The Imperialism of Standards

An Empirical Strategy for Measuring the Effects of GMO Regulations on International Trade Flows

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Abstract

This paper deals with the quantification of GMO regulations on bilateral trade flows. A composite index of the 'complexity' of such regulations for sixty countries as well as an 'objective' score for six GMO regulatory sub-dimensions has been developed. Using a gravity model, we show how bilateral similarity / dissimilarity in GMO regulations, affect trade flows for the composite index and its components. The results show that bilateral distance in GMO regulations negatively affect trade flows. Across GMO regulatory sub-dimensions, those that are more detrimental to trade are the approval process, labeling policies and traceability requirements. Finally, we show that GMO regulations tend to be endogenous to trade flows.

JEL: F13, F14, Q13, Q18, Q17
Keywords: GMO standards, Harmonization, Trade Flows, Gravity Model

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1. Introduction

The stark polarization of public and private policies on genetically modified organisms (GMOs) represents one of the main issues of modern international agri-food supply chain. GMO standards differ strongly across countries and regions, resulting in a market fragmentation that currently challenges the international trading regime (Isaac et al. 2004).

Several authors have pointed out that the stringency of the GMO regulations of big agri-food importers, like the European Union (EU) and Japan, in contraposition with the 'soft' regulations of GMO producers, like the US and Argentina, could represent a serious problem for the developing country' strategy concerning GMO production and regulations (see, e.g., Tothova and Oehmke, 2004; Anderson and Jackson, 2004). Indeed, while the potential gains from GMO adoption by several Asian and African countries appear quite high (see Huang et al. 2004; Anderson, 2005; Smale, 2006; Gruére et al. 2007), developing countries are struggling because of the trade–off between the expected production and agronomic benefit of GM crops, and the potential loss of access to rich markets with strong consumer opposition to GMOs.

The purpose of this paper is to investigate the trade effect of GMO standards across a large sample of developing and developed countries. To deal with this, the paper develops a composite index of the stringency of GMOs regulations, for a sample of about sixty countries, to study how similarity / dissimilarity in GMO regulations, affects trade flow.

The paper adds to the existing literature in two main directions. First, we focus on 'harmonization' issues, instead of the more traditional concern about standards as a barrier to trade. This is done by using, in the empirical analysis, a bilateral measure of GMO

standards, with the aim of capturing the level of 'harmonization' in GMO regulations. Thus, our research does not directly address the trade reduction effect induced by the stringency in GMO regulations. Indeed, we try to answer a slightly different question: how much does the similarity, or dissimilarity, in GMO regulations between exporting and importing countries affect bilateral trade? This question appears more relevant to understand the actual pattern of a (developing) country's strategy to GMO regulations.

The second main contribution of the analysis is to treat GMO standards as endogenous, an issue rarely covered by the existing empirical literature[1]. Indeed, both political economy motives and the idea that countries set-up GMO regulations by trading-off internal benefits with external (trade) costs, call for the endogeneity of standards to trade flow.

Our paper is related to several studies on the trade-related aspects of the introduction of GMO and the costs induced by its regulations.[2] Within this literature, particularly relevant for our analysis are the studies of Cadot et al (2001), Parcell and Kalaitzandonakes (2004), Disdier and Fontagné (2008), Tothova and Oehmke (2004) and Veyssiere (2007).

Cadot et al (2001) discuss the 'regulatory protectionism' aspect of EU GMO regulations, reporting preliminary econometric evidence indicating that there were no repercussions to the US export of corn seeds. However, they did find a negative effect with regard to other forms of corn, suggesting that, downstream, traders' and food retailers' private decisions not to purchase GM products were more important than the cultivation bans. Using a different approach, Parcell and Kalaitzandonakes (2004) did not find any effect on future prices after major food companies announced a voluntary ban on GMO crops. More recently, Disdier and Fontagné (2008) used a gravity equation to estimate the reduction of exports from complainants to the EU GMO *de facto* moratorium for potentially affected products. In general terms, and contrary to the findings of Cadot et al (2001) and Parcell and Kalaitzandonakes (2004), they show that the EU moratorium, as well as other EU regulations, have negative trade effects on exporting country trade.

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[1] To date, in the literature concerning the trade effect of non-tariff barriers (NTBs) based on gravity models, the problem of the endogeneity of NTBs to trade flow is rarely taken into account. The exception to this rule can be found in Olper and Raimondi (2008) and Djankov et al. (2008).

[2] Important studies about trade-related aspects of genetically modified organisms (GMOs) introduction and regulations, can be found in Lapan and Moschini (2004) who, from their derived results, show that labeling regulations on trade in GMOs can redistribute income among trading nations, and may benefit the importing country. Concerning GMO labeling issues, see also Runge and Jackson (2000), Fulton and Giannakas (2004) and Veyssiere and Giannakas (2004), among others. Finally, see Josling (2001), Sheldon (2002) and Gruére (2006) about EU, US and world wide GMO regulatory systems.

Particularly relevant to our analysis is the paper of Tothova and Oehmke (2004), who developed a Krugman-type trade model to study the endogenous choice of different countries to set GMO standards, and the consequent endogenous formation of a 'club' that acts as a sub-global preferential trading agreement. Their model suggests the formation of two trading blocs, one in favor, the other against GMOs. Moreover, between these two blocs there emerges a third group of developing countries, potential losers that must face the tension that will arise between lower production costs (through the adoption of GM crops) and the maintenance of an export market in conventionally grown varieties, such maintenance being achieved by restricting GMO production. A similar question is analyzed by Veyssiere (2007), who studied the dilemma facing large exporting countries of agricultural products; such countries have to determine whether or not to approve GM products with or without a labeling regime. An interesting result from this model is that GM product approval is optimal under a labeling regime, whereas non-approval is optimal in the absence of mandatory labeling requirements.

The organization of the paper is as follows: Section (2) explains how we constructed the GMO regulatory index; Section (3) presents the data and specifications of the empirical model; Section (4) gives the results and discusses them; while Section (5) conclude.

