From "May Contain" to "Does Contain": The price and trade effects of strict information requirements for GM maize under the Cartagena Protocol on Biosafety

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Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2010 AAEA, CAES & WAEA Joint Annual Meeting, Denver, Colorado, July 25-27, 2010.

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Abstract

Article 18.2.a of the Cartagena Protocol on Biosafety requires that each traded shipment of living modified organisms intended for food, feed or processing (LMO-FFPs)- essentially unprocessed genetically modified (GM) products- be labeled as such. More specifically, in 2006, Protocol members decided on a two-option rule. Shipments containing well identified LMO-FFPs would be labeled as "*does contain*" LMO-FFPs and would include a list of all GM events present in each shipment. Shipments containing LMO-FFPs that are not well-identified would be labeled as "*may contain*" LMO-FFPs as done previously. Members would also post a complete list of GM events approved on an internet database.

This paper provides a comprehensive trade assessment of strict documentation requirements on traded shipments globally. More specifically we evaluate the trade diversion, price, and welfare effects of implementing the "does contain" rule on the maize sector in all significant trading countries. Using a new spatial trade equilibrium model, we implement scenarios by adding differential transport costs only between GM producers and CPB members.

Our results show that information requirements would have a significant effect on the world market for maize. But they would have even greater effects on trade, creating significant trade distortion, diverting exports from their original destination. The measure would also lead to significant negative welfare effects, for all members of the Protocol and non-member that produce GM maize. While producers in non-GM Protocol member countries may benefit from increased protection, consumers and producers in selected countries of Sub-Saharan Africa will have to proportionally pay a much heftier price for such measure. This results call for governments in African and other affected Protocol member countries to reconsider their support for this new regulation that is bound to have no environmental benefits but significant and lasting economic costs.

Key-words: Genetically modified food, International Trade, Cartagena Protocol on Biosafety.

1. Introduction

The Cartagena Protocol on Biosafety (CPB), a supplementary agreement to the United Nations Convention on Biological Diversity introduced in 2000 (Convention on Biodiversity 2000), that entered into force in September 2003 with the goal of setting up a harmonized framework of risk assessment, risk management and information sharing on the transboundary movements of Living Modified Organisms (LMOs).[1] Among the key measures of the Protocol, there are specific rules for LMOs intended for direct uses as food, feed or processing (noted LMO-FFPs), which are essentially unprocessed genetically modified (GM) agricultural commodities.[2]

In particular, Article 18.2.a of the Protocol requires that each traded shipment of LMO-FFPs be labeled as "may contain" LMO-FFPs not intended for release in the environment, though it also noted that a more specific rule on information requirements should be determined at a later date (Convention on Biodiversity 2000). At a March 2006 meeting in Brazil, after a very contentious debate on this issue, Protocol members agreed to adopt a two-option rule consisting of a more stringent option and the less stringent one that had previously been in effect (BRIDGES 2006). Under the stringent option, shipments containing LMO-FFPs identified through means such as identity-preservation (IP) systems would be labeled as "*does contain*" LMO-FFPs and would include a list of all GM events present in each shipment. Shipments containing LMO-FFPs that are not well-identified would follow previous practice and would be labeled as "*may contain*" LMO-FFPs. At the same time, a complete list of GM events commercialized in the exporting country would be available to importers via the Biosafety Clearing House (BCH), an internet database. At the same meeting, Protocol members also agreed that the two-option rule would be reconsidered in 2010, with the possibility of making the stringent "does contain" option mandatory for all countries in 2012 (BRIDGES 2006).

While the benefits of this proposed change are highly debatable, its implementation would generate significant new costs (e.g., Kalaitzandonakes 2005, Redick 2007). More specifically, under the "does contain" rule, countries that only produce and export non-GM products would be exempt from verifications and tests, while countries that export GM would have to test each shipment to verify the accuracy of GM-event identification. Importers that are ratifying parties of the CPB would also need to pay for the IP system or to conduct tests to confirm the validity of shipment statements in order to ensure enforcement of mandatory information requirements.

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1 - Also called genetically modified organisms.

2 These products represent more than half of total import values of the four main GM commodities. Approximately 51% of soybeans and 88% of maize import value comes from unprocessed commodities (Gruere 2006).

Previous studies have analyzed the likely economic implications of adopting the "does contain" rule in different countries, such as Argentina (Direccion Nacional de Mercados Agroalimentarios 2004), the United States (Kalaitzandonakes 2004) or Australia (Foster and Galeano 2006), reporting that the costs of such change would be potentially significant. More recently, Huang et al. (2008) show that the cost of implementation would be large globally, but not really significant for China (their focus country). Gruere and Rosegrant (2008) assess the potential implementation costs of article 18.2.a on all countries member of the Asia Pacific Economic Cooperation (APEC),[3] and provide a range of cost estimates for exporters and importers, noting the disproportional cost for less developed countries that have been supportive of this measure. They also show that it would effectively constitute a new entry cost for GM adoption and for Protocol membership in this region.

Yet most of these studies provide short-run, partial cost estimates of the strict rule in particular regions, leaving aside potential price and trade diversion effects. Huang et al. (2008) do use a multi-region computable general equilibrium model to assess the potential trade effects of this new measure, showing that it would affect the prices of maize and soybeans. But their approach focuses only on a few regions (China, the Americas and the world), uses aggregate sectors from the GTAP database, and does not provide a detailed assessment of potential long run trade diversions. While their results show that the cost of implementation would be large for all, but not really significant for China, they note that other developing countries would likely pay a higher price.

The objective of this paper is to complement previous studies by providing a comprehensive global trade assessment of strict documentation requirements in all countries members of the Protocol. In particular, our analysis intends to evaluate the market effect it would have on developing countries member of the Protocol. To do so, we developed a spatial trade model and simulate scenarios to evaluate the trade diversion, price, and welfare effects of implementing the "does contain" rule on the maize sector in all significant trading countries, using data from multiple sources in the reference period 1995-2005. This includes transportation costs; allow a lower level of product analysis (HS-4 digit) and the inclusion of more countries than GTAP-based models, and accounts for trade diversion and the creation of new trade flows.

The results of our policy simulation intend to provide an overview of the medium to long run effects of mandating the "does contain" rule to all members of the Protocol, ahead of the CPB negotiation in Japan in October 2010. Developing countries members of the CPB have been vocal supporters of using precautionary measures for trade of GM commodities, such as Article 18.2.a, but they may have

[3] APEC is a regional trade body covering 21 countries located around the Pacific Ocean, from Chile to New Zealand, including large traders like Mexico, the United States, Canada, China, Japan, South Korea, Indonesia and Australia.

underestimated the cost of such measure on their economies. Beyond the cost estimates, and their geographic and product differentiation, our findings aim at giving an outlook of a possible future trade scenario for GM commodities in the presence of increasingly stricter trade regulatory measures in specific trade blocks.

In the following section we provide a conceptual framework for analysis. We then present the simulation model, data, and policy scenarios. The fourth section presents and discusses the first results of our simulations, and we close the paper with some policy conclusions.

