

In this section we describe the approach that we developed to quantify the effect of testing and labeling LMO-FFP due to biosafety regulation, in general, and

the BSP, in particular, on China's economy.   The explanation includes two parts.
First, we describe the process by which we collected the data to elicit the direct
compliance costs associated with China's biosafety regulation.   Using these data, we
then describe the trade model we use to assess how such costs influence trade flows,
imports and domestic production and, ultimately, the real price of soybeans and maize.
The results of the scenario analysis are described in the next section.

Collecting the data on testing costs for biosafety assessment in China

The first step in our study entailed collecting information on the direct costs
that China's biosafety regulation and the BSP impose on exporters and importers of
soybeans and maize. The data collection effort included eliciting information on a.)
the number and size of the vessels that bring soybeans and maize to China; b.) the
cost of testing for different types of ships; and c.) an assessment of other, non-testing
costs.

To collect the information, six well-trained enumerators from the Center for
Chinese Agricultural Policy visited port officials in 6 major ports: Dalian,
Qinghuangdao, Qingdao, Lianyungang, Shanghai and Shenzhen. The enumeration
team visited with the port authorities, officials in charge of China's biosafety protocol,
officials in charge of traditional quarantine inspection and personnel in the
laboratories that conduct the testing for LMOs. Members of the team also visited
soybean traders and importers to cross-check the information given to them by the
government officials.

From our survey we were able to estimate the total number of vessels and

sizes of the vessels that arrived in China with imported soybeans in 2005 (Table 2).

According to our data, all but 6 of the shipments arrived in large, panamax-type

vessels that averaged around 60,000 tons. In addition, 25 percent of soybean vessels

contained more than 60,000 tons; most of the others were loaded to near maximum

capacity; only 6 vessels were about 5,000 tons. Arriving from Brazil and Argentina in

the summer and from the US in the winter months, China's ports hosted more than

one vessel per day. The total tonnage from these vessels is consistent with the total

import volume reported in official trade statistics (China's Customs Authority).

Given the testing procedures (described in the previous section), on average

we assumed that the typical cargo (the average of our sample) contained 60,000 tons.

For a cargo of this size, China's biosafety inspectors take an average of 70 samples

(20 for the first 10,000 tons; 50 for the rest 50,000 tons or 1 for each of the next 1,000

tons). Therefore, in our analysis we assume that in 2005 China's biosafety system all

panamax vessels required importers to pay for the testing of 70 samples (and 10 for

the other 6 smaller vessels with average of about 5,000 tons). Hence, in total, in 2005

testing laboratories tested 29040 samples of LMOs from the 420 vessels (Table 2).

Note that according to this analysis, on average, a sample was taken for each 840 tons

that arrived in China's ports in 2005 (a piece of information that is used in our

analysis to calculate the average per ton cost of testing).

During our visits to the testing laboratories we also asked a series of questions

about the cost of testing the samples under current and alternative testing criteria

(Table 3, column 2).[5] The respondents in the laboratory told us quite consistently

(across testing facilities of different ports) that the current cost of testing soybeans is

2900 yuan per sample (or US$358—row 1). The costs included both the laboratory

testing costs (about 70 percent of the value) and other service charges assessed by the

port (about 30 percent) on a per sample basis. As discussed above, according to the

regulations in force in China today, laboratories test if the shipments contain LMOs

and then identify if the LMO in the sample matches that type of LMO that is reported

on the importer approval certificate. Since each sample on average was 840 tons, this

means that in 2005 importers paid US$0.43 per ton (358/840—row 2).   This means

that in total in 2005 the charges for biosafety testing for soybeans was more than

US$10,000,000 (row 3). Given the average CIF price of soybeans in 2005 was

US$282, this means that, on average, biosafety testing cost was about 0.15 percent of

the price of soybeans (rows 4 and 5). Hence, in answering whether testing costs are

high or low, it depends on whether one considers the entire cost or the per ton cost.

While one-tenth of one percent sound low, 10 million US dollars does not; or 10

million US dollars sound high, one-tenth of one percent does not.