2. GMO regulatory index

2.1 Sample, data source and strategy

The index was built for 60 countries, from which it was possible to collect information on the laws or acts regulating GMO cultivation and commercialization. The considered countries include the most EU countries, most OECD members, important exporters of agricultural goods like Argentina, Brazil, China, India, Ukraine and Asian countries, important producers like Bangladesh, Hong Kong, Indonesia, Malaysia, the Philippines, Singapore, Sri Lanka, Taiwan, Thailand and Vietnam. Moreover we also included Chile, Colombia, Guatemala, Israel, Jamaica, Peru, Russia, Saudi Arabia, Venezuela and some African countries: Kenya, South Africa, Zambia, and Zimbabwe (Figure 1 gives the full list of countries).

The main information source used to classify the GMO regulations is the Global Agriculture Information Network (GAIN) reports on biotechnology provided by the

Foreign Agricultural Service (FAS) of the United States Department of Agriculture (USDA). For missing information we refer to official national acts, reports or essays.

Six categories of GMO production and commercialization regulations were considered:

1. Approval process;
2. Risk assessment;
3. Labeling policies;
4. Traceability system;
5. Coexistence guidelines;
6. Membership in international GMO related agreements.

Each GMO regulatory dimension was scored with values ranging from 0 (first condition) to the total number of *conditions* identified for each category (description of categories and conditions are discussed below). Higher scores indicate an increasing restrictiveness of the regulation. For example, for those countries that declare themselves to be 'GM free', which means that no GM products can be cultivated domestically or introduced, the highest score is assumed.

The overall GMO index is then obtained by adding the normalized scores of each category – each score being normalized to vary between 0 and 1. Unfortunately, for some of the countries included in the sample we were not able to get information for all six categories considered (i.e. lack of information). Following Feld and Voigt (2003) we therefore decided to divide the sum of the coded dimensions by the number of categories for which data was available. The final GMO index can thus take on any value between 0 and 1, with higher values indicating a more complex national regulation on GMO production and commercialization, which suggests increasing restrictions to cultivation and trade.

Stringent regulations generally require more expansive procedures for exporters, and comprehensive policies can have a greater trade effect. It is assumed that approval procedures represent fixed costs, traceability and labeling variable costs, influencing present and future GM and non-GM crop exports (Gruére, 2006).

Some categories are strongly related to each other. For example, in many regulations an approval process cannot be conducted without a product risk assessment, or to comply with a label threshold of GM content it is not feasible if there is no traceability system. However, this logic does not often apply to the GMO standards context. The analysis of

60 country policies suggests many unexpected and ambiguous stages of implementation. For example, there are countries which require a mandatory approval process but the risk analysis is under the responsibility of the importer (e.g. EU countries), and countries with a voluntary labeling regime but with no declared traceability requirements (e.g. Canada).

An overview of the GMO index ranking and score is given in Table A.1. Several interesting patterns emerge. First, as expected, there is the well known polarization of the US and EU countries. The former has a GMO regulatory index of 0.26, which contrasts with the EU average of 0.71. Secondly, with the exception of Zambia and Zimbabwe, which are both GMO-free countries, the developing countries tend to be collocated in the low part of the ranking, but with some notable exceptions. For example, countries like Colombia or fast growing economies like China and Thailand, have a GMO index score not so far from those of the EU average. All the considered EU countries, as well as food importers like Japan and South Korea, displayed a higher GMO index. However, it is interesting to note that also within the EU we detect some differences in the GMO score. For example, the highest score of 0.75 was found for countries like Austria and Italy that have imposed a ban on the cultivation of EU approved GMO maize. Instead, EU countries like Spain and Germany have significantly lower scores, 0.60 and 0.65, respectively.

The next section discusses and justifies how each regulatory dimension of the GMO index has been classified (by a score) and considered.

2.1.1 Approval process

The first condition permitting any possible handling of a GMO product is its approved status in a country. In contrast with the majority of conventional commodities, GM foods need specific approval procedures, both for import and cultivation, related to safety issues that are managed in different ways among countries: from a very comprehensive pathway including assessment of effect on mammals to, in several countries, a complete ban.

In contrast with requirements like traceability and labeling, which act similarly to trade standards, import approval for a GM food is a measure directly affecting market access: if a GM event is not approved it is not possible to introduce it in the country.

The requirements for an approval process vary widely across countries. There are two main groups of countries which share similar approaches. One that follows the EU regulations that are based on the 'precautionary principle', which means that any product produced with, or derived from, transgenic crops is subject to GM regulations and the consumers' 'right to know'. The second group follows the US attitude of 'substantial

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equivalence', which exempts for essentially equivalent products any specific requirements (Gruére 2006). Between the two groups there are many different approaches to the approval process. We defined *five* levels of restrictiveness (from 0 to 4) of approval processes based on the degree of national implementation of the regulation. A score of 0 is given when there are no constraints on GMO cultivation and marketing; a score of 1 if there exists a mandatory approval process established at the legislative level, but not yet implemented; a score of 2 when the mandatory approval process follows the principle of substantial equivalence; a score of 3 when a mandatory approval process follows the precautionary principle; and finally a score of 4 in situations of GMO free status (prohibition of cultivation and marketing) (see Table 1).

Most EU members, Japan and fast-growing income countries like China and India are scored in the third condition, which is the most comprehensive. The zero or first conditions include developing or emerging countries, which take what is called a 'wait and see' position with respect to the international polarization led by the EU and US.

2.1.2 Risk assessment

Assessments are based on the biological characteristics of the new organism, and test the safety of food, fodder and the environment. Authorization depends on a positive risk assessment, usually conducted by an independent body that establishes standards for testing and detection. The typology of the testing depends on the country's approach, whether it be a substantial equivalent typology or a precautionary principle one. In many cases the exporter is the legal subject responsible for the assessment.

On the international scenario biosafety assessment is gaining importance, being the target for international harmonization efforts for setting a common methodology, though still at the discussion stage. Biosafety assessment requires deeper analysis through the adoption of field trials. Indeed, for those countries possessing native plants, testing of potential gene flow from GM crops to their wild (native) relatives is needed. The scheduling and realization of programs for field trials is expensive and some countries (e.g. developing countries) are not able to deal with these costs.

We identified a scoring classification of requirement levels (range 0-3) for a national risk assessment regulation. The conditions scoring 0 and 3 indicate a lack in the risk assessment framework, but the differences are substantial: a score of 0 (e.g. Ukraine) means a normative void that does not affect trade or cultivation as there are no standards; score 3, on the contrary, applies to countries declaring themselves 'GMO free', those

totally opposed to the importation (and cultivation) of GMOs and imposing the strongest degree of regulation restrictiveness. Between these two scores, we have 1 if the risk assessment is at a regulation proposal stage, and 2 if risk assessment is compulsory.