2. Conceptual framework

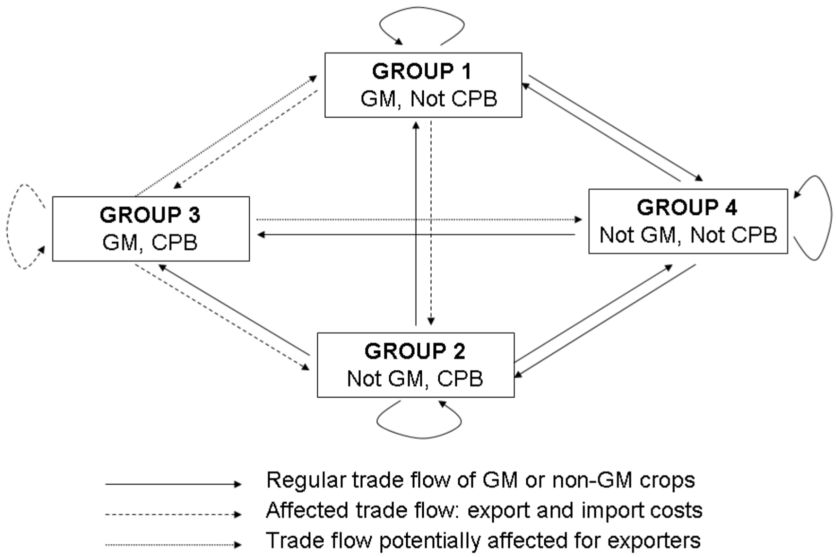
While the "may contain" and "does contain" rules may share usefulness for regulatory purposes, their costs of implementation widely differ. Under the "does contain" rule, countries that export GM would have to test each shipment to verify the accuracy of the list of GM-events, whereas the "may contain" would not require additional test beyond those to reject unapproved events in the importing countries. Even if all GM events are approved in all importing nations, the exporter will be required to provide precise information on each shipment. This may also include additional insurance cost for shippers against the rejection of shipments On the importing side, CPB member countries will need to pay for the IP system or to conduct tests to confirm the validity of shipment statements in order to ensure enforcement of these requirements. Naturally importers will also have to pay the price for the information given the additional testing and insurance applied to shipments.

Given these general considerations, we propose an analytical framework based on the characterization of Gruere and Rosegrant (2008) that categorize countries to assess the cost of information requirements. More specifically, we divide countries into four groups according to their membership to the CPB and whether they produce GM maize. In particular:

- Group 1 countries produce GM maize but are not members of the CPB (e.g., Argentina)
- Group 2 countries do not produce GM maize but are members of the CPB (e.g. Japan, Mexico)
- Group 3 countries produce GM maize and are members of the CPB (e.g., Brazil, South Africa)
- Group 4 countries do not produce GM maize and are not members of the CPB (e.g. Russia)

This categorization is used to impose the effect of strict information on specific trade flows, i.e., those linking the groups of GM maize producing countries to groups of CPB members. Figure 1 shows the specific trade flows being affected by information requirements.

Figure 1. Affected and non affected trade flows.



Source: Gruere and Rosegrant (2008).

Two types of trade relationships are bound to be affected, those that will request testing at the import and export sides (dashed arrows in Figure 1), linking GM producers to CPB members, and those that would affect only exporters, linking CPB GM producing countries to non-CPB member countries (dotted arrows in Figure 1).

We use this framework to set up a simplified partial equilibrium model of trade with four countries (*A*, *B*, *C*, and *D*) representatives of the four groups, to illustrate the potential price effect of such regulation. Each country *I* faces a linear supply S^I defined by the inverse relationship: $p^I = c_k^I Q^I$, whose slope coefficient depends on whether the country adopts GM (*k* = *g*) or not (*k* = *n*). We assume that the slope coefficients are ranked as follows: $0 < c_g^A < c_g^C < c_n^B < c_n^D$, and that A and C are net exporters, while the two others are net importers. The demand in each country is linear and defined by the inverse demand equations: $p^I = a^I Q^I + b^I$ $(a^I < 0)$. The equilibrium price is reached when all excess supply equals excess demand. The original price of the world (p_0^W) is:

$$p_0^W = \frac{-\frac{b^A}{a^A} - \frac{b^B}{a^B} - \frac{b^C}{a^C} - \frac{b^D}{a^D}}{\frac{1}{c_g^A} + \frac{1}{c_g^C} + \frac{1}{c_n^B} + \frac{1}{c_n^D} - \frac{1}{a^A} - \frac{1}{a^B} - \frac{1}{a^C} - \frac{1}{a^D}}$$

The proposed regulation is modeled as an additional transport cost for GM and non-GM for A to B and C,[4] and from C to B, for simplification. Let us assume a per unit cost τ, applied as a relative tariff on the affected trade flows. At the equilibrium, there are two prices for commingled commodities: one with affected flows and the other with non-affected. The affected equilibrium is going to be defined by the relationship between A and B and C, while the other will be affected by the relationships A and D. Naturally A and C will only export to B and D under price arbitrage conditions.

The main equations are the following:

$$p^W = c_g^A Q^A = c_g^A (Q_{CPB}^A + Q_{OUT}^A)$$

$$Q_{OUT}^A = \frac{p_{OUT}^W - b^A}{a^A} + \frac{p_{OUT}^W - b^D}{a^D} - \frac{p_{OUT}^W}{c_n^D}$$

$$Q_{CPB}^A = \frac{p_{CPB}^W - b^C}{a^C} + \frac{p_{CPB}^W - b^C}{a^C} - \frac{p_{CPB}^W}{c_n^B} - \frac{p_{CPB}^W - \tau}{c_g^C}$$

$$\{\pi_{CPB}^A = \pi_{OUT}^A\} \Rightarrow \left\{\frac{(p_{OUT}^W)^2}{2c_g^A} = \frac{(p_{CPB}^W - \tau)^2}{2c_g^A}\right\}$$

We find that at the equilibrium, the price of the non-affected area, affected area and world prices are respectively:

$$p_{OUT}^W = p_{CPB}^W - \tau$$

$$p_{CPB}^W = \frac{-\frac{b^B}{a^B} - \frac{b^C}{a^C} + \tau\left(\frac{1}{c_g^A} + \frac{1}{c_g^C}\right)}{\frac{1}{c_g^A} + \frac{1}{c_g^C} + \frac{1}{c_n^B} - \frac{1}{a^B} - \frac{1}{a^C}}$$

$$p^w = a^A(p_{CPB}^W) + p_{OUT}^W\left(\frac{1}{a^D} - \frac{1}{c^D}\right) + \frac{b^B}{a^B} + \frac{b^A}{a^A}$$

In this simplified case, the cost of the regulation acts as a wedge between the two prices- the higher the cost, the larger the difference between the two. The international price may or may not differ, but the local consumer price will increase in B and C, and may decrease in A and D. Therefore consumers in A and D may experience welfare gain, but because of the tariff like effect, producers of A, C and potentially D will lose, while producers in B will gain. These changes will occur in the short to medium term, in the long term, countries may decide to produce or abandon GM, while others may decide to join or abandon

[4] The basic transport costs are not included explicitly here, because we focus on the new costs associated with the regulation, but they are treated with care in the empirical application.

the CPB. If the effect on price is significant, A producers may try to avoid planting new GM crops, to lower additional losses.

Naturally the use of this aggregate trade model can only provide a crude, medium term, and inaccurate appreciation of what information requirements will do. Not all GM producers are large exporters, not all importers are the same, and transport costs, tariffs, and the structure of supply and demand vary largely from one country to another, even within the same group. We will now turn to our simulation model to explore the observable effects of the strict option under specific scenarios in the case of GM maize.