We also priced the potential testing costs of two alternative documentation

regimes that have been broadly discussed and considered in the context of the BSP

negotiations (Table 2, columns 1 and 3). When testing soybeans under the least strict

criteria ("does the shipment contain LMOs" or, henceforth, simply "contains LMOs"),

according to our data, the cost per sample was US$286 (or 2316 yuan), about 20

percent lower. When performing this test, the laboratories do not need to identify

which LMOs are contained in the sample, only that there is some type of LMO. We also evaluated the costs associated with a more strict labeling and documentation regime which requires the lab to verify the *shares* of each type of each LMO in the vessel.[6] Under this last testing and labeling regime, the cost rises to US$481, about 35 percent higher. While the total amount of the biosafety costs would rise or fall proportionally with using the different criteria, so would the per ton cost. Therefore, when using the most strict criteria, the total cost reaches 13.98 million US dollars and the per ton cost is US$ 0.57 or about 0.2 percent of the CIF price.

During the survey, it was more difficult to calculate the cost of testing the LMO content of maize (since it has never been done yet in China). The officials in the ports and laboratories personnel, however, were helpful and were quite confident that their estimates would be fairly accurate (Table 3, rows 6 to 10). Because there are more different types of GM events in the case of maize (there are 7 approved for import into China; plus there are a number of varieties that have stacked gene events, which are not yet approved for import into China), testing to identify the type of LMO (column 2) and to quantify the share (column 3) is more expensive. Only under the "contains" labeling regime testing costs remain the same. Hence, on a per ton basis, the cost of testing is higher and the range is greater (from 0.24 to 1.13 percent of the CIF price of maize—row 9) for two reasons: first, the price of a ton of maize is lower (about half as much per ton); and two, the testing costs per sample is higher. For exporting, we assumed the testing costs are the same, but because the FOB price of maize is a bit lower, the per ton cost rises marginally (Table 3, rows 11 to 13).

We make one additional assumption about the testing procedures. While we have not accounted for time delays given the ability of China's lab infrastructure to deal with the current load, the possibility for such delays (and significant incremental costs in the form of demurrage charges) exists, especially in other developing countries where the testing/laboratory infrastructure is limited or non-existent.

Testing costs in the US

Since we are going to simulate the impact of the BSP globally (as well as on China), we need testing costs for maize and soybeans in the rest of the world (we report our estimates of the testing costs of the US—Table 4).[7] To do so we follow the methodology used in Kalaitzandonakes (2004). For data, we use information from customs statistics and identify only the vessels with bulk cargoes. Vessels with containerized, boxed and bagged cargoes are assumed to be identity-preserved and not in need of biosafety testing.

When testing soybeans under the least strict criteria "contains LMOs" and "identifies LMOs" a qualitative PCR test for event GTS40-3-2 is used at a laboratory cost of $180 per sample.[8] Along with a 20% in port service charges, the cost for this test is $216 per sample. When using the more strict criteria a quantitative PCR test for the same event is performed at the cost of $324 per sample. Hence, all soybean test costs in the US are lower than those in China. An estimated 965 vessels averaging 29,210 metric tons cargo is assumed to be subjected to a similar testing regime as that used in China. Accordingly, on average, 40 samples are assumed to be collected and tested from each soybean export vessel from the US with an average tonnage of 730

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metric tons per sample and an estimated total cost of US$8.3 to US$12.5 million. On a per ton basis, testing costs for soybean exports from the US vary between 0.12 and 0.18 percent of the FOB price.

Testing costs for US maize exports, however, are more expensive. With 8 commercial events in production, the costs of the 3 testing regimes are different. Under the least strict criteria "contains LMOs" a PCR test for 35S and GA21 is sufficient implying laboratory costs of $380 per sample. Along with the 20% service charges, the testing expenditure is equal to $456 per sample. The more demanding regime that "identifies LMOs" requires a qualitative PCR test for the events MON810, NK603, TC 1507, MON863, BT11, 176, T25 and GA 21. The laboratory expense for such a test is $660 per sample. The most restrictive regime, "Quantifies LMOs," requires a quantitative PCR for the same events as above at the cost of $1280/sample. After the charges, the per sample costs for the most restrictive regime is $1536.

To come up with a total cost figure for maize, with an estimated 2,270 bulk vessels averaging 22,450 metric tons of cargo, an average of 33 samples are assumed to be taken and tested resulting in an average tonnage of 680 metric tons per sample. The overall testing costs for maize exported from the US range from $34 to $115 million. As a share of the FOB maize price, testing costs represent 0.64 to 2.15 percent—certainly significantly higher than in the case of China. With these adjustments, the final testing costs that are applied to LMO soybeans and maize as a share of FOB and CIF prices (depending on whether the country was an exporter or importer) are reported in Table 5.