2.1.3 Labeling policies

In 1997, the EU introduced GMO labeling policies with the purpose of guaranteeing "the consumer's right to know", but labels carry indications other than just the presence of GM ingredients, they also give information on health factors and product diversification (Veyssiere and Giannakas, 2004). Labeling has also met environmental issues, playing a role in consumption decisions of consumers concerned by environmental factors associated with GM products (Appleton, 2000). Indeed, a label can act as a warning, indicating potential hazards and thus affecting the demand for GM and non-GM products, particularly reducing the demand for the former (Gruère, 2006).

Over the past ten years, an increasing number of countries have become involved with labeling requirements, and all have different regulation characteristics (Gruère and Rao, 2007). We have defined five categories of labeling characteristics, where thresholds play a fundamental role as a specific standard for trade issues. Compliance with a restrictive threshold implies an increase in production and commercialization costs.

The possibility of labeling is strictly related to traceability requirements, without which it is not possible to distinguish between GM and non-GM. Nevertheless labeling and traceability represent two separate categories as several country's policies do not necessarily consider the two as being strictly related.

A labeling regime is expected to influence trade flows, and, in particular, to affect the trade of the chief suppliers of GM crops (Gruère and Rao, 2007). Costs caused by a labeling regime depend on: the threshold level, the capacity of the public authority to enforce labeling requirements, and the capacity of industry to comply with labeling rules. GM labels have effects on the whole agri-food chain. Actors have to collect and handle information concerning the presence of GM food components until reaching the final consumer, but the transfer of this information adds onerous segregation costs. Ultimately, labeling indirectly affects trade through the imposition of implementation costs for GM crop exporters.

Among the countries we registered two main attitudes: voluntary and mandatory labeling regimes. Mandatory labeling requirements are divided into a further two groups: label on the finished product (Australia and Japan), and on GM technology as a

production process (EU and China). In the former case, the quantification of GM ingredients is required to be labeled, and, usually, the threshold is higher. In the latter case any product derived from GM crops has to be reported. In this case, thresholds decrease in entity and the process based system directly requires the exporters to have a form of identity preservation or a traceability system.

This category is scored from 0 to 5, the scoring being: 0 in the absence of labeling requirements; 1 with voluntary regime; 2 in the presence of a mandatory regime with a threshold of 5%; 3 with mandatory regime but with a threshold of 1%; and, finally, 4 in countries that declare themselves GM free.

2.1.4 Traceability requirements

Traceability is an instrument to create a safety net that will pick up any unexpected effects of any product to mammalian health and the environment, and that guarantees efficient withdrawal from the food and feed market. In the case of GMO products, the producers, transformers and retailers have to collect, retain and transmit information on the origin of products in each stage of the agri-food chain (Bailey, 2002).

Countries with a comprehensive traceability regulation must create procedures for the identification of industry chain participants who supply and demand products. Actors of the food chain must transmit information on the identity of the product and whether it contains GMOs, retain such information for a long period (post-market monitoring), e.g. 5 years, and guarantee its availability for applicants (Wilson et al., 2008).

At the producer level, farmers have to be certain of the absence of cross-pollination between neighboring crops, and must comply with certified storage and harvesting. Elevators, processors and retailers must keep information on product identity and transmit this information by lot numbers and test results.

All these requirements produce increasing segregation costs, but also benefit the market niche gains. Cost increase is difficult to establish because traceability is an issue with long term implications, with variable costs depending on crops, e.g. soya and maize provide a great number of byproducts in different agri-food industries. Moreover, liability and compensation schemes are crucial.

The main costs are referred to certification, record collection and information keeping, and are carried by GMO producers and suppliers countries, with a potentially higher final market price, for both GMO and GMO-free products.

For the traceability category we define the following scores: 0 if the regulation does not require a traceability system; 1 if the traceability requirement is at the proposal stage; 2 if it is mandatory; and 3 if the country is GM free.

2.1.5 Coexistence guidelines

The purpose of managing coexistence is to guarantee consumers and farmers the possibility of choosing what to consume or produce among GM, traditional and organic products. This is feasible only if there is the preservation of identity among crops, which must be segregated in space and time. Thus it is not possible to cultivate nearby fields of GM and organic crops, or to manage them in short rotations. Coexistence managing procedures require distances between fields of GM, traditional and organic products, refuges areas and dedicated machineries, but also compensation and liability systems. It also requires strong cooperation between farmers in close proximity.

Production costs in a coexistence scenario arise due to isolation costs, monitoring, purity testing, dedicated equipment and/or its cleaning, which can vary at the establish purity levels, taking into account that zero threshold of transgene in GMO-free crops is not feasible in some agricultural systems. Some developing country policy makers assume that coexistence is not feasible or can be done only by facing prohibitive costs.

Because of the difficulties in establishing coexistence strategies, the level of implementation of coexistence policies varies widely across countries, and in several cases requirements are not stated clearly. For this reason we decided to score 0 those countries without any coexistence rule, 1 if coexistence policies are at embryonic stage, 2 if partial guidelines were prepared, 3 if exhaustive coexistence guidelines are adopted and 4 if the country is GM free.

2.1.6 Membership in international GMO related agreements

We considered two institutions, the Codex Alimentarius and the Cartagena Protocol on Biosafety, which, among several international agreements, have effects on the trading of biotech products.

The Codex Alimentarius has the purpose of protecting consumer health, and promoting fair relationship in trade international practices. It has successfully reached an agreement on safety assessment procedures for GMOs, but no formal labeling standards were adopted, these remaining a disagreed issue.

The aim of the Cartagena Protocol on Biosafety (BSP), part of the United Nation Convention on Biodiversity, is to introduce a shared procedure for risk assessment, risk management and trans-boundary movements of Living Modified Organisms (LMOs). The BSP intervenes between importers and exporters, introducing an Advanced Informed Agreement (AIA) for the intentional introduction of LMOs into the environment. In particular, it requires a comprehensive risk assessment and risk management framework provided by the exporter before the first introduction of any LMO in the importer territory.

Rules from the BSP are on bundling, transport, packaging and identification during any LMO trans-boundary movement. This comprehensive mechanism for the safe movement of LMOs was offered by the Cartagena Protocol on Biosafety as a primary policy for all those countries without domestic regulations, including liability rules for the illegal flow of LMOs, and calls for a ban of GM crop imports as a precautionary measure.