3. Model and scenarios

We built a spatial trade equilibrium model (Samuelson 1952, Takayama and Judge 1971) of the international market for maize, which includes 80 countries that produce, export, and/or import maize. All countries are maximizing their welfare function subject to a set of spatial trade arbitration equations. The structure of the model is based on the application by Devadoss et al. (2005) in the case of trade of timber (with fewer regions). The objective function is a quasi welfare function (QW), that Devadoss et al. (2005) call a net social monetary gain function, defined as:

$$QW = \sum_{i=1}^{80}(\alpha_i - \beta_i y_i)y_i - \sum_{i=1}^{80}(\gamma_i - \delta_i x_i)x_i - \sum_{i=1}^{80}\sum_{j=1}^{80} x_{ij}t_{ij} - \sum_{i=1}^{80}\sum_{j=1}^{80}\left(\rho_j^D - \rho_i^S\right)x_{ij} + \sum_{i=1}^{80}\sum_{j=1}^{80}\left(\frac{\rho_j^D}{1+\varepsilon_{ij}} - \rho_i^S\right)x_{ij} \qquad (1)$$

Where α_i, β_i, γ_i, and δ_i are the positive demand and supply coefficients, respectively, y_i is the quantity demanded, and x_i the quantity produced in country i, t_{ij} is the transportation cost from i to j and x_{ij} is the volume exported from i to j, ρ_j^D and ρ_i^S are the market supply and demand prices for maize (which accounts for constraints in and access to the international market), and ε_{ij} is the *ad valorem* tariff equivalent for an import of maize from i to j. The market prices should not be confused with the country prices $\left(p_i^D, p_i^S\right)$ that are defined by the inverse demand and supply equations $p_i^D = \alpha_i - \beta_i y_i$ and $p_i^S = \gamma_i + \delta_i x_i$. This objective function is maximized subject to the following set of feasibility constraints, capacity constraints and arbitrage conditions:

$$\forall i \in [\![1,80]\!] \quad \sum_{j=1}^{80} x_{ij} \leq x_i$$

$$\forall j \in [\![1,80]\!] \quad \sum_{j=1}^{80} x_{ij} \geq y_j$$

$$\forall i \in [\![1,80]\!] \quad \alpha_i - \beta_i x_i \le \rho_i^D$$

$$\forall i \in [\![1,80]\!] \quad \gamma_i + \delta_i x_i \ge \rho_i^S$$

$$\forall (i,j) \in [\![1,80]\!]^2 \quad (1+\varepsilon_{ij})(\rho_i^S + t_{ij}) \ge \rho_j^D$$

$$\forall (i,j) \in [\![1,80]\!]^2 \quad \{x_i \ge 0, y_i \ge 0, x_{ij} \ge 0\}$$

The two first constraints imply that the total quantity exported does not exceed the production and that the total quantity imported is greater or equal than the demand. The third and fourth conditions state that the market demand price should not exceed the country demand price and that the market supply price should be greater than or equal to the country supply price. When these inequalities are binding, in the case of an interior solution, market and country prices are equal, and the country produces or consumes a nonzero quantity of maize. The fifth constraint relates the market supply price (accounting for transport costs and tariffs) to the market demand price, and the last condition is that demand, supply and trade are nonnegative.

Table 1. List of exporting and importing countries included in the model and their respective groups

	Countries and groups
Net exporters	Argentina (1), Austria (2), Bulgaria (2), Brazil (3), China (2), Czech Republic (3), France (2), Hungary (2), India (2), Moldova (4), Namibia (2), Paraguay (2), Romania (2), South Africa (3), Swaziland (2), Thailand (2), Uganda (2), Ukraine (2), USA (1)
Net importers	Algeria (2), Angola (4), Bangladesh (2), Belgium-Luxemburg (2), Bolivia (2), Canada (1), Chile (4), Colombia (2), Costa Rica (2), Croatia (2), Cuba (2), Cyprus (2), Ecuador (2), Egypt (2), El Salvador (2), Germany (3), Greece (2), Guatemala (2), Honduras (2), Indonesia (2), Iran (2), Israel (4), Italy (2), Jamaica (4), Japan (2), Jordan (2), Kenya (2), Kuwait (4), Lebanon (2), Lybia (2), Malawi (4), Malaysia (2), Mauritius (2), Mexico (2), Morocco (4), Mozambique (2), Nigeria (2), Netherlands (2), North Korea (2), Pakistan (4), Panama (2), Peru (2), Philippines (3), Russia (4), Saudi Arabia (2), Slovenia (2), South Korea (2), Spain (3), Sri Lanka (2), Sudan (2), Syria (2), Tanzania (2), Turkey (2), Uruguay (1), Venezuela (2), Vietnam (2), Yemen (2), Zambia (2), Zimbabwe (2)

Source: authors. The groups are based on the year 2009 for protocol membership and 2008 for GM maize production (James, 2009).

Table 1 shows the list of countries retained for the simulation, that includes all countries with maize production, export and/or import volumes during 1995-2005 exceeded 0.1% of total volume and for which key data was available. Because spatial trade models only allow for unidirectional bilateral trade flow, we distinguish net exporters from net importers based on United Nations COMTRADE data at the HS 4 digit level (1205) from 1995-2005.

Table 2. Data sources for key parameters.

Parameters	**Years**	**Sources of original data**
Production	1995-2005	FAOSTAT, UN Food and Agricultural Organization
Domestic Prices	1995-2005	FAOSTAT, UN Food and Agricultural Organization
Consumer prices	1995-2003	FAOSTAT, UN Food and Agricultural Organization
Elasticities of supply	2001-2005	IMPACT model, International Food Policy Research Institute
Elasticities of demand	2001-2005	IMPACT model, International Food Policy Research Institute
Net trade flows	1995-2005	UN COMTRADE 1005 (HS-4) bilateral trade data.
Transportation costs	2004-2006	Ocean freight rates from the International Grains Council.
Ad-valorem tariffs	2005	MAcMap database.

Source: authors.

Table 2 summarizes the major sources of data used for parameterization. As noted above, we assume linear supply and demand in each country, with initial coefficients based on production data from the Food and Agricultural Organization FAOSTAT database, and supply and demand elasticities from the IMPACT model of the International Food Policy Research Institute. Transportation costs for each bilateral trade flow are estimated using report ocean freight rates from the International Grains Council as references and distances between ports computed with data from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). Tariff rates are based on MAcMap HS-6 database of ad valorem equivalent aggregate tariff developed by the CEPII and the International Trade Centre (ITC). Producer and consumer prices are derived from above listed data and consumer and producer support equivalents from IMPACT and the Organization for Economic Cooperation and Development (OECD).[5]

Because of the inconsistency across data sources (Table 2), and incomplete datasets for some of the parameters, we use cross-entropy methods to calibrate the models, following a procedure used by Robinson et al. (2001) and You and Wood (2006). More specifically, the parameterization is completed in two stages. In the first stage, bilateral trade data are entered and rebalanced to fit with the rest of the data. In the second stage, transport costs are being adjusted to fit with the rest of the data. In these two stages, the prior distributions of probabilities for the parameters of interest (bilateral trade flows and transport costs) are based on distributions of frequencies of trade volume per exporter and of transport costs directly derived from available data. The support used for these cross entropy stages is therefore a uniform distribution. The third stage runs the model of quasi-welfare maximization in a standard fashion using a non linear solver in GAMS.

[5] The complete procedures, while not presented here, are available from the authors.

Table 3. Definition of scenarios

	Affected trade flows	Additional cost imposed on trade flows			
		Base	**Scenario 1**	**Scenario 2**	**Scenario 3**
Set A	1→2, 1→3, 2→2, 2→3	0	$1.5/ton	$6.5/ton	$13/ton
Set B	1→2, 1→3, 2→2, 2→3	0	$1.5/ton	$6.5/ton	$13/ton
	3→1, 3→4	0	$1/ton	$5/ton	$9/ton

Source: Authors, based on Gruere and Rosegrant (2008).

We run six scenarios of simulations by implementing marginal increase in transport costs of affected trade flows of potentially GM maize. Table 3 presents each of the scenarios. Set A imposes additional transport costs only on flows between GM producers and CPB members. Set B includes the same chocks but also include additional costs for exports from GM producing countries that are CPB members (Group 3) toward any non-CPB members. In other words, set A provides a minimum (or pragmatic) implementation of the requirements by CPB members, and set B shows the situation if CPB members implement it to all their exports as long as they produce GM crops.