The impact analysis of BSP on China and the rest of the world using GTAP

The impacts of implementing the BSP worldwide (and on China) are analyzed

under a number of different scenarios and simulated using the modeling framework

developed by the Global Trade Analysis Project (GTAP). GTAP is a multi-region,

multi-sector computable general equilibrium model that is built around an economy

that is assumed to operate under perfect competition and constant returns to scale.

The model approach is fully described in Hertel (1997). It has been used to generate

projections of policy shifts and biotechnology breakthroughs in China in the future

(Arndt et al., 1996; Huang et. al., 2004).

In our GTAP approach, taxes and other policy measures are represented as ad

valorem tax equivalents. These create wedges between the undistorted prices (e.g., the

price before the implementation of the BSP) and the policy-inclusive prices (the price

after the implementation of the BSP). Production taxes are placed on intermediate or

primary inputs, or on output. Trade policy instruments include applied most-favored

nation tariffs, antidumping duties, countervailing duties, export quotas and other trade

restrictions. Additional internal taxes can be placed on domestic or imported

intermediate inputs, and may be applied at differential rates that discriminate against

imports. Taxes can also be placed on exports and on primary factor income. In this

study we impose additional costs at the border for imports and exports of LMOs that

are related to BSP implementation. In other words, because port authorities in

exporting and importing countries require additional testing, the real price of exports

will be higher as will the real price of imports.

Data adjustments and improvements

The GTAP database contains detailed bilateral trade, transport and protection data characterizing economic linkages among regions, linked together with individual country input–output databases which account for intersectoral linkages among the 57 sectors in each of the 87 regions. The database provides quite detailed classification on agriculture, with 14 primary agricultural sectors and 7 agricultural processing sectors. Unfortunately, the 14 agricultural sectors did not break out soybeans and maize. Because of this, we needed to modify the database to have separate commodity groups for both soybean and maize for all countries (see appendix A for detail). The base year for version 6 (the version used in this study) is 2001.

Before we apply GTAP version 6 for the current analysis of the impact of the BSP, we carefully examined the database and parameters for China and made a number of adjustments. These changes improved the database in several ways, especially in the agricultural input and output ratios, demand parameters, trade policies and production values. The main ways that we adjusted the database are listed in Appendix A.

Scenarios and impacts

Because of the uncertainties in the detailed LMO-FFP labeling requirements that will ultimately be required by the BSP, the analysis runs the model to assess its potential impacts under alternative scenarios. After we run the baseline scenario (without testing LMOs at the national border), following Table 5, we run the model

under three alternative scenarios: scenario I for the least strict criteria that requires traders to indicate that the cargoes "contain" LMOs; scenario II for the second criteria (which is also China's current criteria) requiring traders to "identify" the types of LMOs contained in the cargo; and scenario III for the most strict criteria that requires the traders to "quantify" the LMOs present in the shipment.

We then examine the impact of the BSP on different parameters of interest. The first and most direct is the impact of the BSP on prices. While this is primarily influenced by the nature of the cost of testing (the direct costs of testing required by the BSP), as prices rise from these compliance costs, consumers in the importing countries demand less and domestic producers supply more because they are facing higher, quasi-BSP-protected price. The price impacts in our analysis account for all direct and indirect effects of the BSP. Given the change in prices, we also examine the effect on international trade and domestic and world production. It is important to note that in our analysis the impact of the BSP is different in China since it already has implemented its own biosafety regulations. This is explained in the discussion of the results below.

The full impacts of the BSP

As expected, after the world implements the BSP in 2010 the international price of soybeans and maize will rise (Table 6). Regardless of what decision is made on the criteria for testing international shipments for LMOs, according to our analysis the international price of LMO soybeans will rise by 0.07 to 0.11 percent (columns 1

to 3, row 1). Reflecting both the fact that the cost of testing is relatively higher (on a per ton basis) and the more complicated nature of testing (since there are more individual and stacked GM events used), the international price of maize will rise proportionately more under all three scenarios, from 0.31 to 1.07 percent (columns 4 to 6, row 1).