The adoption of one or both of the international agreements could impose higher production and marketing costs on agricultural goods, both GM and non-GM, because of the institution of domestic structures for annual testing. If the country does not adhere to either of the two considered international agreements the score is 0, otherwise the score is 1 or 2 when the country subscribes to a one or both agreements.

Until the Codex Alimentarius Commission reaches an agreement on labeling and BSP is implemented in all member countries, neither of the two international institutions will influence trade. However if they become effective regulation instruments with, as expected, a direct influence on trade, then this analysis must consider them.

3. Data and the gravity equation

3.1 Data and sample

Our analysis focuses on the three major biotech crops for the agri-food market: maize, soybean and rapeseed, both for human consumption and for animal feed. We also include cotton production, mainly dedicated to the textile industry, as a comparison benchmark. Thus, the inclusion of cotton will allow the testing of whether standards imposed by biotech regulations affect the overall trade of agricultural products, and food products in particular.

Trade data comes from the Commodity Trade (COMTRADE) database maintained by the United Nations Statistical Division (UNSD). We work at the 6-digit level of the 2002

Harmonized System (HS) classification. Because it is not possible to distinguish between GMO and non-GMO products, we considered raw, transformed and by products, both for food and for feed, recognized, in the literature, as sensitive to transgenic crops (see, e.g., USDA 2008). Thus, as in previous empirical analyses (Disdier and Fontagné 2008) we face a sort of identification problem, because a reduction in trade flows can only partially be attributed to the existence of GMO restrictions. We take care of this issue through a proper specification of the gravity equation, ruling out, as close as possible, the potential determinants of trade flows reduction different from GMO standards, like other trade costs.

We considered four aggregated of HS 2002 headings, called for simplicity: *Maize*, *Soybean*, *Oilseed Rape*, and *Cotton*. For cotton, we take into account headings related to the agri-food channel, particularly seeds, oils and cake that are exploited as animal fodder or as a part of such feed. In our estimations we work with both the total aggregate of potential GMO trade, and with each of the four groups considered individually.

The country sample is selected using the following rules. Within the importing country sample we select all the countries for which it was possible to build the GMO regulatory index. Instead, the selection criterion for exporters is based on trade and production data (FAO source), excluding those countries that, simultaneously, have no export or production of maize, soybean, rapeseed and cotton products.

Finally, because the index is built on regulatory information updated to 2008, the time period considered covers the average trade flows of the previous three years: 2005, 2006 and 2007. Up to 2008, international regulations were implemented in a wide number of countries; in fact, despite the 1996 adoption of GMOs, we have, in recent years, witnessed the detailed specification and diffusion of biotech regulations; this is due not only to the growing amount of biotech products being traded, but also to international trade controversy which has led to the defining of GMO import and export rules.

3.2 Econometric trade model

The objective of this section is to present our strategy to assess the effect of GMO regulations on trade flows. The bilateral trade equation is derived by the now standard new trade theory CES monopolistic competition trade model, with increasing returns to scale and iceberg trade costs, introduced by Krugman (1980). In the theory driven

empirical version of the model the bilateral trade flow from j to i (M_{ij}) can be summarized by the following log-linear bilateral trade equation:

$$\log M_{ij} = \beta_0 + \lambda_j + \chi_i + (1-\sigma)\gamma \log D_{ij} + (1-\sigma)\log \tau_{ij} + u_{ij}, \qquad (1)$$

with λ_j and χ_i the exporter and importer fixed effects to control for the size terms as well as the unobserved number of varieties (firms) and the price term of the exporter, and for the expenditure and the unobserved price term of the importer, respectively. D_{ij} is the transport costs proxy by distance between i and j, τ_{ij} is the *ad valorem* bilateral tariff, $\sigma > 1$ is the elasticity of substitution between home and foreign goods and, finally, u_{ij} is an error term.

We augment this basic trade equation through the introduction of the GMO regulatory index. However, as the correct identification of trade costs elasticity needs to check for importer and exporter fixed effects, we transform the GMO index into a bilateral one by taking the absolute deviation of the GMO index across country pairs, namely $GMO_{ij} = |GMO_i - GMO_j|$. Thus the GMO_{ij} bilateral index increases in the level of dissimilarity or distance in GMO regulations across country pairs or, put differently, it represents an inverse index of 'harmonization' in GMO regulations.

When equation (1) is applied at the disaggregated level, the first problem that emerges is the presence of a high number of zero bilateral trade flow. One of the most common methods of dealing with zero trade is the Heckman (1979) two stage selection correction: i) a Probit equation where all the trade flow determinants are regressed on the indicator variable, T_{ij}, equal to 1 when j exports to i and 0 when it does not; ii) an OLS second-stage with the same regressors as the Probit equation, plus the inverse Mills ratio from the first stage, correcting the biases generated by the sample selection problems.[3] Following the modification suggested by Helpman et al. (2008) and supported by Martin and Pham (2008), we omitted in the second OLS stage an independent variable associated with the fixed trade costs of establishing trade flow.[4]

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[3] As an alternative approach to deal with zero trade flow and heteroskedasticity problems, Santos Silva and Tenreyro (2006) recommended the Poisson Pseudo Maximum-Likelihood (PPML) estimator. However, Martin and Pham (2008) and Raimondi and Olper (2009) have shown that the PPML approach produces biased results when used in the presence of a large fraction of zero trade flow, a situation consistent with recent trade models with firms' heterogeneity (Melitz 2003; Helpman et al. 2008) and very frequently working at a disaggregated product level as in our application.

[4] The underlying idea is that fixed trade costs, here proxy by the language dummy, especially affect the probability to export. Thus it is included only in the (first stage) selection equation, but not in the level OLS equation (see Martin and Pham, 2008).