Under each set, the Base scenario represents the initial situation, which can be interpreted as the "may contain" option. Scenario 1 introduces a small per volume cost on affected trade flows (see Figure 1), based on a sum of the export and import costs assumed by Gruere and Rosegrant (2008), but that are also consistent with the costs estimated by Huang et al. (2008) in the case of China. Scenarios 2 and 3 impose higher additional costs, following Gruere and Rosegrant (2008), citing JRG Consulting (2004) and Kalaitzandonakes (2005), that represent less efficient testing systems,[6] and that may be more representative of the costs for less developed trading countries.

In each case, we focus on three key variables: the relative changes in trade volume, prices and quantities in major countries. The following section provides a first set of results.

[6] JRG Consulting (2004) and Kalaitzandonakes (2005) study the cases of major exporters of GM products, with very advanced infrastructure, and therefore their proposed cost may still be small compared to the actual transport costs for smaller developing countries. But because they are much higher than those of Huang et al. (2008), that appear to be more precise, we take them as benchmark value for possible high cost of implementation.

4. First results

a. Set A

- *Changes in main market variables*

Table 4. Relative changes in world market variables compared to the Base

	Scenario A1	Scenario A2	Scenario A3
Aggregate quantity	-0.04%	-0.16%	-0.32%
Average p^S	+0.2%	+0.8%	+1.6%
Average p^D	+0.0%	+1.2%	+2.4%
Quasiwelfare	-8.6%	-37%	-77%

Source: derived from simulation results.

At the global level, the additional transport cost implemented on the main affected trade flows decreases the total production of maize by 600,000 (scenario A1) to 1.6 million ton (A3). As expected, an increase in the cost of information requirements amplifies the effects it has on the world market. The average country supply price increases by 0.2 to 1.6% in scenario A3. The average country demand price also increases, signifying a drop in demand, by up to 2% in scenario A3. The aggregate quasi-welfare does decrease significantly with increased additional costs as net monetary gains decline by a large relative amount but a lower absolute value (from -14 to -25) with lower supply and demand and additional transport costs.

However these results do not provide a good overview of the changes experienced at a lower level of aggregation. Since the shocks are implemented by group, it is useful to first analyze differences in groups, as shown in Table 5.

Table 5. Relative changes (%) in key variables compared to the base in each group of countries

	Group 1			**Group 2**			**Group 3**			**Group 4**		
Scenario	A1	A2	A3	A1	A2	A3	A1	A2	A3	A1	A2	A3
Supply	-0.1	-0.6	-1.1	+0.1	+0.3	+0.6	-0.1	-0.4	-0.9	+0.0	+0.2	+0.4
Demand	+0.2	+1.0	+2.0	-0.2	-0.8	-1.5	-0.3	-1.3	-2.6	-0.0	-0.1	-0.1
Average p^S	-0.4	-2.0	-3.9	+0.3	+1.4	+2.7	-0.3	-1.3	-2.9	+0.0	+0.1	+0.2
Average p^D	-0.3	-1.5	-3.0	+0.3	+1.6	+3.2	+0.4	+1.9	+3.6	-0.0	-0.2	-0.7

Source: Derived from simulation results.

Group 1, whose exports are affected does experience a decrease in supply and supply prices. Production declines by about 2.9 million tons, a non-negligible amount. Most of this decline is experienced by the United States (-2.6 million tons), but all Group 1 countries do reduce their production. With the average demand price decreasing by 0.3 to 3%, internal demand does increase by about 4.4 million tons, which have to come from a reduction of exports or an increase in imports.

Results for Group 2 are opposite in direction and amplitude. Countries in this group slightly increase their production of maize (by 190,000 to 1.6 million tons), due to the effect of the new tariff like measures, but decrease their demand because of an increase in the demand prices. This region is the largest consumer of maize, and a 1.5% decline in maize demand (scenario A3) translates into a reduction of consumption by about 4.6 million tons. This suggests that the region does import more maize that it increases its exports overall. However, the group includes a large number of countries that do not all share the same trend. Mexico, India, Indonesia, Italy, France and Nigeria experience large decrease in demand (exceeding 250,000 tons), but Mexico is the only country with a drop exceeding 1 million tons. China and Japan do not experience any change in demand or supply. On the supply side, France, Mexico, Nigeria and Italy lead the group in production increase (ranging from 100,000 to 200,000 tons in scenario A3). These suggest both significant domestic changes towards exports outside the region.

Group 3 countries experience an intermediate situation, with decreased supply and demand, with a higher demand price and a reduction in the supply price. But the drop in demand (from 200,000 in scenario A1 to 1.8 million tons in scenario A3) largely exceeds the decrease in supply (-81,000 to -702,000), signifying a growing maize surplus. Most of the decline in demand is borne by Brazil (-1 million tons in A3), South Africa (-300,000 tons) and Spain (-200,000 tons). The decrease supply is also experienced most largely by Brazil (- 375000 tons in A3) and to a smaller extent, South Africa (-140,000 tons), but much less by other countries in the group. The main maize producers in this Group may therefore experience consumer losses but producers gains with new exports outside of the region.

Lastly, Group 4 has a distinct pattern with on average, negligible changes in supply demand, following the same pattern as Group 2. However the minor observed decrease in demand is associated with a minor decrease in demand price, suggesting the presence of heterogeneous effects in countries with differentiated demand elasticities. Indeed, unlike in other groups, there is a significant variation of demand effects within Group 4. Some countries, like Moldavia, Israel and to a larger extent Malawi (-100,000 tons in A3), experience lower demand, while other larger countries, like Pakistan, Russia and Chile increase their demand for maize. These variations mimic the demand price fluctuation across countries. Significant variations are also observable on the supply side, with Moldova and Malawi producing more maize (up to +58,000 tons) to take advantage of higher supply prices, while Chile and Bosnia decrease their production, and larger countries do not change their production level. Angola slightly increases its production under scenario A1 and decreases it under the two other scenarios.

- *Trade effects*

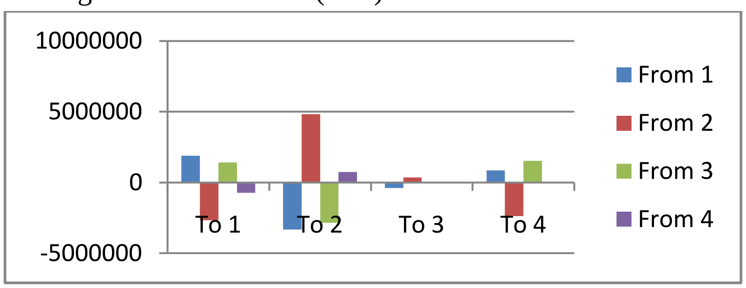
The simulation results on trade are generally consistent with our expectations; trade flows with additional costs are affected. But the magnitude of trade diversion is perhaps more significant than expected and varies across regions and scenarios. Table 6 shows a decomposition of trade by groups under the three scenarios. Figures 2, 3, and 4 illustrate these changes.