Interestingly, because of the nature of the responses of producers and consumers around the world in response to the extra cost of testing, the increase in the international price is less than the testing cost itself. For example, in the case of scenario I for soybeans, by 2010 the international price rises by 0.07 percent (Table 6, column 1, row 1). This rise in price, however, is less than the amount added in percentage terms by the cost of testing (0.12 on both a CIF and FOB basis—Table 5, column 1, rows 1 and 2). The reason for this, of course, can be seen in Table 7. When the CIF and FOB prices rise internationally due to the cost of testing required by the BSP, world trade in soybeans falls (columns 1 to 3, rows 1). At higher world prices, importers demand less soybeans, 12.1 million dollars less when using a "contain" label. When the strictest criterion is imposed, the fall in world trade is 18.7 million dollars. World trade for maize falls from between 20.2 and 74.7 million dollars due to the BSP (columns 4 to 6, row 1). Of course, when importers demand less, the international price falls, and so the final impact on world prices is less than the rise in price due to testing.

The analysis of the BSP impact on world trade volumes also shows the tension between trying to decide if the effect of the protocol is large or small. In absolute

terms that amount of trade that is affected by 2010 is large and rises as the labeling

and reporting requirements for LMOs-FFP become increasingly strict (Table 7, row 1).

However, in terms of the impact on percent of world trade, the effect appears fairly

small (Table 7, row 5). World soybean trade falls from between 0.08 and 0.12 of the

baseline rate in 2010, which, even given the strictest criterion, is only a bit more than

one-tenth of one percent of the total volume of trade. The volume of maize falls

somewhat more, it falls by near one percent (0.87 percent) given the most strict

criterion. The reason, of course, is that even though on an absolute basis the decline is

large, the volume of world soybean and maize trade is enormous and the price effect

of the BSP, while significant in absolute terms, is relatively small in percentage terms.

While the trade flows fall for all the countries that are involved with China's

soybean trade (Table 7, rows 2 to 4; rows 6 to 8), the direction of the impact of the

domestic price changes depends on whether the country is a net exporter (e.g.,

NAFTA countries or South and Central American countries) or importer (e.g., China).

In the case of China, the difference between implementing and not implementing its

domestic biosafety regulations (which is equivalent to scenario II), means that China's

domestic price of soybeans is higher by 0.08 percent and the domestic price of maize

is higher by 1.12 percent. In contrast, the domestic prices of soybeans and maize fall

in the NAFTA and South and Central American countries. In other words, the BSP

acts similar to a tariff, keeping trade down and forcing prices up for importing

countries and reducing domestic price in exporting nations.

Importantly, if the BSP ultimately decides to require countries to test for the presence of LMOs in international shipments on the basis scenario I or II, there would be no effect on China. The measured upward pressure on prices and the downward impact on trade in scenarios I and II is probably already exceeded by the current situation in China which implemented its own domestic set of biosafety regulations. However, these numbers are still useful in discerning the variable costs (that is, net of initial investment costs) of biosafety in general. In other words, because China already has its own set of domestic regulations, the only impact of the BSP would come if the labeling requirements for LMOs-FFP demanded that importers quantify the shares of different LMOs within each vessel (that is criterion III). If this were the case, the effect on China's soybean price would only be 0.02 percent (0.10-0.08). The effect on China's maize price would be 0.16 percent (0.33-0.17). In other words, the marginal impact on China's domestic price of requiring the strictest of testing (difference between scenario II and III) would still be small.

When domestic prices rise in importing countries and domestic prices fall in exporting countries, there is an effect on production in each individual country, even though the overall effect on world production is small (almost zero—Table 8). When China's domestic price rises due to biosafety regulation, producers, seeing a higher price, respond by producing more. In contrast, in exporting counties, the lower domestic prices induce producers to cut back on production. Again, however, although the absolute amounts are relatively large, the percentage amounts are not.

Concluding remarks

In this paper we have sought to calculate the impact of the BSP on agricultural commodity trade in China and the world. Our results suggest that in absolute terms the BSP will require large investments internationally and will induce compliance costs, especially for those countries that do not currently have monitoring regulations or institutions to manage the flow of LMOs at their borders. Assuming the institutions get put into place, the BSP also will increase the cost of trade due to the requirements to monitoring and test international shipments as they leave exporting countries and as they arrive into importing nations. In absolute terms the amounts are not small, amounting for each commodity into the tens of millions of dollars. The results also show that the more stringent the policies, the higher the costs.