Data on distance, with dummies for other trade costs normally used in similar exercises (contiguity, language, and colony), are taken from CEPII (Centre d'Etude Prospectives et d'Informations Internationales). Finally, bilateral tariffs are obtained from the MAcMap database jointly developed by ITC (UNCTAD and WTO, Geneva) and CEPII (Paris). It includes *ad-valorem*, as well as specific components of each bilateral tariff line at the six digit level of the Harmonized System (see Gruère et al. 2007). Note that the inclusion of bilateral tariffs in the trade costs function is particularly important in our context to proper identify the effect of GMO regulations. Indeed, if our bilateral GMO index is positively correlated with bilateral tariffs, then omitting the tariff from the gravity equation results in an overestimation of the GMOs effect on trade flow.[5]

4. Econometric results

Table 2 shows the regression results of equation (1), pooling the data across the four groups of products and testing for the trade effect of both the GMO regulatory index (Column 1) and its sub-components (Columns 2 - 7). Figures refer to the second stage of the Heckman procedure. The Mills ratio reported at the bottom of the table, always strongly significant, justifies the use of this estimation approach to correct for selection bias. This is not surprising given the large fraction of zero trade flow of the dataset.

Starting from standard gravity covariates, the distance coefficient is always negative and significant, while the common border and colony dummies are positive and significant. As expected, bilateral tariffs have a negative and significant effect on bilateral trade flows. Moreover, if we give a structural interpretation to the tariff coefficients, equal to $(1 - \sigma)$, then we have an estimate of the elasticity of substitution between home and foreign products. It ranges from 2.6 to 3.4, thus broadly in the same order of magnitude as recent estimate reported by Raimondi and Olper (2009).

Turning to the variable of interests, column (1) shows that the GMO index has a negative and strongly significant coefficient (p-value < 0.01). Because the index measures the across-countries distance in GMO regulations, a negative coefficient means that bilateral trade flow decreases with increasing dissimilarity in GMO regulations. The result implies that a one standard deviation reduction in GMO regulatory distance, equal to

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[5] The correlation between tariffs and NTBs is an empirical question. To date, broad evidence of a positive correlation for agri-food products can be found in Kee et al (2008). In our sample, running a fixed effect regression of tariffs on the GMO index, the coefficients of tariffs is positive and strongly significant.

0.175 points, increases exports by about 15 percent, all else remaining equal. To give sense to this number, note that it approximately corresponds to the change from the USA-France GMO regulatory distance (= 0.45) to the USA-Australia distance (= 0.29). Thus the effect it is not only statistically significant but appears also relevant from an economic point of view. It is important to note that the GMO index also exerts a negative and significant effect on the first stage Probit model (see Column 3 of Table 4). Thus, GMO standards affect not only the volume of trade but also the propensity to export.[6]

Columns 2 - 7 of Table 2 investigate which GMO regulatory sub-components matter the most. In line with the results of column 1, all GMO components exert a negative effect on bilateral trade flow. However, only the components related to the *labeling system* (column (2)), *approval process* (column (3)), and *traceability requirements* (column (4)) are significant at 5 percent level or more. As long as an agreements will not internationally shared, for example through the Codex Alimentarius, labeling is going to remain one of the major regulatory components that have effects, either directly (e.g. food marketing) or indirectly influencing consumers choice and information. Labeling' provisions is a complex field of across countries conflict in terms of trade policies (Carrau, 2009).

Table 3 investigates the sensitivity of different product groups to the GMO regulatory index, by running regressions for each group separately. Column (1) replicates the pooled regression results reported in Table 2 (column (1)) for comparison purposes. The estimated coefficients on the GMO index is significantly negative with increasing (absolute) magnitude on passing from *corn* to *rapeseed* through to *soybean*. It is interesting that the rapeseed GMO effect appears stronger in magnitude with respect to corn and soybean, but this makes sense as segregating non-GMO from GMO rapeseed is much more complicated than segregating non-GMO corn or soybean. It is also interesting to note the result for *cotton*, where the GMO index is positive, though barely significant. Thus, differences in GMO regulations do not affect cotton trade flow, probably because it is only partially involved in the agri-food chain.

4.1. IV regressions

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[6] Moreover, by comparing the OLS regression and the Probit selection equation reported in Table 4 (columns 1 and 3), we also have indirect confirmation that our identification assumption, based on the use of language as proxy for fixed trade costs, is correct in our context. Indeed, the language coefficient is insignificant in the OLS regression, but strongly significant and positive in the selection equation, meaning that it affects the probability to export but not the volume of trade.

There are different potential sources of endogeneity in our model. Here we are specifically concerned with endogeneity in the form of the direction of causality between the GMO index and trade flow. First, a large political economy literature on trade policy (see, e.g., Trefler, 1993; Grossman and Helpman, 1994) suggests that not only does trade policy affect imports, but also that trade policy itself is affected by the level of imports. In such a case, if import and protection are not modeled as being simultaneously determined, then the estimated impact of protection on imports will be biased downward.

The applicability of this reasoning to our specific context is not so clear, as GMO standards, *prima facie*, are not trade policy. However, other than political economy motives, we have important reasons to suspect that GMO regulations could be affected by trade flow. Indeed, as stated in the introduction, previous evidence stresses that in recent years many developing countries have set GMO standards, taking care of the trade-off between agronomic advantage and market access loss in countries with GMO consumer concerns (see Tothova and Oehmke, 2004; Veyssiere, 2007).

Generally speaking, it is difficult to address this simultaneity bias because of the lack of good instruments. Previous tentatives to deal with endogeneity in gravity models have followed the idea of Lee and Swagel (1997), using industrial conditions (like value added share, employment numbers and so on) as instruments for trade policy (see Olper and Raimondi, 2008). However, working at the HS 6-digit level precludes this strategy due to data constraints. An alternative strategy is to follow Djankov et al (2006), dealing with the potential endogeneity of the GMO variable by using indices of neighboring countries as an instrument. Specifically, the instrument is based on the weighted average GMO index of the five closest neighbors, using the distance between capital as a weight.

The results of this exercise are seen in Table 4. Columns 1 and 2 respectively report a benchmark OLS and a IV regression. We start from this regression because, as well noted (see Wooldridge 2002; Persson and Tabellini, 2003), instrumental variables are also an approach to dealing with selection bias problems. Interestingly, on passing from OLS to instrumental regression, the coefficient of the GMO index increases 3-fold (from -0.65 to -2.02), moreover IV regression increases also the precision of the estimate. This result gives clear evidence that endogeneity matters for the final results. Columns 4 and 5 give a substantial confirmation to this conclusion. Indeed, by running a IV second stage Heckman regression, the coefficient of the GMO index increases by about two times and, as expected, it is now virtually the same as that obtained without using the Heckman selection correction.