Table 6. Change in trade volume relative to the Base under the three scenarios (highlighted cells represent affected trade flows)

Scenario	Origin\Destination	To Group 1	To Group 2	To Group 3	To Group 4	Total exports
A1	From Group 1	1885156	-3317062	-394530	845115.9	-981319.7
	From Group 2	-2680557	4829371	355383.2	-2390560	113636.84
	From Group 3	1412203	-2853939	-3059.76	1534353	89557.269
	From Group 4	-728304	732137.5	25.18012	0	3858.9336
	Total imports	-111502	-609492	-42181.4	-11091.3	-774266.7
A2	From Group 1	152547.8	-4137491	-761814	504045.6	-4242712
	From Group 2	-2680557	5065918	587044.6	-2930275	42130.082
	From Group 3	2771135	-4772298	-8214.7	2400019	390642.57
	From Group 4	-728304	745408.6	-346.341	0	16758.505
	Total imports	-485178	-3098462	-183331	-26209.6	-3793181
A3	From Group 1	-119571	-9915063	-893923	2561052	-8367504
	From Group 2	-2680557	5951708	350953.4	-3020496	601608.16
	From Group 3	2478937	-2098506	25908.67	418164.8	824504.51
	From Group 4	-728304	553884.3	208551.8	0	34132.283
	Total imports	-1049495	-5507977	-308509	-41278.6	-6907259

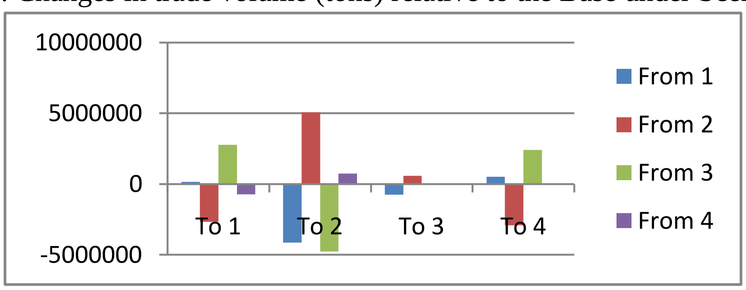
Source: Results from simulation.

Figure 2. Changes in trade volume (tons) relative to the Base under Scenario A1



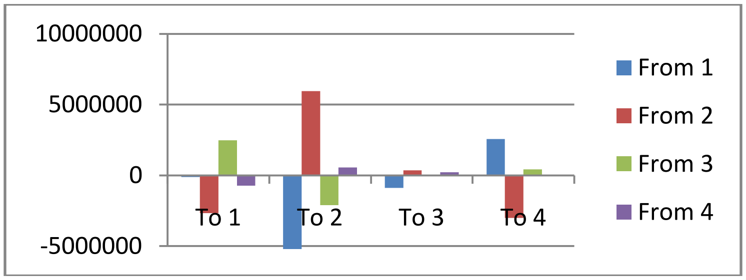
Source: Results from simulation.

Figure 3. Changes in trade volume (tons) relative to the Base under Scenario A2



Source: Results from simulation.

Figure 4. Changes in trade volume (tons) relative to the Base under Scenario A3



Source: Results from simulation

In Scenario A1, an additional transport cost is imposed on trade flows going from Group 1 and Group 3 to Group 2 and 3 (Table 3). As shown in the shaded cells, these trade flows are largely reduced because of the additional transport cost. In particular, Group 1 and 3 export around 6 million tons less toward Group 2 and 400,000 tons less toward Group 3 than in the Base scenario. But these deficits are partially compensated by exports from other groups; Groups 2 and 4 export 5.6 million and 355,000 additional tons to Group 2 and 3, respectively. A domino effect follows, with countries in affected groups (1 and 3) diverting their exports towards non-affected regions (1 and 4) and countries in compensating groups (2 and 4) reducing their exports towards affected exporters (1 and 3). Still, in aggregate the total trade volume is reduced by 700,000 tons, and all groups import less maize than before. But Group 1 is the only one to reduce its total exports because of the additional cost. In consistency with above observations, Group 2 and 3 do in fact export larger amounts than in the Base scenario.

The same general effects are observed at a larger scale under scenarios 2 and 3. Overall, the total trade volume decreases by an additional 3 million and 6.2 million tons in scenarios A2 and A3, respectively. Results from Scenario A2 are fully consistent with the ones presented in A1, at a larger scale. Results from Scenario A3, however, do deviate minimally; instead of diminishing, exports from Group 3 to Group 3 increase slightly by a non-significant amount (+26,000 tons, which is equivalent to one small cargo). This may be due to the fact that exports to Group 2 are so much diminished (-12 million tons from Group 1 and 3), that compensating groups (2 and 4) send an even larger volume to this group than to Group 3, creating an excess demand in Group 3 that may be met by minimal additional amounts from exporters in 3.

At the country level, the largest changes are experienced by major trading countries in Group 1 and 3, as expected. For instance in scenario A1, the United States decrease its exports by about 800,000 tons overall, but it decreases its exports to Turkey (group 2) and the Philippines (group 3) by 820,000 and 165,000 tons, respectively. In the same scenario Brazil (Group 3) exports more overall, but 1.2 million tons less to Italy (Group 2), that is compensated by an increase in exports of 1.8 million tons to Canada (Group 1). South Africa (Group 3) also decreases its exports to various Group 2 countries by 1.2 million tons, but compensates by exporting 1.3 million tons more to Russia (Group 4).

b. Set B

-Change in main market variables

Table 7 shows the relative changes in prices, quantities and quasiwelfare at the global level. These results are almost identical to the ones under set A when comparing the three scenarios (Table 4). In particular, the volume of production, and average of supply and demand prices experience identical relative changes. The estimated changes in quasiwelfare are almost identical, with only scenario B3 leading to a very minimal decline compared to scenario A3. This may indicate that the additional changes have only minor effects on the market, given that they do not represent major trade flows.

Table 7. Relative changes in world market variables compared to the Base

	Scenario B1	**Scenario B2**	**Scenario B3**
Aggregate quantity	-0.04%	-0.16%	-0.32%
Average p^S	+0.2%	+0.8%	+1.6%
Average p^D	+0.3%	+1.2%	+2.4%
Quasiwelfare	-8.6%	-37%	-78%

Source: Results from simulations

Table 8. Relative changes (%) in key variables compared to the base in each group of countries

	Group 1			**Group 2**			**Group 3**			**Group 4**		
Scenario	B1	B2	B3	B1	B2	B3	B1	B2	B3	B1	B2	B3
Supply	-0.1	-0.6	-1.1	+0.1	+0.3	+0.6	-0.1	-0.5	-0.9	+0.1	+0.2	+0.4
Demand	+0.2	+1.0	+2.0	-0.2	-0.8	-1.2	-0.3	-1.3	-2.6	-0.1	-0.1	-0.2
Average p^S	-0.4	-2.0	-3.9	+0.3	+1.3	+2.7	-0.3	-1.3	-2.9	+0.1	+0.1	+0.2
Average p^D	-0.3	-1.6	-3.0	+0.4	+1.6	+3.2	+0.4	+1.9	+3.6	+0.0	-0.2	-0.6

Source: Results from simulations.

Table 8 presents the same relative changes by Group. Once again, the results are extremely similar to the ones obtained under set A, both in terms of signs and quantitative relative changes from the Base. A few changes appear for selected scenarios and variables, but never exceeding +/- 0.1%. The only visible difference concerns Group 4. This group, a relatively lower trader of maize than others, experiences additional costs for its imports from CPB members (countries of Group 3) compared to set A. This results in non-zero effect of B1 and slightly different effects on the demand side under scenario B3, compared to A3- the demand price decreases a little less, and the demand decreases a little more. While Group 1 also witnesses the same changes for imports from CPB members, the effects of additional transport costs are negligible, because it is constituted of mostly net exporting regions, or regions that may compensate their losses.

-Trade effects

The trade effects of the shocks implemented under scenarios B1, B2, and B3 are presented in Table 9 and Figures 5, 6, and 7, in the same fashion as for set A. Naturally two more cells are shaded under each

Table 9. Change in trade volume relative to the Base under the three scenarios (highlighted cells represent affected trade flows)

Scenario	**Origin\Destination**	To Group 1	To Group 2	To Group 3	To Group 4	**Total exports**
B1	From Group 1	3951520	-8312947	-644972	4021576	-984824
	From Group 2	-2680557	5047996.1	136315.8	-2390470	113284.8
	From Group 3	-653435	2391414.2	689.6625	-1650040	88629.4
	From Group 4	-728304	266166.43	465983.1	0	3845.724
	Total imports	-110776	-607370.7	-41984	-18933.9	-779064
B2	From Group 1	3577957	-11483886	-885787	4544955	-4246762
	From Group 2	-2680557	5401785.2	250647.6	-2930188	41687.3
	From Group 3	-653435	2667651.3	25393.43	-1650040	389570.3
	From Group 4	-728304	318403.31	426643.7	0	16743.24
	Total imports	-484339	-3096047	-183103	-35272.9	-3798761
B3	From Group 1	3059161	-14155187	-1849733	4618595	-8327164
	From Group 2	-2680557	5343064.3	1093854	-3020425	735936.2
	From Group 3	-653435	3071940.9	54717.8	-1650040	823184.2
	From Group 4	-728304	369549	392868.3	0	34113.49
	Total imports	-1003135	-5370633	-308293	-51869.4	-6733930

Source: Results from simulations.