However, it is possible to give our findings another interpretation. Given the large volume of flows of international commodities, and the relatively low cost per sample tested, an argument can also be made that the impact is fairly small—at least in percentage terms. Even under the most strict testing criteria, the direct cost per ton is relatively low. Trade flows are dampened, but also only marginally. Because producers and consumers react to the higher prices (due to testing), the final (direct and indirect) impact on prices is even lower—although its impact is different in exporting and importing countries. In short, the overall impacts in percentage terms—as a share of total trade flows; as a share of total production; as a share of total price—are small.

Moreover, the impact is even smaller when carefully making the comparison of the situation before and after the BSP implementation. Our analysis compared the scenarios of no monitoring or testing for GMOs/LMOs at the border and after the implementation of the BSP. For countries with some biosafety regulation of their own, such comparisons may overstate the projected compliance costs of BSP. For instance, as we show, China already has a fairly comprehensive system of biosafety management and testing. Hence, if we compare the additional costs to implementing the BSP with the current costs of China's own domestic biosafety management program, when we use the less strict criteria for testing under the BSP, there is near no impact.

A caveat is needed here, especially when thinking about the lessons of the China case for the rest of world. Above all, it should be remember that compared to some developing countries, China's capacity to design and implement policies are much greater. The base from which China began to implement its bio-safety policy is higher. Hence, the marginal cost to China is likely to be less than other nations.

Based on this analysis, there might be a tendency to suggest that since the cost is low, why not ignore the BSP and allow for its approval using the strictest testing criteria. But there are reasons why from a scientific, economic and political-economy point of view that this may not be desirable. For example, one must question why it is that if the impact of the BSP under some of the most plausible testing options will have little impact, there should be a BSP at all. This is a serious question. We have shown that left on their own that countries such as China have taken seriously issues

of biosafety and have already invested in a system that is providing almost all of the services at the same level of rigor that is contained within the BSP. From this point of view, it is true that such a document is of very little use to China itself. Therefore, an argument can be made the redundant agreements are wasteful and unnecessary.[9]

However, the ultimate lesson from the China study is that good policies that are science-based and that are designed to monitor but not obstruct can be implemented without being costly or disruptive. Countries, like China—that is those with long histories of being able to implement policies to protect their own economies—are likely to be neither hurt nor helped by international agreements that are reasonable. But, it is important to remember that other nations may need more helps; and that it will be more costly.

Appendix A
Adjustments Made to China GTAP database

Before we apply GTAP 6 for the current analysis of the impact of the BSP, we carefully examined its database and parameters for China and made a number of adjustments. These changes improved the database in several ways, especially in the agricultural input and output ratios, demand parameters, trade policies and production values. The main ways that we adjusted the database are listed below.

1) We aggregate 87 regions into 7 regions (China, Japan and Korean, Australia and New Zealand, North American Free Trade Area or NAFTA, South and Central America, European Union, and Rest of World). This aggregation reflects the major trade flows of soybean and maize among regions.

2) We aggregated 57 sectors into 16 sectors, and then separated soybean from oilseeds and maize from coarse grains. The production shares and domestic consumption shares in 2001 are calculated from the FAO database. The bilateral trade shares in 2001 among different regions are from the UN COMTRADE database.

3) We also had to modify the input-output tables in the agricultural sector of China's model.   In this study, we overcame some of the shortcomings in the GTAP database by taking advantage of data that have been collected by the National Development and Reform Commission (NDRC). These data are collected from more than 30,000 households and include detail costs of production of major crops and livestock.

4) Demand elasticities in the base year. For China, we incorporated the most updated and empirically estimated price and income elasticities of demand for various foods in China for the base year (2001) into GTAP version 6.   These are consistent (although updated) with those published in Huang and Chen (1999).

5) Trade distortions. We adjusted both import and export tariff equivalents of agricultural commodities in the base year (2001) based on the results from a study by Huang et al. (2004).

6) The baseline is constructed by applying a recursive dynamic approach. We implement the simulation in two steps (2001-2005; 2006-2010) to reflect the change of endowments and actual performances in 2001-2005 in different countries and in the different periods. The baseline projection also includes a continuation of existing policies and the implementation of important policy events related to international trade as they are known to date. The important

policy changes are: implementation of the remaining commitments from the GATT Uruguay round agreements; China's WTO accession between 2001 and 2005; global phase out of the Multifibre Agreement under the WTO Agreement on Textiles and Clothing (ATC) by January 2005; EU enlargement.