These results are important, first because they strongly confirm the idea that the GMO index is endogenous to trade flows, and secondly because they suggest that selection bias issues are dominated by the causality bias. Specifically, based on our estimate, the downward bias due to causality is about 2.7 times more important than that due to selection bias.[7]

5. Conclusion

Motivated by the complex pattern and evolution of GMO regulations, this paper deals with the quantification of GMO regulations on bilateral trade flows. A composite index of the 'complexity' of such regulations for sixty countries, as well as an 'objective' score for six GMO regulatory sub-dimensions, has been developed. Using a gravity model, we have shown how bilateral similarity / dissimilarity in GMO regulations, affects trade flows for the composite index and its components. The empirical evidence highlights three main results.

First, countries with strong differences in GMO regulations, trade significantly less, suggesting that what matters for trade flows are not only the stringency of the standards, but their level of harmonization between countries. Second, the regulatory dimension that matters the most is that related to the approval process, labeling system and traceability requirements, other dimensions like coexistence, appear less important from the point of view of trade flows. Finally, we highlight and test the endogeneity nature of GMO regulations to trade flows, showing that causality bias is important. Accounting for endogeneity increase the GMO coefficients of about two times, an effect that dominates selection bias problems.

Thus, the strong emphasis given to selection bias concerns in the gravity literature in recent years should be partially redirected to better study causality issues between policy and trade flows.

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[7] To see this, it is sufficient to compare the GMO index coefficients in Table 4. Indeed, sample selection issues induced a downward bias in the GMO index of about 42.6% = ((0.927-0.650)/0.650) * 100, differently causality bias induces a downward estimation of the GMO coefficient of about 117% = ((2.011-0.927)/0.927)*100.

References

Anderson, K. (2005). Interactions between trade policies and GM food regulations. Paper for the Conference on Economics of Regulation of Agricultural Biotechnologies, Arlington VA, 10-12 March 2004.

Anderson, K. and Jackson, L.A. (2004). Standards, trade and protection: the case of GMOs. Selected Paper for the American Agricultural Economics Association Annual Meeting, Denver, Colorado, July 1-4, 2004

Appleton, A.E. (2000). The labeling of GMO products pursuant to international trade rules. N.Y.U. *Environmental Law Journal*, 8, 3: 566-578.

Bailey, R. (2002). The looming trade war over plant biotechnology. Cato Trade Policy Analysis n.18, August.

Cadot, O., Suwa-Eisenmann, A. and Traça, D. (2001). Trade-related issues in the regulation of genetically modified organism. Paper prepared for the workshop on European and American Perspectives on Regulating Genetically Engineered Food, Insead, 7/8 June 2001.

Carrau, J.G. (2009). Lack of Sherpas for a GMO Escape Route in the EU. *German Law Journal*, 10(8): 1169-1199.

Disdier, A.C. and Fontagne, L. (2008). Trade impact of European measure on GMOs condemned by the WTO panel. Paper prepared for presentation at the 12th EAAE Congress "People, Food and Environments: Global Trends and European Strategies", Gent (Belgium), 26-29 August 2008.

Djankov, Simeon & Freund, Caroline & Pham, Cong S. (2008). Trading on time, Policy Research Working Paper Series 3909, The World Bank.

Feld, L.P. & Voigt, S. (2003). Economic growth and judicial independence: cross-country evidence using a new set of indicators. *European Journal of Political Economy* 19: 497–527.

Fulton, M. & Giannakas, K. (2004). Inserting GM Products into the Food Chain: the Market and Welfare Effects of Different Labelling and Regulatory Regimes. *American Journal of Agricultural Economics*, 86(1): 42-60.

Grossman, G., and Helpman, E. 'Protection for Sale', *American Economic Review*, Vol. 84(4), (1994) pp. 833-850.

Gruère, G.P. (2006). An Analysis of Trade Related International Regulations of Genetically Modified Food and their Effects on Developing Countries. IFPRI EPT Discussion Paper 147, February 2006.

Gruère, G.P. and Rao, S.R. (2007). A review of international labeling policies of genetically modified food to evaluate India's proposed rule. *AgBioForum*, 10, 1: 51-64.

Gruère, G.P., Mevel, S. and Bouët, A. (2007). Genetically modified rice and international trade in India in the background of China: should the elefant move ahead of the dragon? Contributed Paper IATRC Symposium, Beijing, July 8-9, 2007.

Gruère, G.P., Mevel, S. and Bouët, A. (2007). Genetically Modified Food and International Trade: The case of India, Bangladesh, Indonesia and the Philippines. Selected Paper for the American Agricultural Economics Association Annual Meeting, Portland, July 29-August 1, 2007.

Heckman J. (1979) Sample Selection Bias as a Specification Error, *Econometrica*, Vol. 47(1), pp. 153-161.

Helpman E, Melitz M, Rubinstein Y. (2008) Estimating trade flows: Trading Partners and Trading Volumes. *Quarterly Journal of Economics*, 123(2), pp. 441-487.

Huang, J., Hu, R., Van Mejil, H. and Van Tongeren, F. (2004). Biotechnology boosts to crop productivity in China: trade and welfare implications. *Journal of Development Economics*, 75, 27-54.

Isaac, G.E., Perdikis, N. and Kerr, W.A. (2004). Cracking export markets with genetically modified crops: What is the entry mode strategy?. *International Marketing Review*, 21, 4/5: 536-548.

Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. In: *American Economic Review* 70: 950-959.

Lapan, H.E. & Moschini, G. (2004). Innovation and Trade with Endogenous Market Failure: the Case of genetically Modified Products. *American Journal of Agricultural Economics*, 86(3): 634-648.

Lee, J-W., and Swagel, P. (1997) Trade barriers and trade flows across countries and industries, *The Review of Economics and Statistics*, Vol. 79 (3), (1997) pp. 372-382.

Martin W., Pham C. (2008) Estimating the gravity model when zero trade flows are important. Working Paper, The World Bank.

Melitz, M. (2003) The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity, *Econometrica* 71(6), pp. 1695-1725.

Olper, A. and Raimondi, V. (2008). Explaining National Border Effects in the QUAD Food Trade, *Journal of Agricultural Economics*, Vol. 59 (3), pp. 436-462.

Parcell J.L. and Kalaitzandonakes N.G. (2004). Do Agricultural Commodity Prices Respond to Bans against Bioengineered Crops? *Canadian Journal of Agricultural. Economics.* 52: 201-209.