Figure 5. Changes in trade volume (tons) relative to the Base under Scenario B1

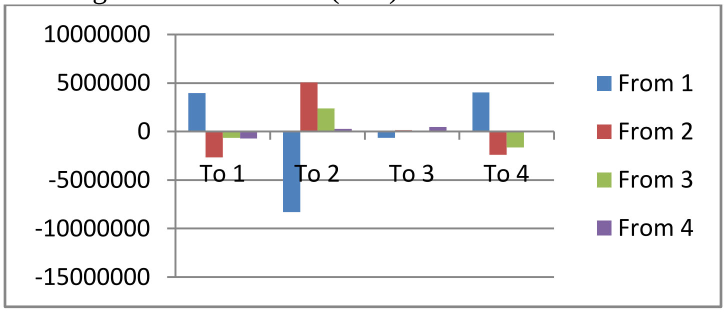


Figure 6. Changes in trade volume (tons) relative to the Base under Scenario B2

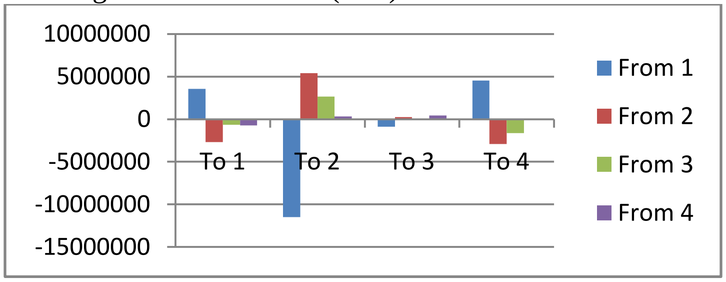
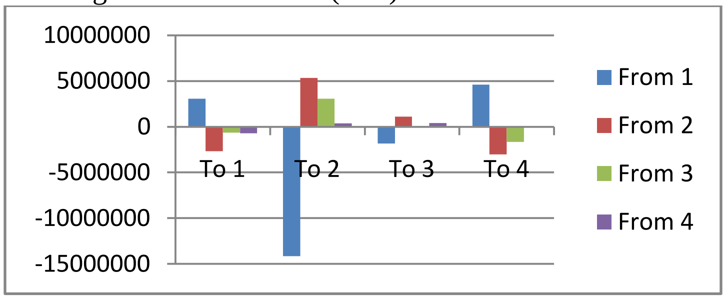


Figure 7. Changes in trade volume (tons) relative to the Base under Scenario B3



scenario in Table 9 to indicate the two new trade flows being affected by information requirements. At first view, the aggregate results of Table 9 appear similar to those observed in Table 6 (set A). Total trade volume is reduced by 770,000 tons under B1, 3.2 million tons under B2 and 6.7 million under B3 (slightly less than for A3). All groups reduce their imports and only Group 1 reduces its exports. But in the detail, the amplitude and direction of intra and inter group trade change largely, as visible on the three Figures below Table 9.

Group 1 countries do follow the same pattern as under set A, they export much less towards Group 2 and 3, and compensate by exporting more toward Group 1 and 4. But the magnitude of these diversions is much larger than under set A. In particular, Group 1 reduces its exports to Group 2 by 8 to 14 million tons depending on the scenario, instead of 3 to 10 million tons under set A. Under scenario B3, Group 1 reduces its exports to Group 3 by 1.8million tons, or double that in scenario A3. Interestingly, these changes happen despite the fact that Group 1 is not directly affected by the new transport costs. The effect is indirect and seen when observing the trade changes in other groups.

Group 2 also follows the same diversion scheme as under set A, diverting its exports to Group 2 and 3 to compensate for the loss due to Group 1's trade reductions. Its overall imports and exports are very similar to those under set A. On the import side however, Group 2 experience a much larger shift in maize suppliers, notably because of the much larger drop in exports from Group 1. But instead of obtaining volume from itself and Group 4 (Set A), it receives a large amount of maize (2.4 to 3.1 million tons) from Group 3.

Group 3 is in fact the most affected by these additional changes, as expected. It faces additional costs for all its maize exports, regardless of their destination, but with more costs imposed on trade to Group 2 and itself than for Group 1 and 4. Interestingly, however, these relative smaller changes on exports to Group 1 and 4 lead to a complete switch in export diversion from Group 3. Group 3 reduces its exports to Group 1 and 4, and increases significantly its export to Group 2 and to a lesser extent Group 3. This may be due to different market considerations, but likely mostly to trade preference factors, such as regular tariffs and transport costs, as well as Group 3 exporters' own competitiveness compared to that of other countries. The drastic drop in exports from Group 1 to Group 2 may also be a driver of this preference for exporting to Group 2, which has the largest set of importers. Despite these significant changes, the aggregate exports and imports under set B scenarios are virtually identical than that under set A scenarios. The effect is a simple and pure trade diversion.

Lastly, trade from and to Group 4 is relatively not affected by the new measure compared to scenario A. It does export more towards Group 3 than under set A, instead of devoting it to Group 2 countries, perhaps as a compensation of the increased exports from Group 3 to Group 2. Its total imports do decrease more than under set A but by relatively small volumes.

At the country level, as under seta the largest changes can be seen in major trading nations of Group 1 and especially Group 3. For instance, in the case of Scenario B1, the United States (Group 1) reduces its exports by 360,000 tons to Saudi Arabia (Group 2), 500,000 tons to Germany (Group 3), 600,000 tons each to Yemen, Zimbabwe and Ecuador (all Group 2), while still reducing its exports to Turkey (Group 2) by 1.4 million tons. These reductions are compensated by increased exports to Russia (Group 4, +2.6 million tons), Chile (Group 4, +800,000 tons) or Kuweit (Group 4, +600,000 tons).[7] Brazil decreases its exports to Canada (Group 1) by 653,000 tons, which are compensated by an additional 655,000 tons of exports to closer Algeria (Group 2). South Africa reduces its exports to Chile and Russia (Group 4) by 750,000 tons and 300,000 tons, compensating by exporting an additional 1.2 million tons toward closer Greece (Group 2). As expected each of this change is consistent with a cost minimizing effort on behalf of the exporting country; substitutions are only made to countries at similar distance or closer or that have similar or not significantly different trade policies.

c. Discussion: from markets to welfare effects

The results from the simulations have shown that implementing strict information requirements with "Does Contain" option on maize could have significant market and especially trade effects. While there is less trade and less volume of maize, which constitute clear market losses, not all countries will experience similar welfare outcomes. In this section we look further by analyzing economic welfare for countries in different regions.

We use the slope and intercept coefficients and the supply and demand variables to compute Marshallian consumer and producer surpluses for each country and group in each scenario. Figures 8, 9 and 10 show the absolute changes in consumer surplus, producer surplus, and total surplus for each group compared to the Base. Table 11 in the appendix provides the results by country.

[7] Overall the United States does decrease its exports by about 800,000 tons in this scenario.