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Table 1. Chinas' soybean imports (thousand tons) by source country, 2001-2005.

	2001	2002	2003	2004	2005(1-11)
USA	5,726	4,619	8,293	10,198	9,107
Brazil	3,160	3,910	6,470	5,616	7,375
Argentina	5,020	2,775	5,964	4,403	7,303
Canada	15	12	13	13	11
Others	15	0	0	1	181
Total	13,937	11,315	20,741	20,230	23,977

Note: the data are for the period of January to November in 2005.
Source: China's Custom Statistics.

Table 2. Estimating the number of test samples for soybeans in China in 2005.

	Number of vessels	Samples per vessel	Estimated number of samples
About 5,000 tons/vessel	6	10	60
About 60,000 tons/vessel	414	70	28980
Total	420		29040

Source: Authors' Survey.
Note: average sample is 840 tons based on China's regulation.

Table 3. Estimated total costs for laboratory and other related costs for LMOs at the border in China in 2005.

	"Contains LMOs"	"Identifies LMOs" (Current case)	"Quantifies LMOs"
Soybean (import)			
Cost per sample (US$)	286	358	481
Cost per ton (US$)	0.34	0.43	0.57
Total cost (million US$)	8.32	10.40	13.98
CIF in Jan 2006 (US$/ton)	282	282	282
Share of CIF price (%)	0.12	0.15	0.20
Maize			
Cost per sample (US$)	286	716	1332
Cost per ton (US$)	0.34	0.85	1.59
For import:			
CIF in Jan 2006 (US$/ton)	140	140	140
Share of CIF price (%)	0.24	0.61	1.13
Total cost (million US$)	0	0	0
For export:			
FOB in Jan 2006 (US$/ton)	135	135	135
Share of FOB price (%)	0.25	0.63	1.17
Total cost (million US$)	0	0	0

Source: Authors' survey.

Note: costs include laboratory testing costs (about 70%) and other service charges (about 30%) to importers if the Biosafety Protocol would be applied in 2005. China did not import maize and did not export GM maize in 2005, so the total estimated costs associated with the Biosafety Protocol were zero.

Table 4. Estimated LMO testing costs of and other fees associated with exporting soybean and maize from the USA.

	"Contains LMOs"	"Identifies LMOs"	"Quantifies LMOs"
Soybeans			
Cost per sample (US$)	216	216	324
Cost per ton (US$)	0.30	0.30	0.44
FOB per ton in Jan 2006 (US$)	245	245	245
Share of FOB price (%)	0.12	0.18	0.18
Total cost (million US$)	8.33	8.33	12.5
Maize			
Cost per sample (US$)	456	792	1536
Cost per ton (US$)	0.67	1.16	2.26
FOB per ton in Jan 2006 (US$)	105	105	105
Share of FOB price (%)	0.64	1.14	2.15
Total cost (million US$)	34.2	59.3	115.1

Source: Authors' calculations.
Note: costs include laboratory testing costs (about 80%) and other service charges (about 20%).

Table 5. Assumed costs of testing and other fees under alternative scenarios.

	"Contains LMOs" – I	"Identifies LMOs" – II	"Quantifies LMOs" – III
LMO soybean			
Share of FOB price (%)	0.12	0.18	0.18
Share of CIF price (%)	0.12	0.15	0.20
LMO maize			
Share of FOB price (%)	0.64	1.14	2.15
Share of CIF price (%)	0.24	0.61	1.13

Note: All LMO exporting countries use the USA's costs; all LMO importing countries use the China's costs.

Table 6. Impacts (%) of Biosafety Protocol on international and domestic prices of soybeans and maize under alternative scenarios, 2010.

	Soybean			Maize		
	I	II	III	I	II	III
International prices	0.07	0.10	0.11	0.31	0.56	1.07
Domestic prices						
China	0.06	0.08	0.10	0.09	0.17	0.33
NAFTA	-0.03	-0.05	-0.07	-0.05	-0.09	-0.17
South & Central America	-0.02	-0.03	-0.04	-0.04	-0.07	-0.13

Table 7. Impacts of Biosafety Protocol on international trade of soybeans and maize under alternative scenarios, 2010.