Persson, T. and Tabellini, G. (2003). *The Economic Effect of Constitutions*. The MIT Press.

Raimondi, V. and Olper, A. (2009). The Sensitivity of trade flows to trade barriers, Paper presented at the 2009 AAEA&ACCI Joint Annual Meeting, Milwaukee, 26-28 July, 2009.

Runge, C.F. and Jackson, L.A. (2000). Labelling, trade and genetically modified organisms: A proposed solution. *Journal of World Trade*, 34, 1: 111-122.

Sheldon, I.M. (2002). Regulation of biotechnology: will we ever "freely" trade GMOs? *European Review of Agricultural Economics*, 29, 1: 155-176.

Silva J.M.C. Santos, Tenreyro S. (2006) The Log of gravity. *The Review of Economics and Statistics*, Vol.88 (4), pp.641-658.

Smale, M, Zambrano, P., Falck-Zepeda, J. & Gruère, G. (2006). Parables: Applied Economics Literature About the Impact of Genetically Engineered Crop Varieties in Developing Economies. IFPRI Discussion Paper 158, October 2006.

Tothova, M. and Oehmke, J.F. (2004). Genetically modified food standards as trade barriers: harmonization, compromise and sub-global agreements. *Journal of Agricultural & Food Industrial Organizationa*, Vol.2, Art.5.

Trefler, D. (1993) Trade liberalization and the theory of endogenous protection: An econometric study of U.S. import policy, *Journal of Political Economy*, Vol. 101 (1), (1993) pp. 138-160.

Veyssiere, L. (2007). Strategic response to GMOs by GM-free countries. *European Review of Agricultural Economics*, 34, 3:365-392.

Veyssiere, L. and Giannakas, K. (2004). Strategic labelling and Trade of GMOs. Paper prepared for the American Agricultural Economics Association Annual Meeting, Denver, August 1-4.

Wilson, W.W., De Vuyst, E.A., Taylor, R.D., Koo, W.W. and Dahl, B.L. (2008). Implications of biotech traits with segregation costs and market segments: the case of Roundup Ready ® Wheat. *European Review of Agricultural Economics*, 35, 1: 51-73.

Wooldridge, J. (2002), *Econometric Analysis of Cross Section and Panel Data*, MIT Press.

Zarrilli, S. (2005). International trade in GMOs and GM products: national and multilateral legal frameworks. UNCTAD Policy Issues in International Trade and Commodities Study Series n. 29.

Table 1. Categories, conditions and relative score of the GMO regulatory index

1.	Approval process	Score
	Proposal to draft for approval or lack of rules or ambiguous situations that do not put constraints on the cultivation and marketing	0
	Mandatory approval process, established at legislative level but still far from implementation	1
	Mandatory approval process in accordance with the principle of substantial equivalence	2
	Mandatory approval process under the precautionary principle including products derived from GM crops	3
	Countries declared GM free, prohibiting cultivation and marketing	4
2.	**Risk assessment**	**Score**
	There is no implementation of risk analysis	0
	The necessity of a risk assessment is at proposal stage	1
	Mandatory risk assessment	2
	Countries declared GM free	3
3.	**Labelling policies**	**Score**
	It is not required a label or is just at proposal stage	0
	Voluntary GMO labelling	1
	Mandatory GMO label without threshold or with threshold >= 5%	2
	Mandatory GMO label with threshold <= 1%	3
	Countries declared GM free	4
4.	**Traceability requirements**	**Score**
	It is not required a GMO traceability process	0
	GMO traceability process is at proposal stage	1
	Mandatory GMO traceability	2
	Countries declared GM free	3
5.	**Coexistence guidelines**	**Score**
	No coexistence rules have been introduced	0
	GMO coexistence policies at embryonic stage	1
	Partial guidelines on GMO and non-GMO coexistence	2
	Exhaustive guidelines on GMO coexistence	3
	Countries declared GM free	4
6.	**Membership in international agreements**	**Score**
	No adherence to international agreements	0
	Adherence to a single international agreement	1
	Adherence to both international agreements	2

Table 2. GMO regulations and trade: Regression results

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				Dependent variable Ln (X_{ij})			
GMO Index	-0.927***						
	(0.245)						
Labeling		-0.795***					
		(0.164)					
Approval			-0.759***				
			(0.197)				
Traceability				-0.534**			
				(0.207)			
Risk					-0.439		
					(0.533)		
Coexistence						-0.019	
						(0.120)	
Agreements							-0.211
							(0.160)
Ln Distance $_{ij}$	-1.733***	-1.705***	-1.747***	-1.692***	-1.577***	-1.882***	-1.763***
	(0.094)	(0.092)	(0.094)	(0.113)	(0.090)	(0.134)	(0.096)
Contiguity	1.272***	1.299***	1.266***	1.261***	1.202***	1.248***	1.256***
	(0.130)	(0.129)	(0.128)	(0.131)	(0.127)	(0.151)	(0.130)
Colony	0.285**	0.319**	0.299**	0.118	0.176	0.266*	0.266**
	(0.130)	(0.131)	(0.131)	(0.152)	(0.142)	(0.142)	(0.131)
Ln (1 + tariff $_{ij}$)	-1.965***	-1.971***	-2.010***	-2.403***	-1.588***	-2.402***	-2.019***
	(0.221)	(0.221)	(0.221)	(0.284)	(0.325)	(0.283)	(0.221)
Mills ratio	2.183***	2.188***	2.196***	2.234***	1.506***	2.166***	2.180***
	(0.211)	(0.207)	(0.210)	(0.237)	(0.195)	(0.265)	(0.212)
Constant	7.775***	10.638***	7.985***	9.817***	10.53***	10.63***	7.838***
	(0.647)	(0.763)	(0.646)	(1.079)	(1.137)	(0.886)	(0.661)
Observations	17112	17112	17112	9669	13057	10800	17112
FE Importer, exporter and HS2	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: figures refer to the II stage of the Heckman regression. In parentheses robust standard error. ***, ** and * indicate significance level at the 1%, 5% and 10%, respectively. Each regression include country fixed effects for importer and exporter, and for HS 2-digit products.