Figure 8. Consumer surplus (USD/year) for each group under each scenario

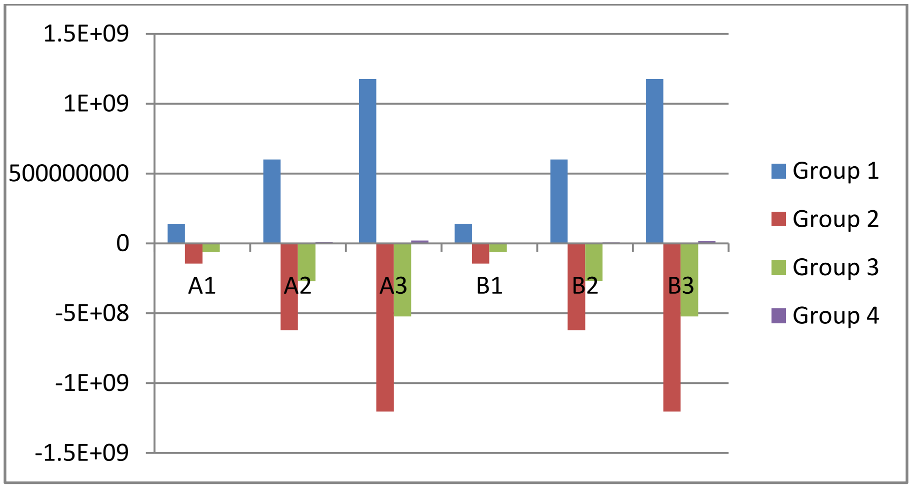


Figure 9. Producer surplus (USD/year) for each group under each scenario

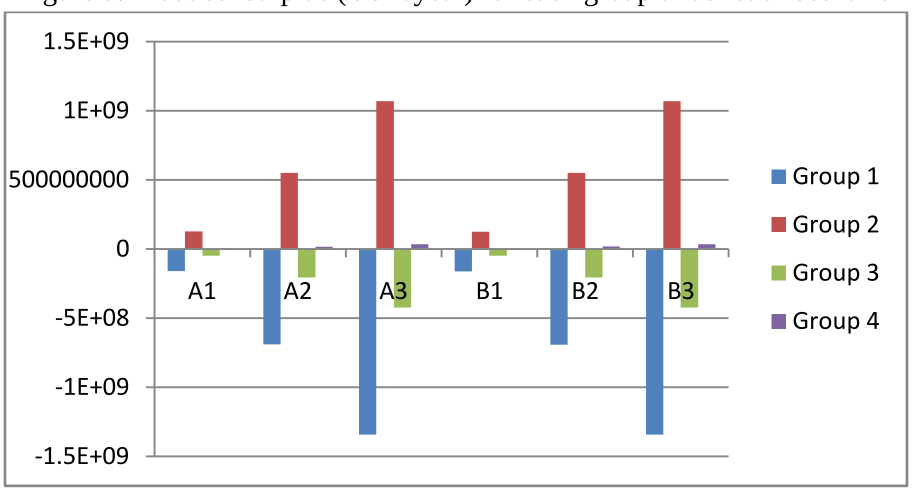
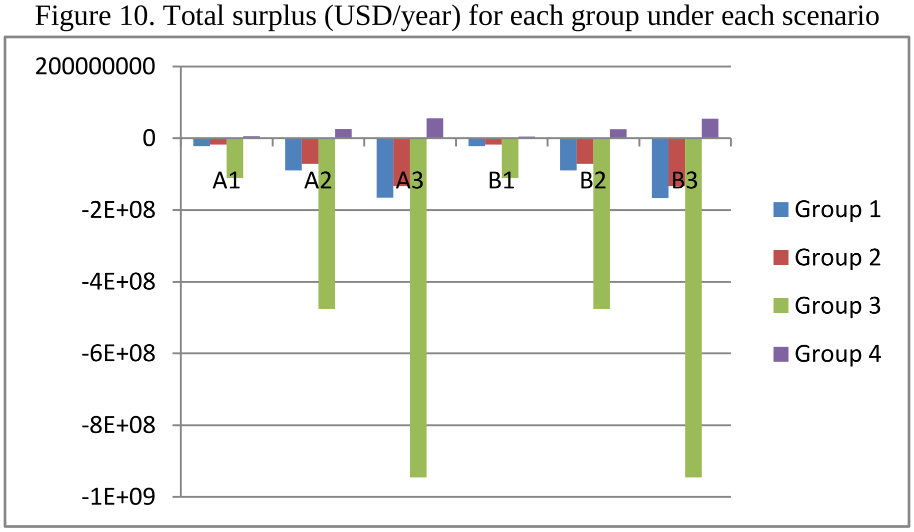


Figure 10. Total surplus (USD/year) for each group under each scenario



The results show that the distribution of welfare effects is indeed quite heterogeneous. On the consumer side, Group 1 is bound to gain, and the other groups, especially Group 2 and 3 lose. These effects are amplified when moving toward more costly scenarios. On the producer side, Group 2 gains and Group 1 and 3 lose. The amplitude of these gains and losses also increase with more costly scenarios. On both side, Group 4 experience small positive changes in welfare, that increase with more drastic scenarios. Overall, when adding these effects, Group 4 is the only one that derives welfare gains that grow from A1 and B1 (+0.1% compared to the Base) to A3 and B3 (+0.5%). Group 1 and 2 suffer significant but not large welfare losses (-0.2% and-0.1% respectively under the more costly scenarios). Group 3 does experience non-negligible total welfare losses from $17million (-0.3% of total welfare relative to the Base) under scenarios A1 and B1 to $134million (-2.4%) under scenarios A3 and B3.

These results suggest that most countries are bound to lose with information requirements, which confirms the conclusions of other studies. But they also provide some light on some of the key supports toward such requirement at the Cartagena Protocol. Non-members only have an indirect role to play in negotiation, so even if the large trading countries in Group 1 (like Argentina, Canada or the United States) continue to push against it, they may not advance much. Group 4 countries are absent from discussions, as smaller trader and non-members. The core of the support obviously needs to come from member countries in Group 2 and 3, that are both bound to lose overall, especially Group 3 countries (Brazil and Romania are the biggest losers, see Table 11). Yet Group 2 and 3 member countries (especially Europe, Brazil and African countries) have generally been very supportive of this measure in meetings of the Protocol. So why do they support a measure that could be economically detrimental for them?

As in other political forums, a largely well known result from the literature (Olson, 1965) is that well organized and smaller groups are bound to be the most influential. In developed countries, the most influential parties tend to be on the production side. Results presented in Figure 9 suggest that producers, especially in countries of Group 2 are bound to gain from this measure significantly. France leads a list of seven Group 4 countries with the highest total surplus gains (see Table 11). Given the voice of countries of agriculture producers in Europe and the prominent role of Europe in Protocol negotiations, directly related to their financial contribution to the Secretariat, these actors may play a non insignificant role in supporting the use of information requirements.

In other countries of Group 2, notably in Africa, producers and consumers are typically not well represented, and the support for such measure has been seen from anti-GM organizations, that are pushing for any restriction in the marketing of GM food. Representatives from African countries typically come from the Environmental ministry and have no background or knowledge of trade implications of Protocol measures.

Yet these countries are bound to be directly affected by the measure, with potentially losses at stake. Table 10 shows the welfare results for Sub-Saharan African countries in our study in the case of scenario B3. Of the fourteen countries in the study, only Swaziland, Namibia and Angola may experience welfare gains overall, due to production gains with a small number of consumers in the first two countries, and the gains of consumers in a small producing country in the third country.