	Soybean			Maize		
	I	II	III	I	II	III
In million US$						
World trade	-12.1	-16.4	-18.7	-20.2	-40.2	-74.7
China's import	-3.9	-5.4	-6.2	-6.1	-12.1	-22.5
NAFTA's export	-7.8	-10.2	-10.7	-21.7	-43.4	-81.3
South & Central America export	-7.8	-10.9	-13.3	-10.6	-21.1	-39.2
Percentage changes (%)						
World trade	-0.08	-0.11	-0.12	-0.23	-0.47	-0.87
China's import	-0.06	-0.08	-0.09	-0.56	-1.12	-2.08
NAFTA's export	-0.10	-0.13	-0.14	-0.44	-0.87	-1.63
South & Central America export	-0.11	-0.16	-0.19	-0.70	-1.40	-2.60

Table 8. Impacts of Biosafety Protocol on world and China's domestic production of soybeans and maize under alternative scenarios in 2010.

	Soybean			Maize		
	I	II	III	I	II	III
In million US$						
World	3.1	4.2	4.6	8.5	17.3	33.4
China	4.1	5.4	5.9	10.8	21.7	41.0
NAFTA	-7.4	-9.6	-9.8	-20.6	-41.2	-77.3
South & Central America	-6.9	-9.7	-11.6	-7.5	-14.9	-27.7
Percentage changes (%)						
World	0.007	0.010	0.011	0.017	0.034	0.065
China	0.130	0.173	0.188	0.097	0.195	0.369
NAFTA	-0.052	-0.067	-0.068	-0.097	-0.193	-0.363
South & Central America	-0.055	-0.076	-0.091	-0.104	-0.206	-0.382

Endnotes

[1] The term "living modified organisms" or LMOs is therefore similar to the term "genetically modified organisms" or GMOs. The major difference between LMOs and GMOs is that LMOs are capable of reproducing whereas GMOs may not if already processed.

[2] Other potential costs include those associated with the implementation of the BSP disciplines in transboundary movements of research material and LMOs intended for release in the environment; and provisions on liability and redress.

[3] Negotiations on the detailed labeling requirements for LMOs-FFP during the March 2006 meetings in Curitiba, Brazil, focused mostly on the "may contain" or "contain" documentation requirements. In the end, the consensus document provided for both options and deferred a final decision until 2012 after sufficient experience in implanting labeling requirements could be gained. In cases when the identity of the LMOs-FFP in a particular cargo is known "through means such as identity preservation" a "contain" label that identifies specifically the LMOs is required. When the identity of the LMOs-FFP is not known through such means, however, a "may contain" label must be used. China's current biosafety regulation already requires a "contain" label that identifies the LMOs-FFP for all cargoes.

[4] It was beyond the scope of this paper to estimate how much investment went into creating China's own biosafety management system, though certainly it was be considerable since there were major investments made into personnel, office facilities, laboratories, etc. Even if one tried to quantify the investment needed to set up the domestic biosafety program, it would be difficult. Many of the personnel and office facilities are shared with other custom agencies, making attributing costs difficult.

[5] It should be noted that we are using information on testing for 2005 (from our survey) to project costs for 2010. While there should be no problem in the assumption that the unit costs are the same (there is no reason to expect China to dramatically raise the cost of a test), there is less certainty about the compliment of GM events that will have to be tested for five years in the future. In other words, in our analysis we assume that, as is the current case, there is only one soybean event and seven maize events that are being tested for. It is certainly possible that over the coming years the number of GM events for both soybeans and maize increase and become more complicated (since there may be more stacked events, etc.). Since it is difficult to predict this, we have little alternative to the current assumption. But, it should be noted, that actually testing costs may increase because of this.

[6] This option was discussed in the MOP-2 but not in the MOP-3 and it appears to have lost support. However, it is unclear whether it could resurface as an option in future negotiations during the review of the "may contain" label. Here it is presented for comparison purposes.

[7] Another assumption of our study is that the testing costs in all countries of the world are similar to those in China and North America. Since we do not have any information on the testing costs associated with the BSP, we can only assume that the costs of importing nations are similar to those of China and those of exporting countries are similar to those of the US, Brazil and Argentina.

[8] In the case of soybeans with just one commercial trait (roundup ready) in the market, the tests for "contains LMOs" and "identifies LMOs" used in the US are the same and imply the same costs.

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[9] The story may be different in the case of other nations that need international treaties to push them to launch a new set of regulations; apparently, as our study shows, this i s not the case in China.