Table 3. GMO regulations and trade: Regressions at product level

| Variables | Dependent variable Ln (X$_{ij}$) | | | | |
	Total	**Corn**	**Soybean**	**Rape**	**Cotton**
GMO Index	-0.927***	-1.061***	-1.299***	-1.408**	2.137*
	(0.245)	(0.295)	(0.412)	(0.694)	(1.100)
Ln Distance $_{ij}$	-1.733***	-1.833***	-1.480***	-2.154***	-4.245***
	(0.0940)	(0.115)	(0.146)	(0.264)	(1.097)
Contiguity	1.272***	1.089***	1.369***	1.583***	1.577*
	(0.130)	(0.151)	(0.232)	(0.233)	(0.858)
Colony	0.285**	0.173	-0.031	0.279	-0.519
	(0.130)	(0.162)	(0.229)	(0.282)	(0.702)
Ln (1 + tariff $_{ij}$)	-1.965***	-1.300***	-2.060***	-3.688**	2.207
	(0.221)	(0.252)	(0.588)	(1.651)	(2.601)
Mills ratio	2.183***	1.998***	1.668***	2.323***	5.763***
	(0.211)	(0.238)	(0.313)	(0.483)	(1.819)
Constant	7.775***	8.480***	4.630**	8.850***	8.167**
	(0.647)	(0.985)	(2.264)	(1.749)	(3.900)
Observations	17112	8236	3983	2119	316
FE Importer, exporter and HS2	Yes	Yes	Yes	Yes	Yes

Notes: figures refer to the II stage of the Heckman regression. In parentheses robust standard error. ***, ** and * indicate significance level at the 1%, 5% and 10%, respectively. Each regression include country fixed effects for importer and exporter, and for HS 2-digit products.

Table 4. GMO regulations and trade: IV regressions

Variables	OLS	IV	Heckman procedure		
			I stage	II stage OLS	II stage IV
GMO Index	-0.650***	-2.024***	-0.211***	-0.927***	-2.011***
	(0.249)	(0.426)	(0.078)	(0.245)	(0.421)
Ln Distance $_{ij}$	-0.863***	-0.807***	-0.665***	-1.733***	-1.716***
	(0.045)	(0.038)	(0.018)	(0.094)	(0.064)
Contiguity	0.952***	0.981***	0.461***	1.272***	1.298***
	(0.135)	(0.087)	(0.067)	(0.130)	(0.086)
Language	0.129	0.612***	0.226***		
	(0.116)	(0.082)	(0.041)		
Colony	-0.173	-0.111	0.213***	0.285**	0.337***
	(0.128)	(0.100)	(0.062)	(0.130)	(0.101)
Ln (1 + tariff $_{ij}$)	-1.640***	-1.548***	-0.345***	-1.965***	-1.906***
	(0.221)	(0.203)	(0.059)	(0.221)	(0.202)
Mills ratio				2.183***	2.256***
				(0.211)	(0.143)
Constant	6.181***	6.540***	4.261***	7.775***	11.00***
	(0.655)	(0.616)	(0.188)	(0.647)	(0.787)
Observations	17112	17112	91253	17112	17112
FE Importer, exporter and HS2	Yes	Yes	Yes	Yes	Yes

Notes: In IV regressions the GMO index is instrumented with the weighted average index of the five more close neighbors. The I stage Heckman is based on Probit regression. In parentheses robust standard error. ***, ** and * indicate significance level at the 1%, 5% and 10%, respectively. Each regression include country fixed effects for importer and exporter, and for HS 2-digit products.

Table A.1 GMO regulatory index score and ranking

	Rank	Country Code	Country	Index Value	No. Of Var.
1	1	ZMB	Zambia	1.00	6
2	1	ZWE	Zimbabwe	1.00	6
3	2	AUT	Austria	0.76	6
4	2	BEL	Belgium	0.76	6
5	2	CZE	Czech Republic	0.76	6
6	2	DNK	Denmark	0.76	6
7	2	FRA	France	0.76	6
8	2	HUN	Hungary	0.76	6
9	2	ITA	Italy	0.76	6
10	2	NLD	Netherlands	0.76	6
11	2	PRT	Portugal	0.76	6
12	3	EST	Estonia	0.72	6
13	3	FIN	Finland	0.72	6
14	3	JPN	Japan	0.72	6
15	4	EUN	European Unione	0.71	6
16	5	COL	Colombia	0.68	5
17	6	DEU	Germany	0.68	6
18	6	GRC	Greece	0.68	6
19	6	IRL	Ireland	0.68	6
20	6	LUX	Luxemburg	0.68	6
21	6	ROM	Romania	0.68	6
22	6	SVK	Slovakia	0.68	6
23	6	SVN	Slovenia	0.68	6
24	6	SWE	Sweden	0.68	6
25	7	POL	Poland	0.64	6
26	7	ESP	Spain	0.64	6
27	7	GBR	United Kingdom	0.64	6
28	8	CHN	China	0.63	5
29	9	NZL	New Zealand	0.61	6
30	10	IND	India	0.60	4
31	10	IDN	Indonesia	0.60	4
32	10	THA	Thailand	0.60	4
33	11	MYS	Malaysia	0.58	4
34	11	KOR	Korea	0.58	5
35	12	SAU	Saudi Arabia	0.53	5
36	12	NOR	Norway	0.53	6
37	13	VNM	Vietnam	0.52	4
38	14	AUS	Australia	0.49	6
39	15	MEX	Mexico	0.48	5
40	15	SGP	Singapore	0.48	4
41	16	CHE	Switzerland	0.46	6
42	17	RUS	Russia	0.44	6
43	17	VEN	Venezuela	0.44	4
44	18	GTM	Guatemala	0.43	5
45	18	PHL	Philippines	0.43	5
46	19	BRA	Brazil	0.42	6
47	20	ARG	Argentina	0.40	6
48	21	CAN	Canada	0.38	6
49	21	CHL	Chile	0.38	6
50	22	ISR	Israel	0.35	4
51	23	PER	Peru	0.33	3
52	23	TWN	Taiwan	0.33	5
53	24	ZAF	South Africa	0.32	6
54	25	JAM	Jamaica	0.28	5
55	26	LKA	Sri Lanka	0.27	5
56	26	TUR	Turkey	0.27	5
57	27	KEN	Kenya	0.26	6
58	27	USA	United States	0.26	6
59	28	BGD	Bangladesh	0.21	6
60	28	UKR	Ukraine	0.21	6
61	29	HKG	Hong Kong	0.12	5

Notes: Mean = 0.558; Standard Deviation = 0.196