Table 10. Change in welfare effects in Sub-Saharan African countries in Scenario B3 compared to the Base scenario

Group	Country	Consumer surplus	Producer surplus	Total surplus
2	Kenya	-31,724,248	26,423,973	-5,300,275
	Mozambique	-14,615,990	12,510,993	-2,104,997
	Mauritius	-4,139,254	30	-4,139,224
	Namibia	-265,445	13,724,421	13,458,975
	Nigeria	-60,431,004	5,190,969	-55,240,034
	Senegal	-5,986,315	1,211,729	-4,774,585
	Swaziland	-840,087	14,174,405	13,334,318
	Tanzania	-31,384,073	27,024,343	-4,359,729
	Uganda	-8,192,094	20,502,256	12,310,162
	Zambia	-12,723,496	6,357,993	-6,365,503
	Zimbabwe	-21,561,995	15,221,805	-6,340,190
3	South Africa	-65,822,828	-56,356,265	-122,179,093
4	Angola	3,429,747	-1,944,368	1,485,379
	Malawi	-24,847,766	22,492,206	-2,355,560

Source: derived from simulation results.

While small producers in Sub-Saharan countries (mostly in Group 2) do not generally connect to the market, urban consumers do and may be affected by price increases as observed during the food price increase of 2008. Producers in Group 3 and 4 that are connected to the market will also lose. South Africa will even experience large losses both for producers and consumers. All these groups will probably pay a much larger proportional price than consumers in developed nations of Group 2 and 3 or even producers in some of the most productive countries of Group 3.

5. Conclusions

In this paper, we investigated the economic effects of implementing a strict information requirement ("Does Contain LMO-FFPs" with a list of specific GM events) under Article 18.2.a of the Cartagena Protocol on Biosafety. Building on previous studies, our analysis focuses on evaluating the medium to long term effect on prices, trade and welfare effects of implementing this regulation at the global level.

Using a simple analytical model, we first show that such new regulation would create price tension with losers and winners, but likely to make many member and non member countries lose. We then use an empirical approach to validate our hypothesis in the case of maize. We find that, under relatively conservative cost assumptions, information requirements would have a significant effect on the world market for maize. But they would have even greater effects on trade, creating significant trade distortion, diverting exports from their original destination. In particular, non-member countries that produce GM would reduce their exports to Protocol members, and GM producing countries that are part of the Protocol would also divert their exports to new destinations depending on the scenario. The measure would reduce world trade and production in maize, with significant welfare effects.

At the global level, total welfare effects (consumer and producer surplus) would decline by up to $1.2 billion or 0.4% annually, but some countries bear a heavier price than others. While producers in non-GM Protocol member countries may benefit from increased protection, consumers and producers in selected countries of Sub-Saharan Africa will have to proportionally pay a much heftier price for such measure. This call for governments in African and other affected countries to reconsider their support for this new regulation that does not present any obvious benefits but, if implemented, would be associated with a large cost for generations to come.

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Table 11. Welfare effects (B3-Base) by country ranked in decreasing order of total surplus effects

Country	Group	Consumer surplus	Producer surplus	Total surplus
France	2	-62,219,713	106,112,897	43,893,184
Hungary	2	-40,865,641	62,843,291	21,977,650
India	2	-96,343,591	115,819,672	19,476,081
Ukraine	2	-30,211,316	48,702,416	18,491,100
Thailand	2	-32,277,708	47,583,287	15,305,578
Bulgaria	2	-9,849,123	25,068,319	15,219,196
Austria	2	-12,610,402	27,585,250	14,974,848
Moldova	4	-9,597,471	24,077,008	14,479,537
Russia	4	14,054,316	0	14,054,316
Pakistan	4	13,569,463	0	13,569,463
Namibia	2	-265,445	13,724,421	13,458,975
Swaziland	2	-840,087	14,174,405	13,334,318
Uganda	2	-8,192,094	20,502,256	12,310,162
Paraguay	2	-4,641,102	16,325,266	11,684,164
Morocco	4	6,040,976	1,211,487	7,252,462
Jamaica	4	4,976,710	0	4,976,710
Chile	4	9,100,478	-5,451,149	3,649,329
Kuwait	4	3,102,900	-884	3,102,016
Bosnia-Herzegovina	4	7,287,869	-4,640,796	2,647,073
Angola	4	3,429,747	-1,944,368	1,485,379
Uruguay	1	4,009,152	-2,777,581	1,231,571
North Korea	2	0	0	0
China	2	0	0	0
Japan	2	0	0	0
Peru	2	-915,919	539,985	-375,933
Canada	1	52,277,220	-52,846,670	-569,450
Indonesia	2	-54,934,316	54,121,374	-812,942
Mozambique	2	-14,615,990	12,510,993	-2,104,997
Vietnam	2	-22,632,465	20,350,015	-2,282,450
Malawi	4	-24,847,766	22,492,206	-2,355,560
Croatia	2	-20,939,053	18,265,160	-2,673,893
Sri-Lanka	2	-3,998,789	239,400	-3,759,389
Lebanon	2	-4,160,264	23,353	-4,136,911
Mauritius	2	-4,139,254	30	-4,139,224
Cyprus	2	-4,315,900	113	-4,315,788
Tanzania	2	-31,384,073	27,024,343	-4,359,729
Bangladesh	2	-5,446,980	718,003	-4,728,976
Honduras	2	-9,193,198	4,435,530	-4,757,668
Senegal	2	-5,986,315	1,211,729	-4,774,585
Slovenia	2	-7,514,575	2,543,382	-4,971,193
Sudan	2	-5,080,130	69,150	-5,010,980
El Salvador	2	-10,684,092	5,665,558	-5,018,534
Lybia	2	-5,125,276	12,702	-5,112,575
Ecuador	2	-9,481,761	4,362,330	-5,119,431
Panama	2	-5,907,887	727,862	-5,180,025
Kenya	2	-31,724,248	26,423,973	-5,300,275
Belgium-Luxembourg	2	-7,135,336	1,652,771	-5,482,565
Yemen	2	-5,917,733	332,608	-5,585,125
Italy	2	-86,068,087	80,352,014	-5,716,073
Jordan	2	-6,005,157	139,282	-5,865,875
Guatemala	2	-14,378,797	8,414,713	-5,964,084

Costa Rica	2	-6,234,065	187,996	-6,046,069
Zimbabwe	2	-21,561,995	15,221,805	-6,340,190
Zambia	2	-12,723,496	6,357,993	-6,365,503
South Korea	2	-6,947,095	445,230	-6,501,865
Venezuela	2	-20,761,655	13,494,932	-7,266,723
Syria	2	-8,125,198	0	-8,125,198
Greece	2	-22,276,350	14,027,592	-8,248,758
Cuba	2	-8,263,933	0	-8,263,933
Israel	4	-8,535,312	0	-8,535,312
Egypt	2	-54,620,170	45,700,845	-8,919,324
Colombia	2	-21,611,781	12,626,420	-8,985,361
Saudi Arabia	2	-9,215,326	74,850	-9,140,475
Bolivia	2	-9,723,926	284,134	-9,439,792
Algeria	2	-9,780,925	5,224	-9,775,701
Netherlands	2	-11,557,941	1,401,634	-10,156,307
Turkey	2	-26,682,745	15,438,971	-11,243,774
Malaysia	2	-12,774,616	219,162	-12,555,454
Czech Republic	3	-2,661,011	-11,068,228	-13,729,240
Mexico	2	-185,123,585	170,500,125	-14,623,460
Iran	2	-19,070,278	0	-19,070,278
Argentina	1	27,794,277	-61,759,402	-33,965,125
Germany	3	-29,015,099	-19,216,524	-48,231,624
Nigeria	2	-60,431,004	5,190,969	-55,240,034
Philippines	3	-22,684,865	-44,544,222	-67,229,088
Spain	3	-48,570,401	-22,128,097	-70,698,498
South Africa	3	-65,822,828	-56,356,265	-122,179,093
USA	1	1,092,923,100	-1,225,618,271	-132,695,171
Romania	3	-76,465,117	-60,754,990	-137,220,108
Brazil	3	-277,352,077	-208,994,953	-486,347,029

Source: Results from simulations.